Manual of Stereoscopic Cinematography

BY

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ILLUSTRATIONS BY

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FUNCTIONAL OPERATING INSTRUCTIONS

1. Criteria Required for Choice of Camera

StereoVision lenses were designed to f it the most common lens mount among modern professional cine cameras: BNCR. This mount which was originally designed by the Mitchell Camera Company is now standard on many cameras, and may be specified on several others. In some cases the BNCR mount design may be retro-fitted to a camera that is not so equipped originally, by a competent camera technician. In any case, the camera must have the BNCR mount for the StereoVision lens to be used on it. (Other mounts, such as Arriflex, PL, and Panavision are available on special order).

For all "above/be low" 3-D, it is absolutely imperative that the camera be equipped with a full aperture film gate aperture plate which will allow coverage of both top and bottom images on the film. Failure to do this will result in an image which is dissimilarly cropped in such a manner that 3-D is lost over most of the area of the picture, and the results will be unusable. The correct aperture plate will cover the entire image area (.735'' or nearly 3/4'' high). Such a plate is usually specified as either a "Full Scope" plate, or a "Full Silent Aperture" plate, with the "Full Silent Aperture" plate being preferable, due to the greater width as well as height. The "Full Silent Aperture" plate images into the sound track area (which is covered during release printing).

There are at least two major advantages to this: The picture may, if necessary, be shifted laterally during printing to change composition or cover action which may have moved out of the normal field. Certain post-operations, such as in special effects, may be implemented, utilizing this additional film area. In any case, apertures designated as "1.85:1" or "Academy Aperture" cannot under any circumstances be used. It is advisable to actually check this by measurement.

The camera should also be equipped with a StereoVision designed 3-D reticle ground glass in the viewfinder. This special reticle serves several important functions relating not only to composition, but also to the alignment of the 3-D image pair, and can even affect whether the final screen image will even be viewable in 3-D. See your StereoVision representative for information on obtaining these special viewfinder groundglass reticles.

Although not mandatory, a camera equipped for reflex view finding is extremely useful in most 3-D work for a multitude of reasons.

Other features can be very helpful, such as variable magnification of the viewfinder image, and in most cases, a video viewfinder. Where action is involved in the scenes, both "strobing" and alternate image flicker may be minimized through choice of a camera equipped with a horizontally travelling, rather than a vertically travelling shutter. A smooth camera movement is essential, with pin registration, though not essential, for general 3-D filming, being desirable and in cases involving special effects or multiple exposures being a necessity. This is due to the fact that any unsteadiness in the image will be more pronounced in 3-D.

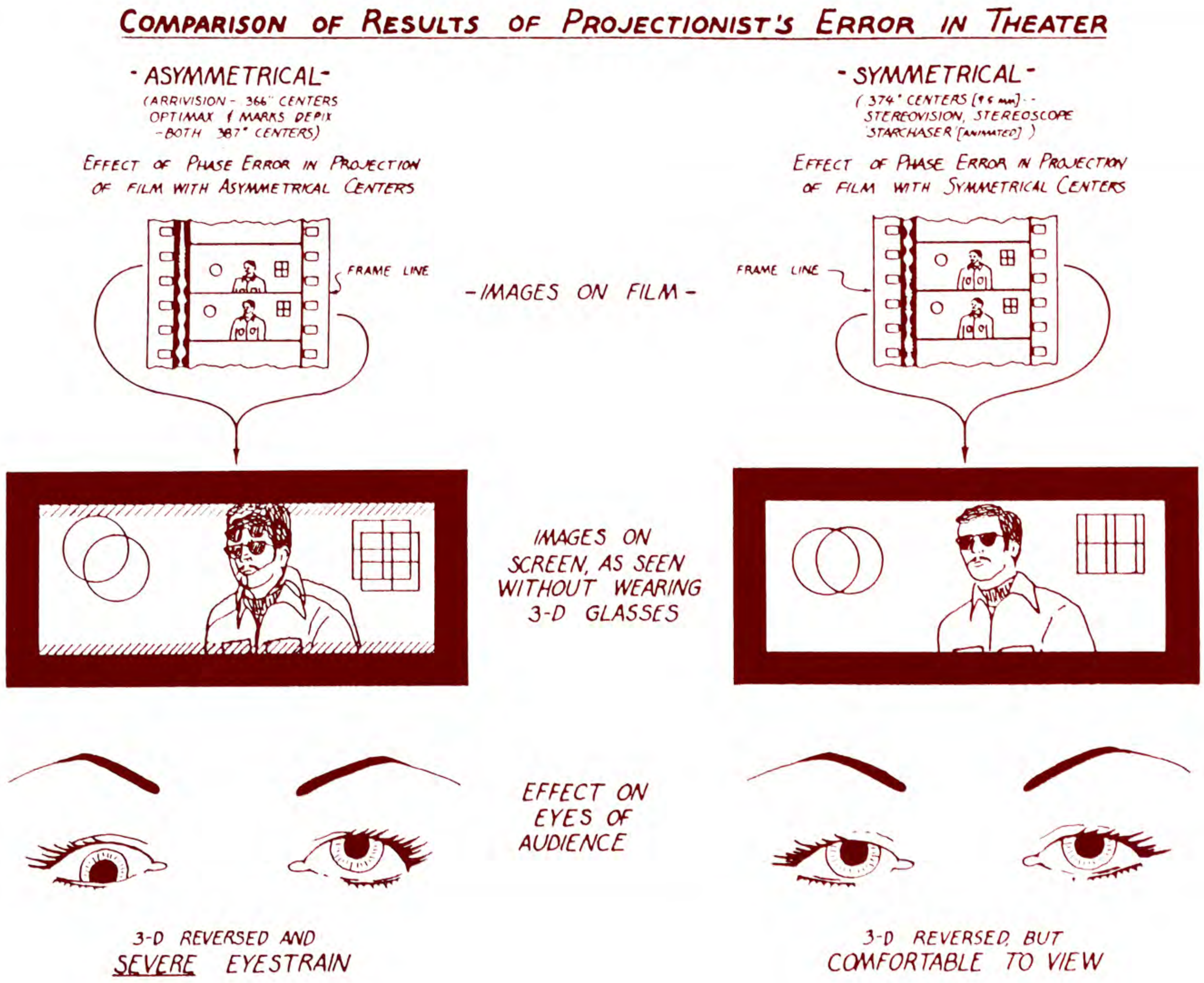
2. Installing of the 3-D Viewfinder Groundglass In Camera

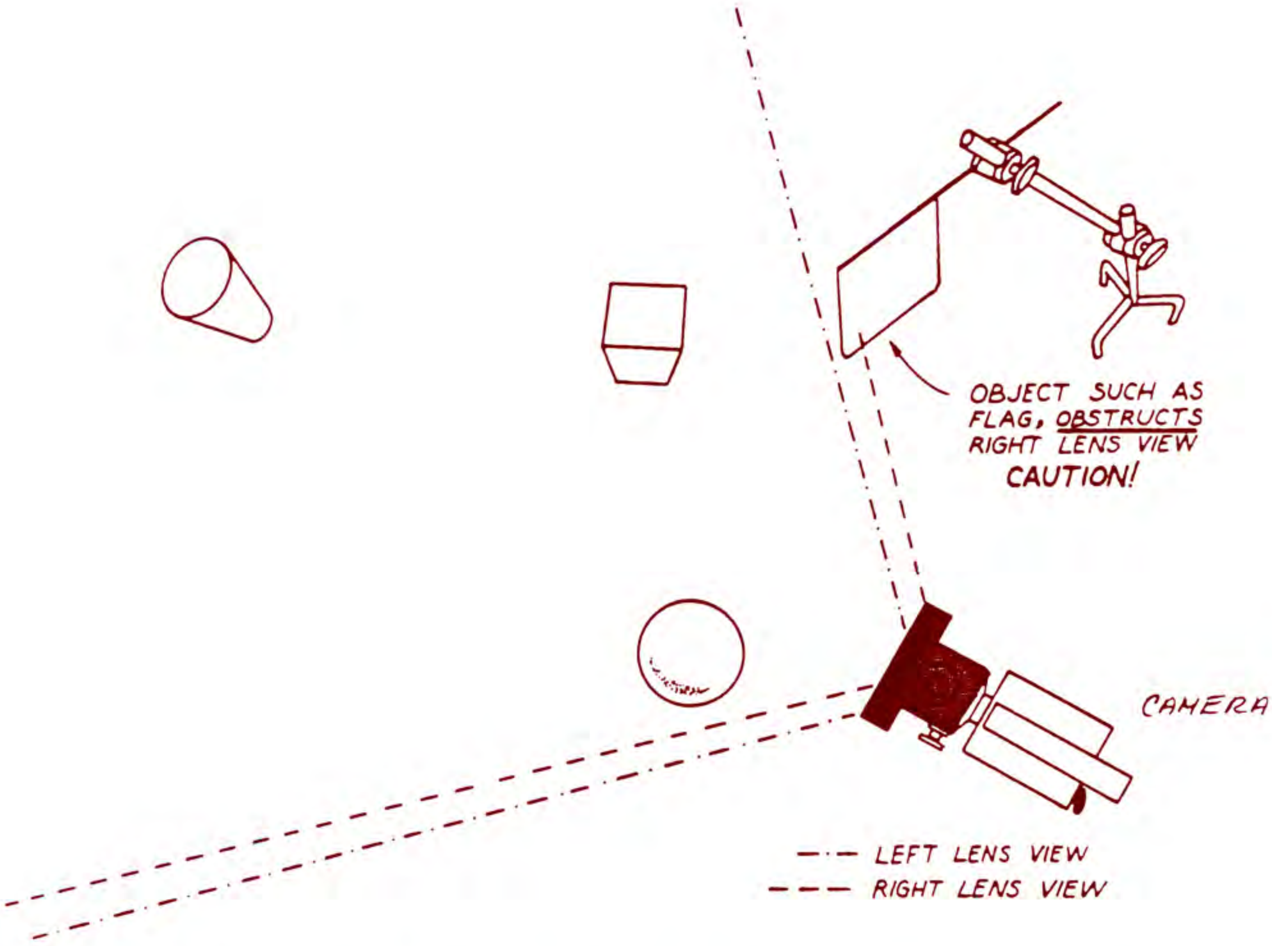
The groundglass in most cameras usually has some type of reticle pattern etched on to the ground surface. As the existing reticle usually bears little relation to the 3-D frame, it serves of little use. Certain indicators are necessary in order that a reference exists in the 3-D viewfinder for purposes of convergence, as well as focus and composition.

These indicators exist on the special reticle design which is etched on the ground surface of the special groundglass which is available through StereoVision. Several groundglass types to fit the more popular cameras are available from stock, others can be made to order.

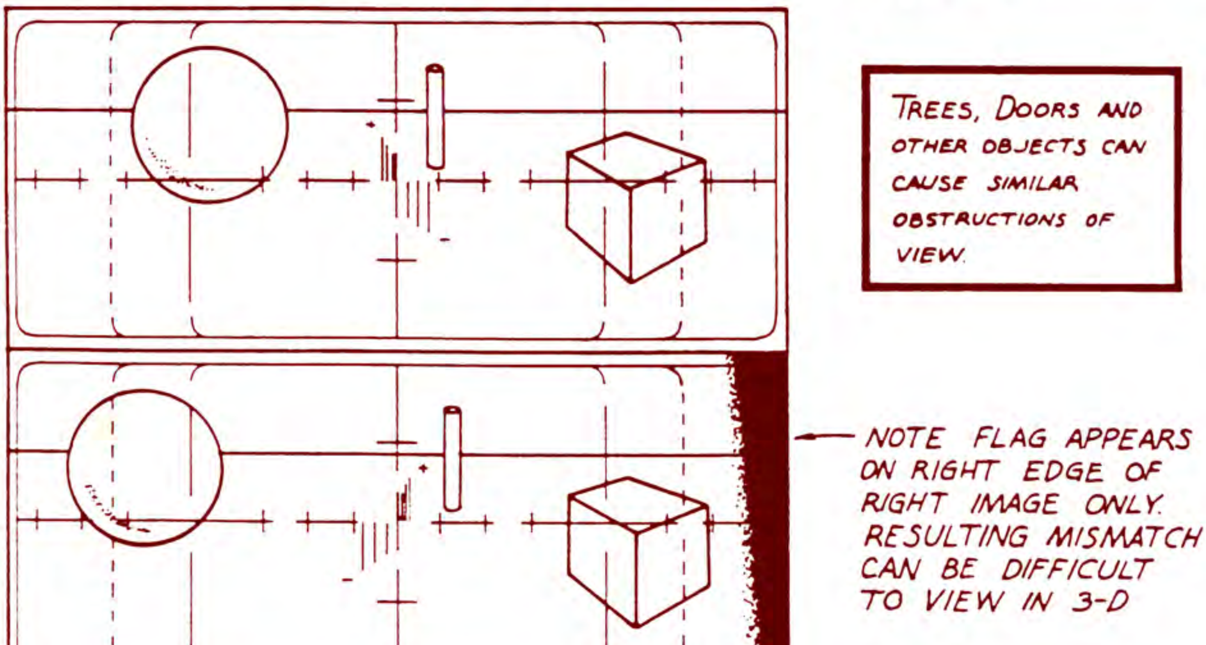
The groundglass in most cameras is removable and replaceable. In some cases this may be done in the field, in others the services of a camera technician are required. When a groundglass is to be replaced, it must be by one that has been manufactured to fit the specific make and model of camera. Care must be taken so that the ground surface be <u>facing the lens</u>, <u>not</u> facing the film.

Although most professional cameras have an accurate and positive seating method for the groundglass, it is vital that this be checked carefully. The orientation of the reticle is predetermined by the location of register elements in the specific camera in most instances. Since viewfinder designs vary as to whether the viewfinder optical system inverts


COMPARISON OF RESULTS OF PROJECTIONIST'S ERROR IN THEATER
- ASYMMETRICAL -
(ARRIVISION - .366" CENTERS
OPTIMAX & MARKS DEPIX
- BOTH .387" CENTERS)
EFFECT OF PHASE ERROR IN PROJECTION
OF FILM WITH ASYMMETRICAL CENTERS
FRAME LINE
- SYMMETRICAL -
(.374" CENTERS [9.5 mm] -
STEREOVISION, STEREOSCOPE
STARCHASER [ANIMATED])
EFFECT OF PHASE ERROR IN PROJECTION
OF FILM WITH SYMMETRICAL CENTERS
FRAME LINE
- IMAGES ON FILM -
IMAGES ON
SCREEN, AS SEEN
WITHOUT WEARING
3-D GLASSES
EFFECT ON
EYES OF
AUDIENCE
3-D REVERSED AND
SEVERE EYESTRAIN
3-D REVERSED, BUT
COMFORTABLE TO VIEW



BEFORE FILMING- EXAMINE BOTH IMAGES, ESPECIALLY THE LEFT AND RIGHT EDGES, FOR OBSTRUCTION AND MISMATCHES



VIEW THROUGH GROUND GLASS OF CAMERA

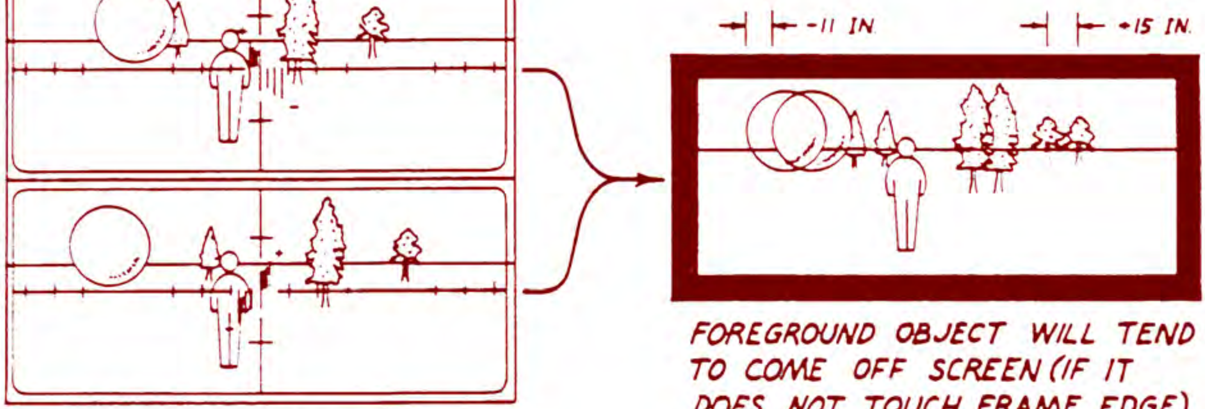
Stereoscopic Depth Range (distant background)

-SCENE PLAN-

-CAMERA IMAGE-

-PROJECTED IMAGE-
AS SEEN WITHOUT WEARING 3-D GLASSES

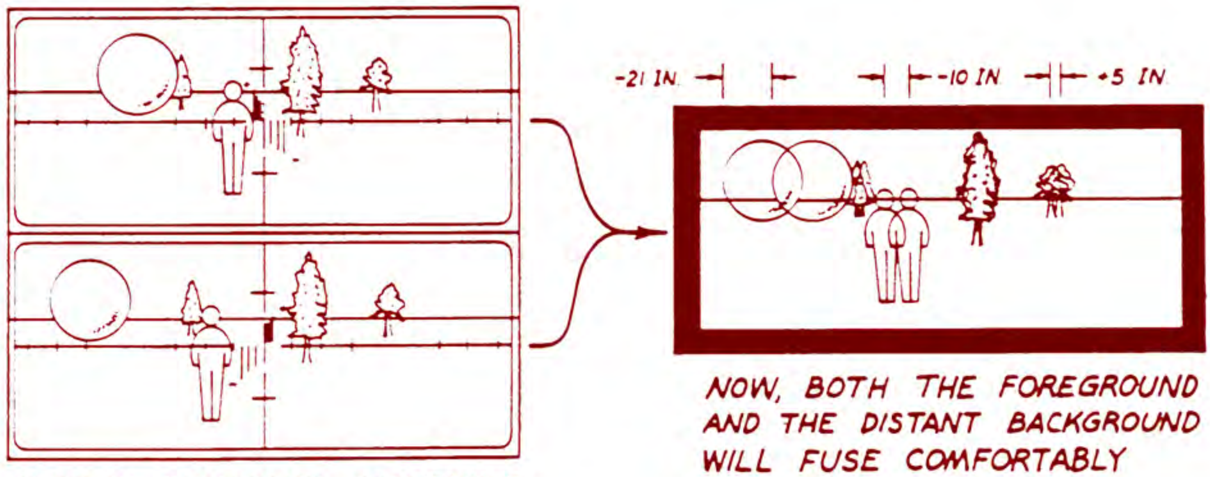
A



SHOT IN VIEWFINDER, CONVERGED ON MAIN SUBJECT

FOREGROUND OBJECT WILL TEND TO COME OFF SCREEN (IF IT DOES NOT TOUCH FRAME EDGE) BUT DISTANT BACKGROUND MAY "SPLIT" APART UPON PROJECTION.

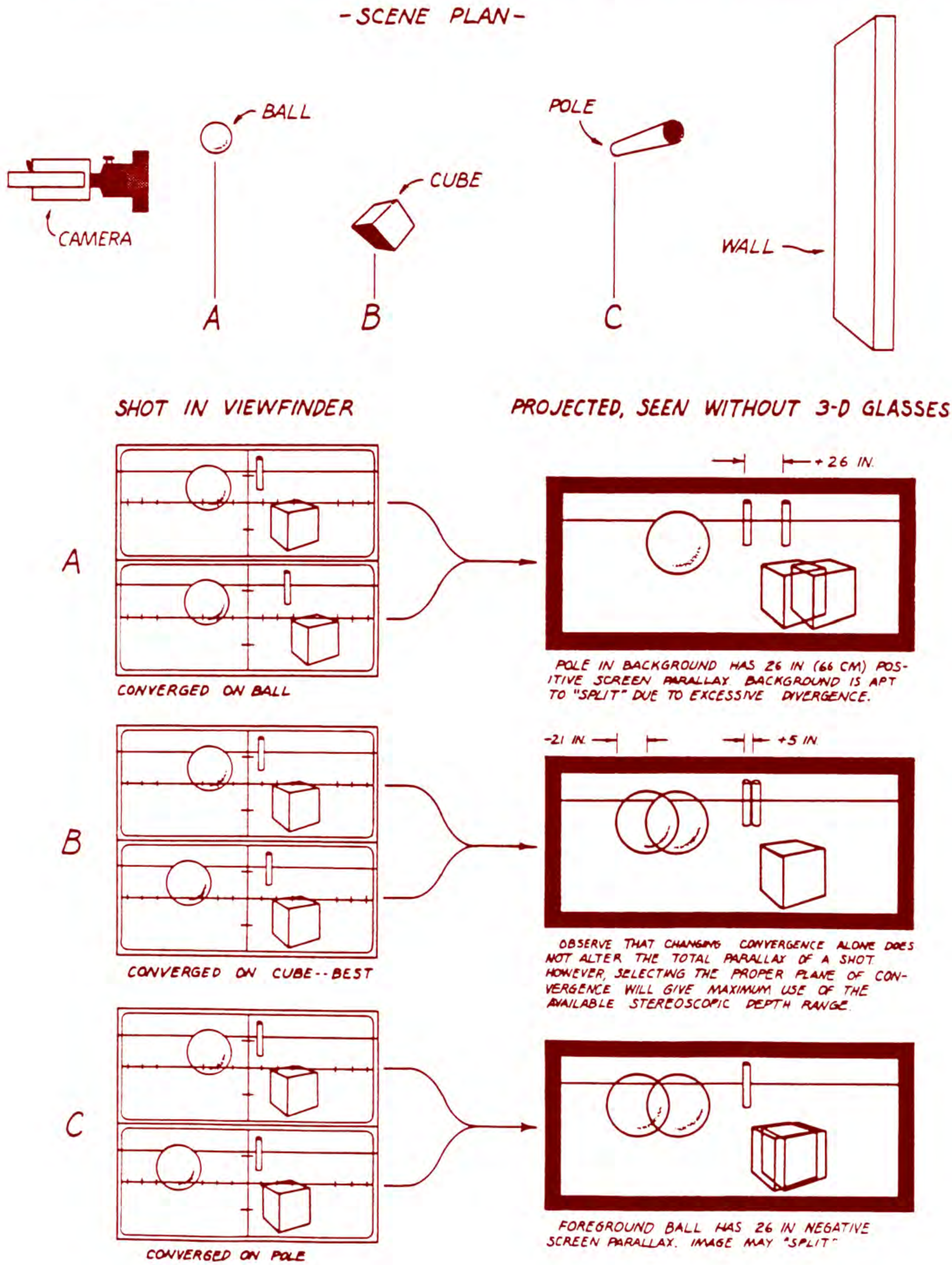
B



SHOT IN VIEWFINDER; CONVERGING BEHIND THE MAIN SUBJECT WILL REDISTRIBUTE THE PARALLAX OVER THE USEABLE RANGE.

NOW, BOTH THE FOREGROUND AND THE DISTANT BACKGROUND WILL FUSE COMFORTABLY WHEN PROJECTED.

Stereoscopic Depth Range (restricted background)

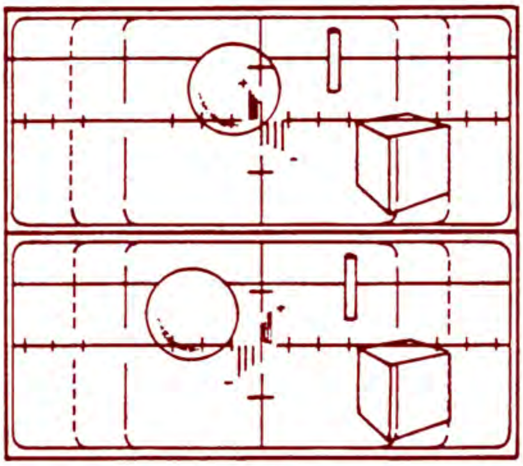


CHECKING SCREEN PARALLAX WITH THE STEREOVISION™ RETICLE

SEE ILLUSTRATION ON PAGE 2A FOR RETICLE DETAILS

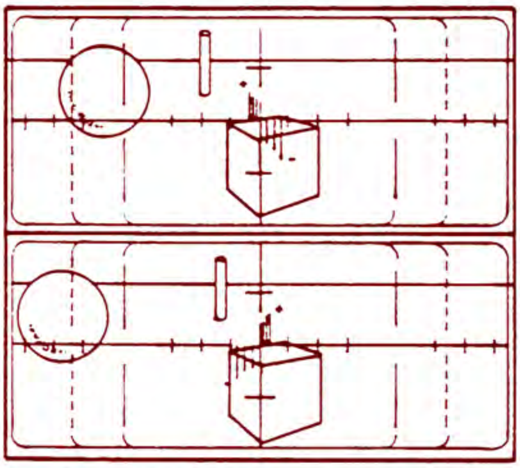
THE VIEW ON THE GROUND GLASS IS RECOMPOSED TO ALIGN DIFFERENT OBJECTS WITH THE PARALLAX CALIBRATIONS OF THE RETICLE. IN THE EXAMPLES ON THIS PAGE, THE SHOT IS CONVERGED ON THE CUBE. THE CONVERGENCE REMAINS CONSTANT

THE BALL REPRESENTS AN OBJECT CLOSE TO THE CAMERA



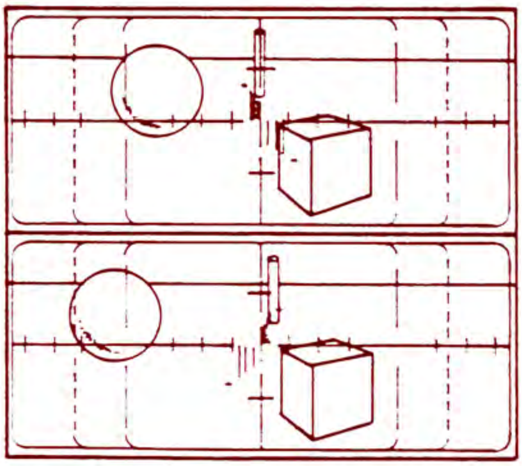
IN THIS EXAMPLE, THERE IS -21" SCREEN PARALLAX FOR THE BALL. THE BALL WILL TEND TO FLOAT OFF THE SCREEN, IF IT DOES NOT TOUCH THE FRAME EDGE AND IS REINFORCED BY OTHER DEPTH CUES SUCH AS DISTANT BACKGROUND DETAIL, INTERMEDIATE OBJECTS, ETC. (SEE TEXT)

THE CUBE REPRESENTS AN OBJECT AT A MEDIUM DISTANCE FROM THE CAMERA



THERE IS ZERO PARALLAX FOR THE CUBE. IT WILL APPEAR AT THE SCREEN PLANE.

THE POLE REPRESENTS A DISTANT OBJECT

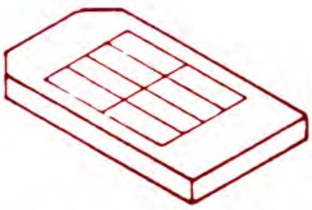


THE POLE HAS +6" SCREEN PARALLAX. IT WILL APPEAR BEHIND THE SCREEN PLANE.

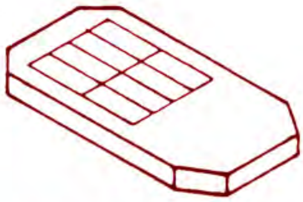
METRIC EQUIVALENTS

21 INCHES = 53.3 CM
14 INCHES = 35.6 CM
7 INCHES = 17.8 CM
3 INCHES = 7.6 CM
6 INCHES = 15.2 CM
9 INCHES = 22.9 CM

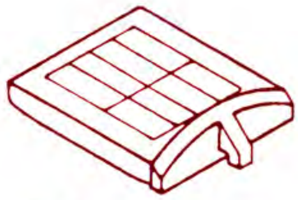
VIEWFINDER GROUND GLASSES



MITCHELL BNC, BNCR
NC, GC, ETC.

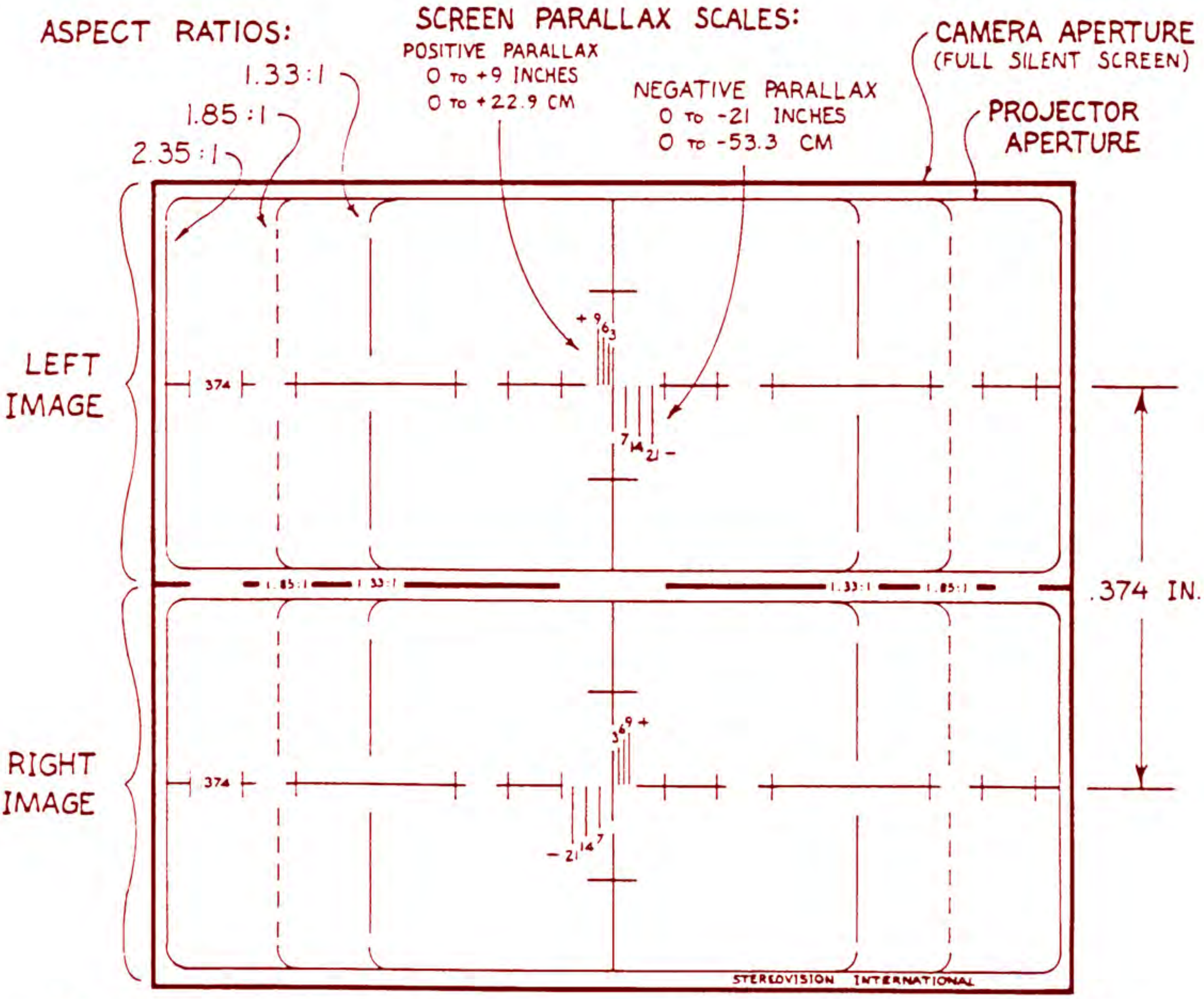


MITCHELL MARK II
& MARK III



ARRIFLEX IIC
(ARRI 35 BL
ALSO AVAILABLE)

GROUND GLASSES FOR OTHER 35MM CAMERAS AVAILABLE ON SPECIAL ORDER



STEREOVISION™ CAMERA GROUND GLASS RETICLE (GRATICULE) or reverts the image, an orientation that is applicable to all cameras does not exist. However, a simple method for checking the orientation is to temporarily put the groundglass in position and check the image of the reticle in the viewfinder. The procedure is as follows:

The camera door is opened and a groundglass, such as the one removed from the viewfinder, is placed in the film plane over the aperture. With any lens on the camera, place objects or targets such as that there are images in each of the four corners of the targets. Then, close the door (it may be necessary to remove the groundglass to do this), and look through the viewfinder. If the new groundglass is installed correctly, the four images will appear in exactly the same positions in the viewfinder frame as they did in the camera gate.

3. Unpacking and Checking Contents of Lens Case

StereoVision lenses are packed in special cases which are lined with plastic foam. When these are shipped by a common carrier, these cases should be further packaged in corrugated cardboard cartons. Before opening the outer carton, check it for external damage, which should be reported immediately to StereoVision and the shipper.

When opening the actual lens case for the first time, observe the location and position of the lens and other items, so that they may be returned to the same configuration after use.

Remove the lens carefully, taking care not to touch any exposed optical surfaces. The lens should always be in the case at all times when it is not actually mounted on a camera and the rear portion covered with the lens cap supplied.

4. Installing of Lens On Camera.

Installation of a StereoVision lens on the BNCR or “PL” mount equipped camera is a very simple operation, but requires care to insure that the lens is exactly level. If it is not exactly level to the camera, the 3-D picture pair will not match, and the results may not be usable.

If all BNCR mounts were identical, this would not be a problem, since the lens could then be indexed to the locating pin in the mount. Unfortunately, BNCR mounts are manufactured by several different companies and individuals, and they do not always match each other. With flat lenses, a slight rotation does not make much difference as long as the lens seats properly. With 3-D, however, rotational position is crucial.

Therefore, the StereoVision lens has been designed to allow for rotational adjustment when it is installed on the camera, so that it can be levelled to the camera as the seating ring is turned to seat the lens in the mount.

In conventional flat cinematography, it is normal procedure during setup to first level the tripod or other camera support, and then level the camera when it is mounted on the support. For this purpose, most professional cameras and supports are equipped with built-in levels, or have flat horizontal surfaces on which the camera assistant can place a pocket bubble level.

This same procedure is followed before mounting the StereoVision lens to the camera. Then the StereoVision lens is mounted in this manner :

First, following normal good practice procedure, make certain that the aperture plate and all seating surfaces on both the camera and the lens are clean and free of dust or other foreign matter. Check that the exposed rear lens elements are clean.

As the camera is approached with the lens, be very careful not to strike the rear elements on any protruding parts on the camera. It is particularly important to be aware of the tabs extending from the seating ring on the BNCR mount on the camera.

Gently draw the lens in to the mount, do not force. If any resistance is felt, check that the pin on the camera mount lines up with the slot on the back of the lens, and that the seating ring is turned to the open, or receiving position (usually rotated nearly all the way to the left when facing the front of the camera).

Holding the lens firmly to the seat, turn the seating ring to the right far enough to insure that it is secure, but do not completely tighten. As a precaution, be sure to keep holding the lens with one hand until this operation is completed.

Observe the level on top of the StereoVision lens. Rotate the lens in the mount until it is exactly level. Now draw it tightly to the seat by turning the seating ring to the right (clockwise). Make sure that it is tight enough so that the lens cannot rotate, but do not over tighten. The same amount of seating pressure is applied as when installing any conventional flat lens.

Re-check the level to make certain that the lens has not rotated during the seating operation. If it has, loosen the ring slightly and repeat the operation. As an extra precaution, the camera assistant will double check that the lens is level by re-checking the camera level, and sighting along the bottom front edge of the StereoVision lens back to the top front edge of the tripod plate, or the bottom front edge of the camera. These should be exactly parallel when viewed straight back from the front of the camera.

Check the front of the lens, examining the exposed front glass plate to insure that it is clean, and that there are no obstructions in the light path in front of it.

5. Installation of T/Stop Slides

Because of design considerations, StereoVision lenses are equipped with a set of precision fixed apertures, instead of the adjustable iris diaphragms commonly used in non-3-D camera lenses.

Sometimes known as “waterhouse stops” a more descriptive term in this application is “T/stop Slide”. This is because the precision apertures in these slides are actually measured as to actual light transmission which they will allow when properly installed in the StereoVision lens. As with most professional cine lenses, the T/stop is similar to, but slightly less than, the corresponding F/stop in terms of light transmission. Since the various factors which affect light transmission through a lens are taken into account, light meter readings will be more accurate for T/stopped lenses than for the more common F/stopped lenses. One advantage of this type of aperture control is that EK gel filters can easily be fitted into each “T” slide.

The StereoVision T/stop Slides are stored in a convenient flat pouch, which is lined with divided individual holders for each of the slides. Several assistant cameramen have found it con-convenient to carry this pouch in their "ditty bag" for easy access during rapid or frequent changes of camera position or location.

It is very important to note that these slides are individually calibrated to each lens, and therefore the slides for one lens should not be used in another lens. If the pouch is carried some place other than the lens case, it is a good policy to return it to the lens case whenever the lens is changed, to avoid the possibility of getting the slides for one lens mixed up with the slides for another.

Keeping the slides in numerical order (according to T/stop} when stored in the pouch will facilitate convenient rapid access, and minimize the possibility of getting the wrong slide during conditions when the lighting level is changing frequently.

When the slide is removed from the pouch, it should be examined to make certain that it is clean and not bent, creased, or otherwise damaged. If the pouch is carried in a pocket, great care should be taken that the pouch is not bent, as this will damage the slides contained inside.

The slide is inserted in the slot near the rear of the lens, making certain that it is seated all the way. The slide is oriented such that the tab faces the front. It should go into the slot smoothly and easily; never force the slide. A slight resistance is normal, due to the spring action of a very slight bend in the metal which has been applied at the factory to facilitate gel filter installation and to prevent the slide from falling out of the slot. It will be found that insertion is easiest if care is taken to line the slide up square with the slot before it is installed.

Removal is the reverse operation, again pulling the slide out very straightly will facilitate easier removal. Do not use pliers or other instruments to remove the slide.

Should any difficulty be experienced during installation of the slide, check that it is not damaged, that it indeed is the correct slide for the specific lens, that the corner of a filter is not sticking out or that a piece of filter inside is not bunching up, that there is no adhesive tape, or even adhesive on the slide, and that the slide is not wedging due to not being inserted straight.

6. Installation of Filters

The T/stop slides also serve the dual function of serving as gelatin filter holders. Although any Kodak Wratten* gelatin filters may be inserted in the slides, the most common are the #85 (for color correction to balance tungsten balanced films to daylight) and the #85N series for simultaneous light reduction when operating under extremely high light level conditions. **NOTE:** Many cinematographers no longer use the #85 daylight correction filter. This increases light transmission by 33%.

The gelatin filter is cut to size such that it is slightly narrower than the total width of the slide, and nearly as long. Although several filters may be cut to size simultaneously, never attempt to put more than one filter at a time in the slide. To do so could damage both the slide and the lens.

The filter is inserted between the two metal leaves of the slide, making certain that the aperture hole(s) is completely covered, and that no part of the filter extends beyond the edges of the slide leaves. If the filter should protrude from between the leaves of the slide, it will catch on the edges of the slot in the lens. Any such protrusion should be cut off with a razor blade.

The very end of the filter (next to the tab on the outside end of the slide) may be secured to the slide with a very thin adhesive tape if this is done very carefully, such that the tape is close enough to the end such that it will not cause the slide leaves to spread and wedge when the slide is inserted in the slot. When the adhesive tape is removed, any remaining adhesive should be removed with solvent.

Before using color correction filters on a production, it is suggested that tests be run and processed and printed at the same laboratory that will be doing the production work, as some labs can produce equal or better results when no filter at all is used.

Reconsider carefully the need for a neutral density filter. Usually it will be preferable to use a smaller stop instead, for this will give a greater depth of field, so very beneficial to 3-D. The one major exception is that of extremely high light levels with lenses of 20mm focal length or shorter, where stops smaller than T/22 may degrade the image due to diffraction.

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*"Kodak" and "Wratten" are registered trademarks of the Eastman Kodak Company.

Immediately replace any filter that is damaged, dirty, scratched, fingerprinted, etc. Any such defects are much more critical in 3-D, since they tend to affect the two images somewhat differently, causing a much more noticeable image degradation.

Should it become difficult to insert a slide into the slot when the filter is in place, check that the filter isn't too long. It only has to be long enough to reach just past the aperture holes, so that it completely covers these holes. If it extends much further into the slide, it will force the leaves apart and cause the slide to wedge.

Filters which are old should be checked very carefully. Even if they do not have any physical defects and are clean, they can become brittle and crack under conditions of low temperature or low humidity.

7. Operations of the Focus Control

Focusing is accomplished by turning the knob on the top of the StereoVision lens. The general operation of focusing is similar to that of most flat lenses, however this can tend to be somewhat misleading, as the visual effect which results can be <u>quite different.</u>

IMPORTANT!

With conventional flat photography, a narrow depth of field is often used to separate different planes in the picture. In 3-D this is not necessary, since the planes are automatically separated by the stereoscopic relief. While a narrow depth of field in a flat film can be advantageous in that it tends to direct attention to the key element and tie the picture together, the effect in a 3-D film is exactly the opposite. A fuzzy foreground or background in 3-D will distract the eye from the key element and break the image up into an artificial representation which has no counter- part in real life. The result can be unpleasant, distracting and annoying.

Therefore, instead of focusing on a key element with a wide aperture, in 3-D the best results are achieved by stopping down as far as practical, and choosing a focus distance such that the depth of field at the aperture selected will keep as much of the picture as sharp as possible from the closest to the farthest elements of the picture.

TALKING TECHNICALLY

By DAVID W. SAMUELSON

TO 85B OR NOT TO 85B

I don't do a lot of filming these days but what I do I choose carefully. Last year I was in St. Paul's Cathedral for the wedding of Prince Charles and Princess Di, this year I went to Madrid for the final of the World cup soccer event. On both occasions I enjoyed the occasion as much as I enjoyed using a camera in anger again.

I was involved filming only the final in Madrid, joining the large crew that had already been filming the preliminary matches over a period of several weeks. With a delicious mixture of Spanish and English and with a touch of humor the 'film will be called "G'OLE!" THE OFFICIAL FILM OF THE XII WORLD CUP, SPAIN '82.

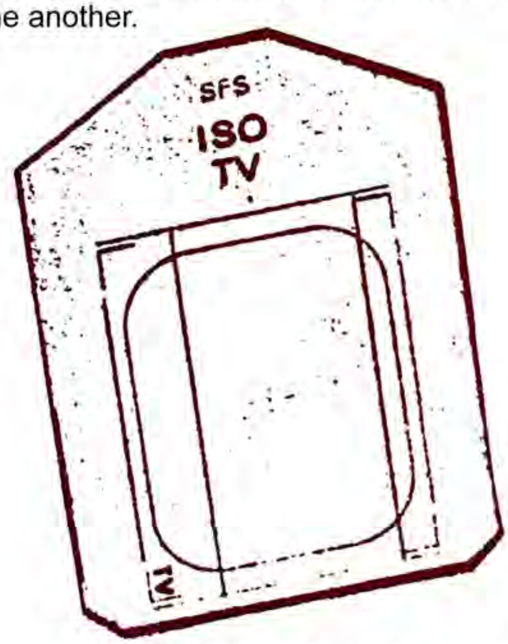
As usual, it seems, when I film this type of sporting event these days, I am given a 1OOOmm lens with the brief to pick up interesting snippets of the play, the players, the trainers and the crowd a brief which suits me fine because among all the regular footage that finds its way into the final film there are always those moments which can be captured on a film camera not dedicated to following the play and then edited in with hindsight that TV, with its instantaneous coverage would not dare to cut away to for fear of missing a goal being scored, or whatever.
It 's what lifts the film out of the TV routine.

Harvey Harrison, BSC, was the overall director of photography and among his instructions to me were not to use an 85 filter.

When I asked if this was because the match started in daylight and continued in artificial light, he said, 'No, it was because he preferred the look that way' and went on to say that these days quite a number of DP's do not use an 85 filter in order to achieve a certain look.

He cited in particular Alex Thompson, BSC, who won an Academy Award nomination for best cinematography for EXCALIBUR last year, which was also shot without an 85.

I later talked to Alex about this (incidentally he has been president of the BSC for the past two years) and he says he finds that 5247 these days seems to be more balanced for daylight than for artificial light. On EXCALIBUR, and on EUREKA which he has recently completed, he was regularly getting printer lights on exteriors without an 85 of 29-30-31 which is more even than he gets on interiors and much more even than he gets on exteriors with a daylight conversion filter. In the latter case he says the printer lights sometimes seem to bear no relation to one another.

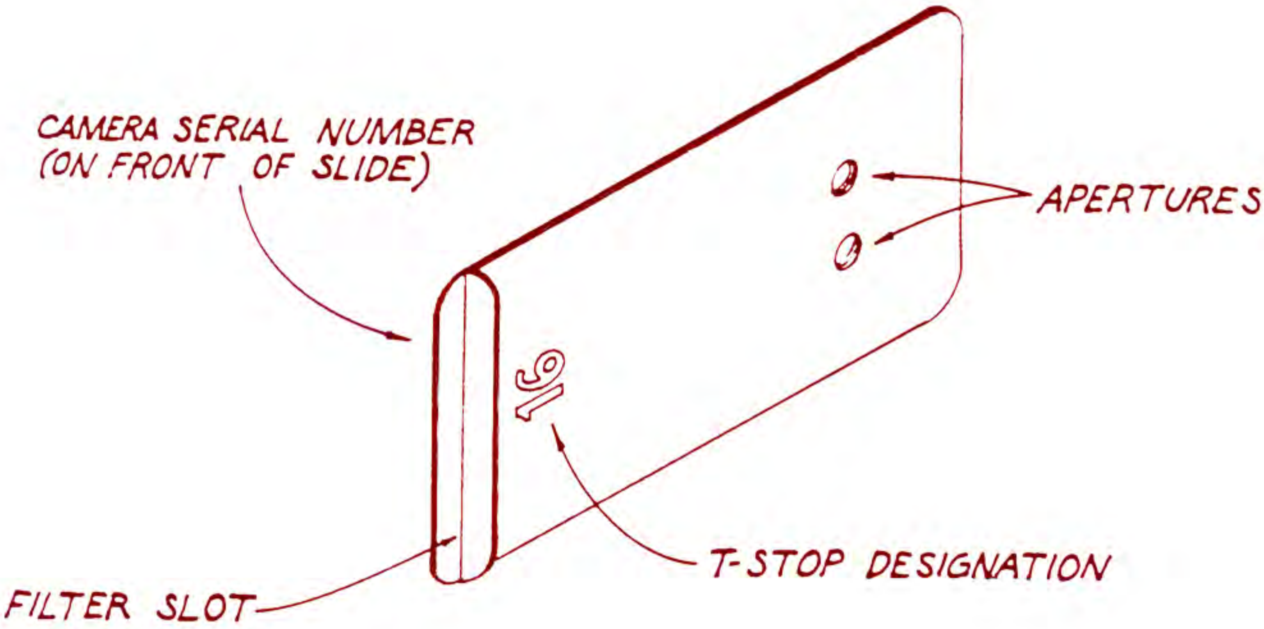


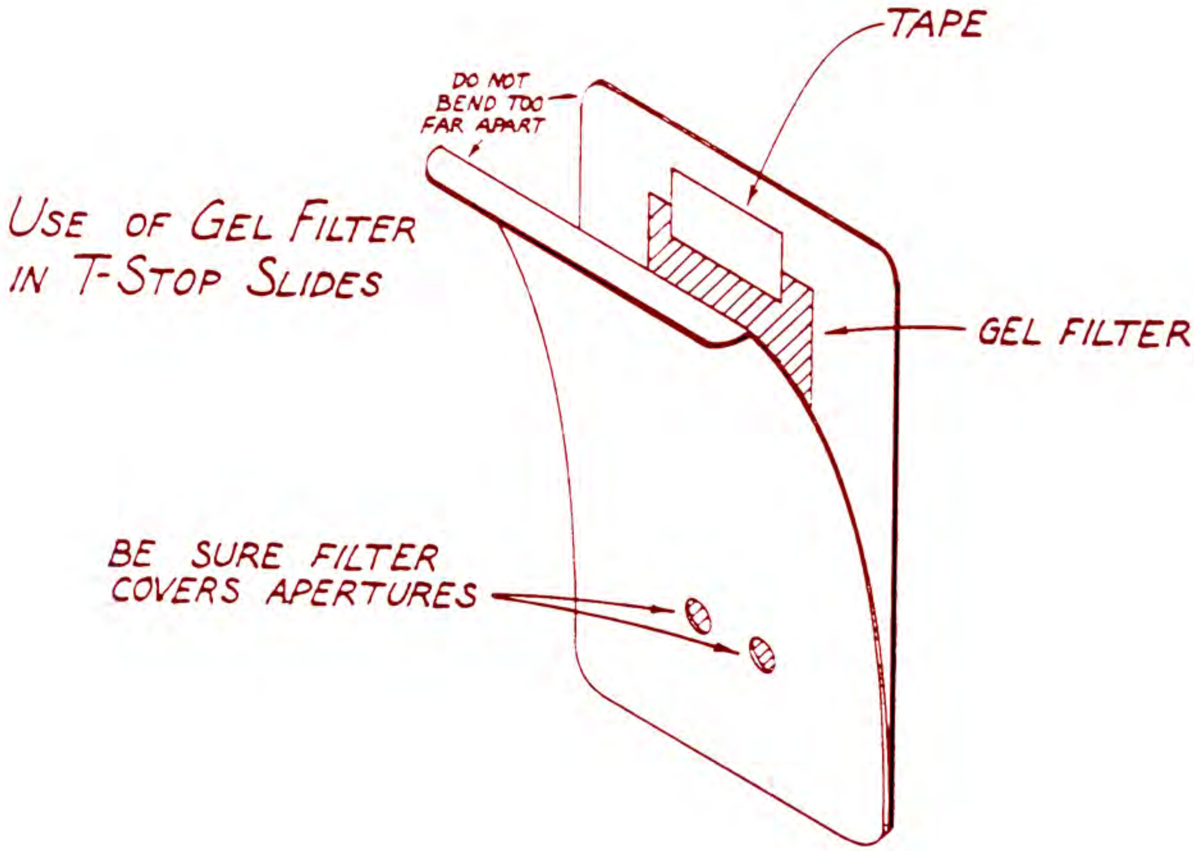
TV ground glass marked for 2.35:1 optically printed anamorphic with common head room with 1.85:1 widescreen.

Other advantages he says are the extra film speed when shooting at 100 ASA instead of 64 and, more importantly, flesh tones are creamy and therefore more flattering. Finally, he finds that when the film is printed for release there are less color corrections to be made and that too he prefers.

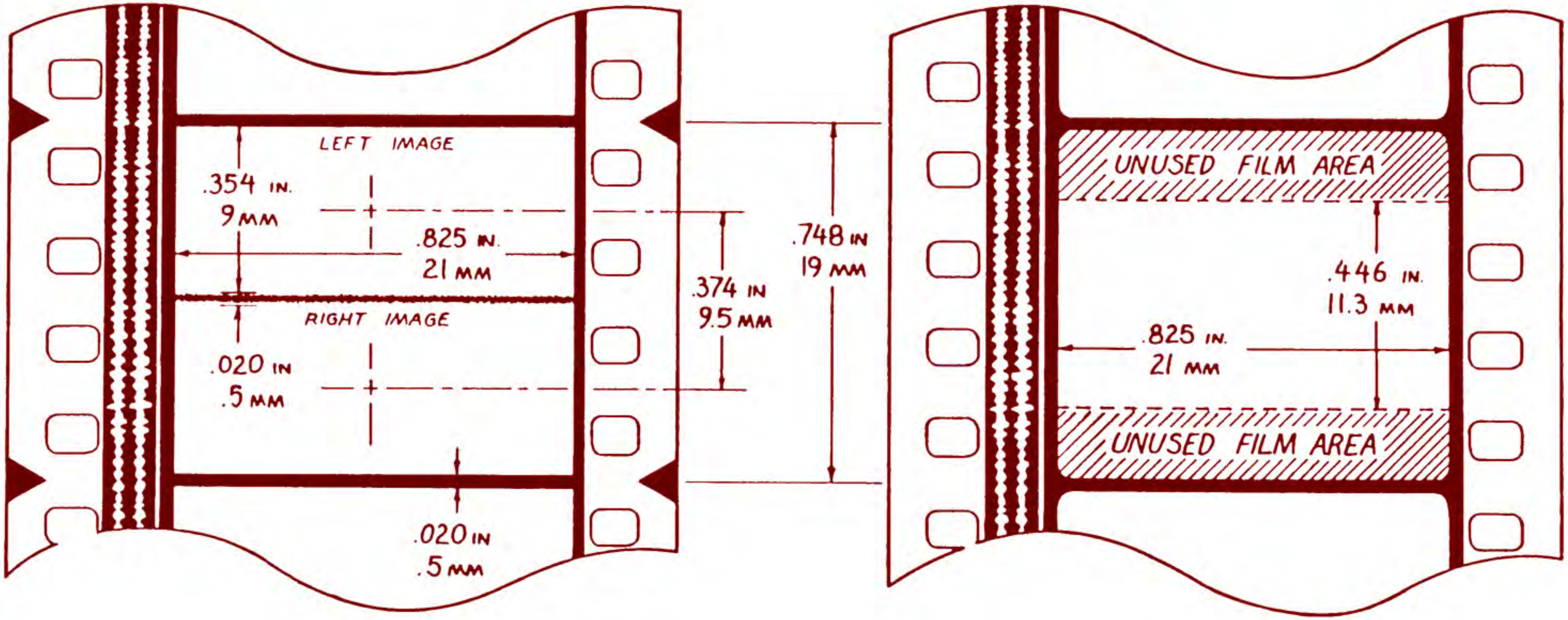
Phoning and asking around I find that most cameramen, both young and old still are 85 users but it seems that everyone has their own way about being creative.

T-STOP SLIDES





Comparison of Frame Sizes



STEREOVISION™ 35MM SYMMETRICAL ABOVE/BELOW 3-D FORMAT (2.35:1)

35MM FLAT WIDESCREEN (1.85:1)

IMPORTANT!

Since elements at this location of optimum focus may not necessarily be easy to focus on, or in some cases there may not even by anything at all at this location, the stereovision star focus target should always be used to bracket both the closest important subject and the farthest. The use of this target will be described in Section 9.

The procedure of using depth of field range for focusing instead of one plane or element might imply that focusing is not critical. Actually, it is just as critical, perhaps more so. A very slight error in judging field depth or in the focus operation itself can result in a very large portion of either the foreground or background being unsharp, which produces very unacceptable results. THIS IS ANOTHER REASON WHY CONSISTENT USE OF THE STAR TARGET IS NECESSARY. Always check focus with this star chart at or near the working aperture!

8. Operation of the Convergence Control

Convergence is accomplished by turning the knob on the left side of the StereoVision lens, as seen from the operator position.

The convergence point may or may not be at the same place as the focus point. There are several factors, which determine this, and they will be discussed later in the usage part of this manual.

The function of adjusting convergence is to select the plane at which the two images make up the 3-D picture will coincide. This plane will later become the plane of the screen upon which the picture will be projected. Whenever it is possible, the key subject or element in the composition should be at or very near this plane of convergence. However, as with depth of field, the depth of convergence range must be considered as well. Incorrect control of convergence range is the most common error in 3-D cinematography. Methods and procedures for controlling convergence correctly will be discussed in Section 9 and in other parts of this manual (convergence is related in varying degrees to most of the other factors to be discussed).

Also, as with focus, the result of adjusting the convergence control is observed on the groundglass in the viewfinder. Since both images of the 3-D pair are seen simultaneously on the groundglass, any subject in the scene which appears exactly lined up vertically (a line drawn between the same points on both images would be perfectly vertical), will be in the plane of convergence (the screen plane) when the picture is projected. This is the main function of the vertical lines on the 3-D groundglass.

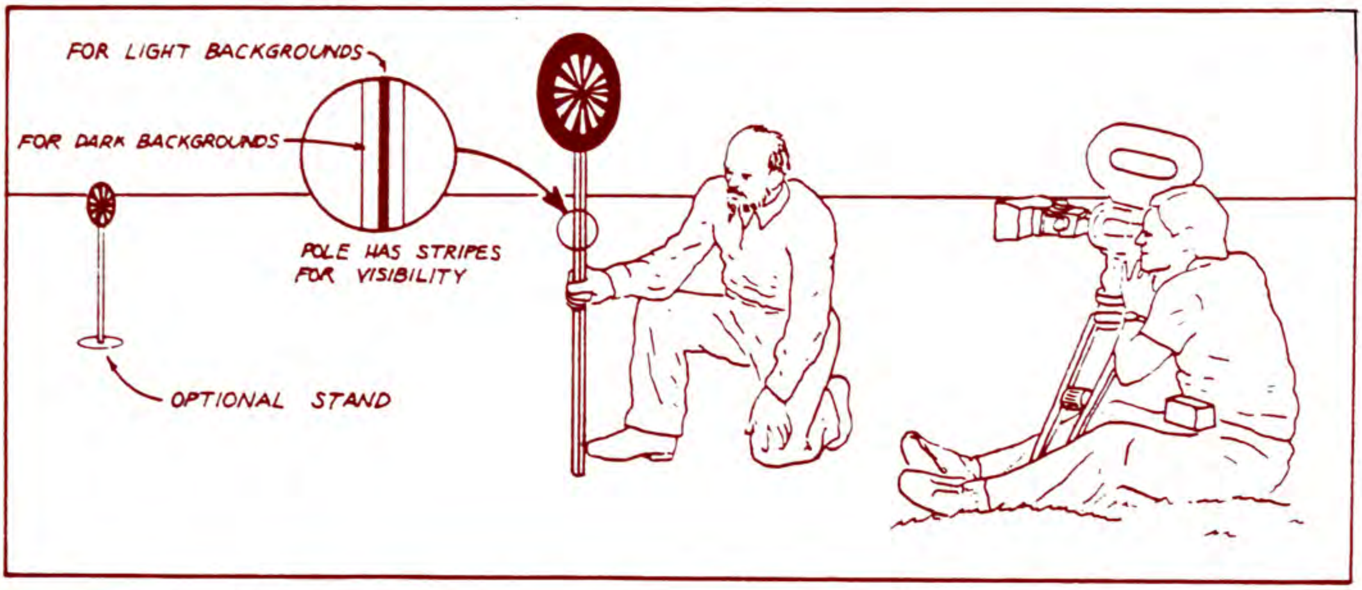
9. Setting Up of the Reference Pole and Star Target

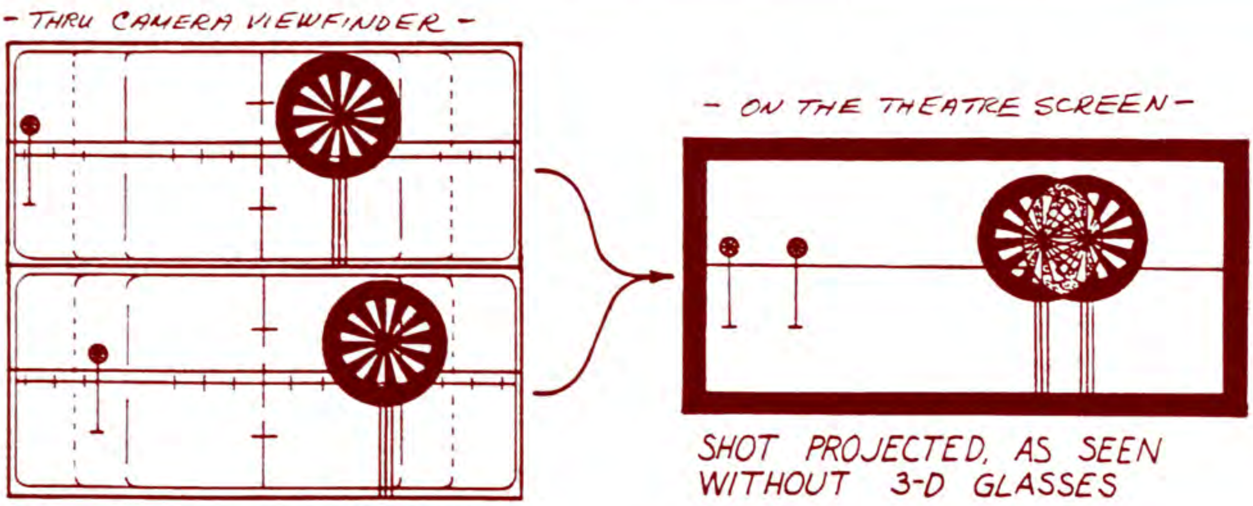
As pointed out in other parts of this manual, the reference pole and the star target serve two very important functions, and are convenient for other purposes as well. The importance of these two major functions cannot be over-emphasized, as the misuse or lack of use, of these simple aids have probably been responsible for more errors in 3-D imaging than any other single cause.

It may sometimes be assumed that under the pressures of a tight production schedule, the use of these procedures and targets will cost valuable production time. Indeed, if the use is approached without organization or pre-planning, this most likely will be the case. However, with the proper approach, it is quite possible that not only will it take no more time, but actually less time for the two reasons: both registration and convergence can be done more rapidly with the references provided, and the reduction of possible errors will minimize the necessity for retakes, which are costly and time consuming.

In a typical production situation, a certain amount of time is required from the set-up of a camera to actual film rolling for normal operations and procedures, such as lighting, practice run-throughs for the actors, directorial instructions, etc. It is during this time that, with the procedure established, focus and convergence may usually be completed. With a minimal training, and cooperation between the camera operator (s) and the 3-D consultant, this operation takes very little time, so that when the director is ready to shoot, all settings on the camera will already have been completed, and the camera will be ready to roll <u>just as quickly</u> as it would have been had the film been an ordinary flat one!

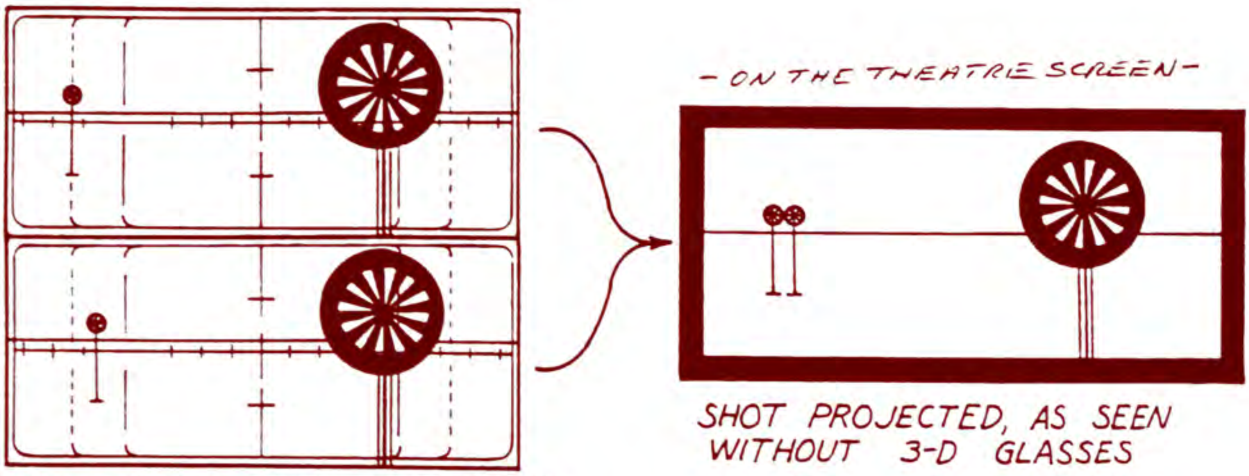
USING THE FOCUS STAR AND CONVERGENCE POLE





SHOT AS SEEN IN VIEWFINDER, PRIOR TO ADJUSTING CONVERGENCE.

SHOT PROJECTED, AS SEEN WITHOUT 3-D GLASSES



FOREGROUND POLE CONVERGED IN VIEWFINDER

SHOT PROJECTED, AS SEEN WITHOUT 3-D GLASSES

Although the reference pole and the star target are two separate tools with two different functions, it has usually been found most convenient to mount the star target on the reference pole, using the pole as a support for the target. Also, although a single pole with target may be moved back and forth, time may often be saved if two poles with targets are employed. Since it has been found that when short focal length lenses are used at normal or long distances, a double size star target makes for more accurate and easier focusing, it is also desirable that one or both of the two star targets be of this larger size.

It might seem that focus with short focal length lenses would be less critical than with long focal length lenses, due to the apparently greater depth of field. Actually, the reverse is true! In 3-D, instead of being concerned only with the sharp focus of a single subject or image plane, it is usually necessary to consider everything in the field of view, and try to get as much as possible in focus for maximum depth range and viewability. As such, a focus point must be chosen such that the widest possible range of objects in the scene are sharp. With the wide angle lens, the greater field depth advantages can be easily be lost, as an extremely small error in focus can change either the near or the far range of what will be acceptably sharp imaging by several feet, in some cases several yards. Also, since all objects as seen on the groundglass in the viewfinder will appear much smaller with the shorter focal length lenses, the focusing operation must be done much more carefully. Be extremely careful that the focus of the camera eyepiece (occular) is set for maximum groundglass sharpness.

Since accurate convergence requires a sharp image to work with, the focusing operation should be carried out first. Whenever possible, the targets should be used on the set itself in the actual scene area, as this both minimizes the possibility for errors and speeds up the operation. However, it is recognized that there are situations where this is not practical. Examples include aerial photography, shooting over bodies of water, and specially dressed sets where the ground or floor cannot be footprinted or otherwise disturbed prior to filming. In these cases, the procedure is to pre-focus and pre-converge with the targets in a position where they can be conveniently set up, then fastened in place. As with conventional flat photography, the use of measuring tapes, sighting levels, range finders, and other aids may be employed in much the same manner to increase the accuracy and help insure against inadvertent changes under these more unusual conditions. Also, for aerial use, vehicle mounted camera, or other situations prone to vibration or jarring of the equipment, the normal procedure of securing camera controls and lens focus rings with adhesive tape, (usually gaffer's tape or white camera tape and a “Sharpie” marker) should of course be extended to the taping of focus and convergence knobs as well, for the same reason.

For this first function, focus, the star target(s) is used. It is very important to recognize that the T/stop slide must be in place when focusing. This should preferably be the same stop at which the scene is to be shot. In a few instances, such as day-for-night photography, the shooting stop may be so small that accurate focusing will be difficult. In such cases, put a stop in that is intermediate size or wider open (for example a T/8 stop when the shooting aperture is to be T/ 16), focus, replace with the actual shooting aperture slide, and then recheck the focus at this aperture before shooting. The reason for this is that the design of the StereoVision lenses is such that they have been optimized for maximum performance at each of the normal working apertures, rather than a compromise design that yields only adequate or marginal performance at the same focus at all apertures. This design which gives maximum image quality for each of the apertures does result in a progressive focus shift as the lens is stopped down, since the optimum focus will be at a different position at, say, T/ 16 than at T/5.6. Observing the usual careful setting of the camera viewfinder eyepiece setting for the operator 's eye correction. The procedure of careful focus at or as close to the working aperture as possible will insure not only that the focus is correct, yielding the maximum allowable depth range, but also that the optimum performance for which the lens is capable at the stop is realized.

There are two main procedures that are usually followed when using the star targets, depending mainly on whether or not there is a main subject on which critical focus is required. There are also variations which apply to special situations, some of which will be covered later, but the basic procedure should still be used as a starting point and as a check.

If there is a single main subject, and that subject is not going to move much closer or further from the camera du ring the scene, one star target is placed at the subject location, and the other at the furthest point in the scene where important detail must be resolved. When targets of different size are used, the larger of the two should be the one furthest from the camera. The lens is focused on the subject target, and the rear target is checked to make certain that it is sharp enough. The closest point at which subject detail is necessary must also be checked, but, due to the magnified image of very close objects, sharpness may often be determined without moving a target. Focus “balance” is important!

If there is more than one main subject at different distances, or if the subject is moving front-to-back or back-to-front, or there is no single key subject, a different procedure must be followed. In these cases, a range must be established. For this purpose, one target is placed at the closest point where the image must be sharp, and the other target at the furthest point. Focus will be between the two targets, 1/3 the distance behind the front target, 2/3 in front of the rear target. When focused correctly, both targets will appear equally sharp, or equally unsharp.

If they are unsharp, a smaller aperture must be used. Sometimes it is easier to focus if one of the targets is placed at the exact focus point (predetermined by the 1/3-2/3 rule just mentioned) and focused upon. However, if this is done, that target should be moved back to its normal position, and the image checked for equality of sharpness before shooting starts.

In the event there is insufficient light to be absolutely certain of critical focus, a small spotlight aimed at the targets can be very helpful. I n one instance, where studio lights would not be turned on until just before the camera was to roll, a 60 watt household l amp a half foot from the target, and shielded from the camera lens with a reflector or flag, allowed the target image to be seen very clearly on the groundglass.

Other details on focusing in special situations or under special conditions will be covered under Focusing in the Usage part of this manual. Sometimes it will be necessary to make a choice on whether to maintain sharp focus on the background and let the foreground go slightly soft or vice-versa. The suggested procedure is to first determine which of the two the audiences' eyes will tend to be attracted to. If the background comprises most of the shot, it is probably better to focus it for maximum sharpness and let the main subject go slightly soft.

For purposes of convergence, a vertical reference is necessary. Although it is possible once the skill has been acquired to converge on references in the scene itself, one should be absolutely certain that the reference does not mislead. For example, a tree or pole that is not absolutely vertical can easily lead to mis-convergence. Attempts to converge on objects that do not have good image contrast or sharply defined edges can also result in unintentional mis-convergence.

In this portion of the manual, it will be assumed that the reader is familiar with the purpose of and general principles behind convergence. A descriptive tutorial on convergence appears in the Usage section.

As mentioned, the poles or stands upon which the star targets are mounted may be used for converging. As backgrounds may be light or dark, it is most helpful if parallel black and white stripes are on the pole. An easy way to do this is to apply vertical stripes of white and black adhesive tape to the pole or stand. These poles can be rapidly moved and need not impede production at all.

Also, as mentioned, convergence may not necessarily be at the same point or plane in the scene as focus. See the Usage section for some of the more common variations to be expected.

Often the exact plane of convergence is selected. In many cases (at least 50% of most normal subject matter) this is at or near the main subject.

One of the poles is placed at this location, and the lens is converged on this pole. Any object in the scene that is at this distance from the camera will now appear to be in the same plane as the screen upon which the film will eventually be projected.

The other pole is normally placed further back in the scene, and there are several determinants as to its location, again major once of which will appear in the Usage section. The main purpose of this rare pole is to determine that definable portions of the image will not be “split apart” or be “unfusable” when the picture is projected. Sometimes, as when the rare most portions of a scene are a considerable distance away, an existing reference in the scene must be used.

In those instances where a definable part of the scene is to appear in front of the projection screen (closer to the audience than the theater screen), it is also necessary to place a pole at the closest distance from the camera to make certain that the image will not “split apart” from too much separation of close objects.. Here the viewfinder reticle graduations can be of help to determine the limits. Carefully examine intermediate subject matter so that the eyes will travel from close-up, medium close-up, medium, etc., to alleviate eye muscle stress.

Both negative and positive parallax (see Definitions section) determine the maximum limits to which closest and furthest objects in a scene may appear to be in relation to the screen plane, and therefore are also determining factors as to the optimum plane of convergence. These and many other items must be taken into consideration before the convergence poles are positioned and convergence set. It is very important that the comments in the Usage section are thoroughly understood, and that the advice of the 3-D consultant is followed exactly to achieve acceptable results consistently during the course of a production.

10. Handling, Care, and Protection of Lens

Extreme care must be used when handling this lens! Although designed as ruggedly as possible, consistent with being light weight and compact, it should be remembered at all times that the StereoVision camera lens is a precision instrument, and should be accorded the care and protection which should normally be extended to any optical instrument. As with most precision equipment, internal damage may be inflicted, which although not visible from the outside, will affect the quality of images and no longer permit the high-resolution accurate results of which the lens was originally capable.

Normally, the best protection available under normal field conditions is the carrying case in which the lens is supplied. Anytime the lens is not actually mounted on the camera, it should be seated in the foam cut-out in the foam-lined case, and the case closed and latched. Whenever a lens is supplied with a front and/or rear cap, these caps should be in place when the lens is in the case, for the foam lining in the cases for those lenses has been cut specifically for most secure cushioning effect when the cap(s) is on the lens. When more than one lens is used simultaneously on a production (as when more than one camera is used to film a scene at the same time), upon completion of the scene, make certain that each lens and the T/stop slide for that lens is returned to the <u>very same case</u> from which it was removed. The lining of each case is custom cut to match only the lens for which it is intended. The cases are numbered with the focal length of the lens which should be inside, but remember that it is quite possible that two lenses of the same focal length may be used on the same scene (as when coverage of two different angles with the same field is required). Lenses and cases should not be interchanged even if of the same focal length, as different models and styles do exist.

When the lens is to be mounted on the camera, first bring the case as near to the camera as practical before opening it. Observe potential hazards in the area, such as cables which may be suddenly moved. Transporting of the unprotected lens from the case to the camera is a particularly hazardous time, until the lens is securely mounted on the camera, and the mount checked. Do not touch exposed lens elements.

Once the lens is on the camera, the rear of the lens is reasonably protected by the camera itself, but the front is still exposed. A responsible individual, such as the operator or assistant cameraman, should be next to the camera at all times when the lens is in place, to prevent accidental damage due to the tripod being bumped, or anything from striking the lens.

If there is any possibility that flying objects, dirt, dust, water, etc. might strike the lens, all reasonable precautions and physical protect ion should be implemented. Plastic bags, umbrellas, etc., can protect against mild rain, but careful continual observation is required to make certain that such measures are indeed protecting totally the lens, and not just the camera.

Clear rigid acrylic plastic sheets (such as Plexiglas(r) or Lexan(r)), can afford some protection from small grains of sand or other small airborne particulate matter, but should not be trusted for large, heavy, or piercing objects. A full enclosure is sometimes desirable, as material can work around a single sheet. For protection against larger objects, a sturdy metal cage may be constructed, with a thick plastic and/or safety glass window. Such a cage should be certified by the designer and competent builder to be safe against considerably higher loads and forces than expected.

When moving the dolly to a new position over a rough surface, it is advisable to remove the lens from the camera as the bouncing can damage or loosen the lens mount.

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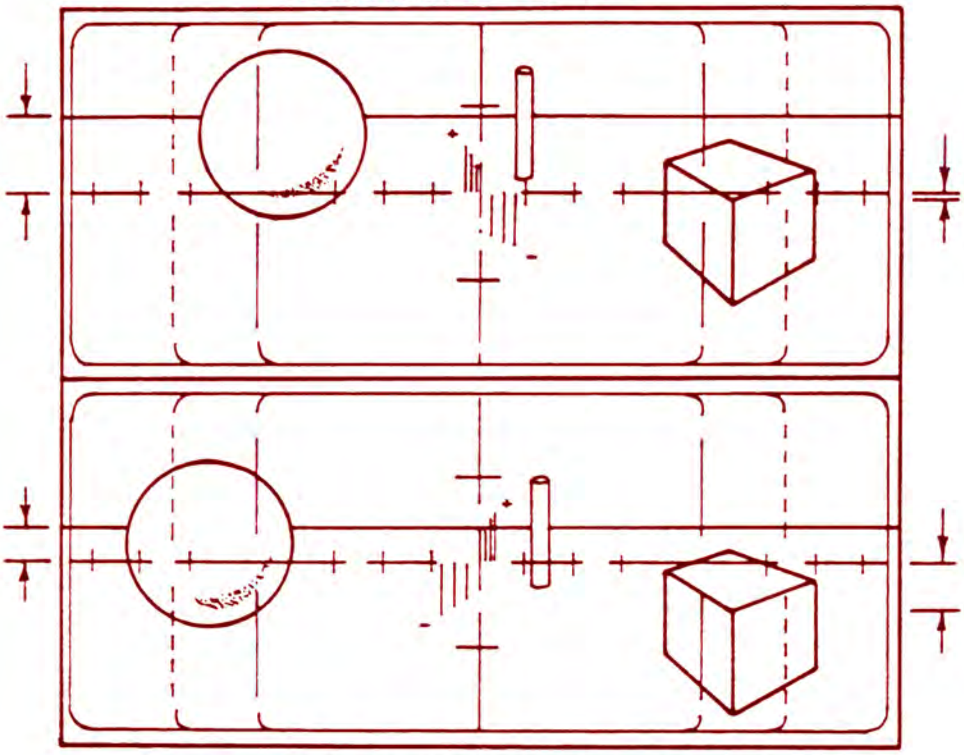
** Plexiglas is a registered trademark of Rohm and Haas, Inc.*

Sometimes a lens may be protected from objects which are intended to appear to be heading straight for the lens by a simple optical trick. A large mirror (preferably front

CAUTION!

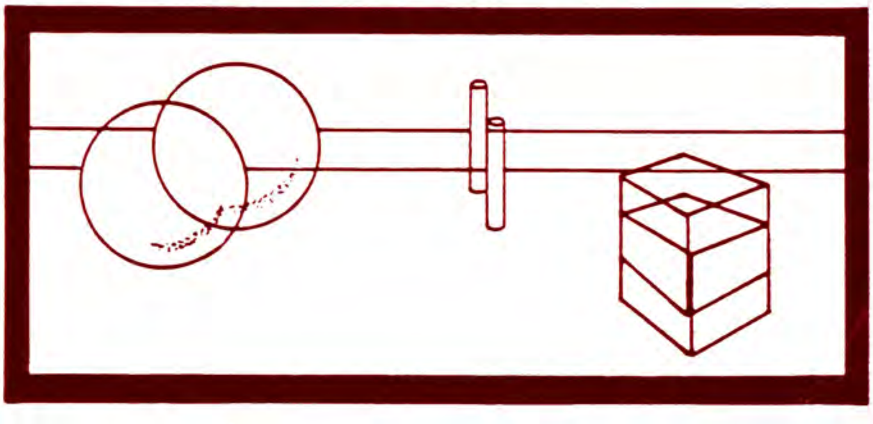
VERTICAL ALIGNMENT ERROR MAY BE CAUSED BY DAMAGED LENS

- VIEWFINDER IMAGE -



CHECK IF LENS IS MOUNTED LEVEL WITH CAMERA. IF THIS DOES NOT CORRECT ERROR, CONSULT YOUR STEREOVISION REPRESENTATIVE.

- THEATRE SCREEN IMAGE -



VERTICAL ERROR - PROJECTED, AS SEEN WITHOUT 3-D GLASSES: STEREO IMAGE MAY BE UNFUSEABLE, CAN RESULT IN EYESTRAIN surface) may be placed in front of the lens at a 450 angle. The flying objects are then directed to the mirror instead of the camera. Care must still be exercised that the objects do not ricochet off of the mirror and still strike the lens. If the objects are of a piercing nature, such as arrows, the mirror should be made of reflectorized mylar stretched over a frame. The arrow will pass right through the mylar. If a large object presents the possibility of shattering a glass mirror, a Plexiglas shield (at least 1/4'' thick) will protect the lens from most small flying shards.

During normal production operations, the best of care and protection cannot prevent a certain amount of airborne fine dust from reaching the lens. This can usually be removed from the exposed lens surfaces by the use of conventional lens cleaning procedures, the preferred method being to first brush off all loose dust, then use of a can of dry, clean compressed air. Make certain that the aerosol is of the type intended for cleaning lenses (some industrial aerosols allow oil or chemicals to be ejected with the air).

Occasionally, a small amount of dust which is so fine that it penetrates the lens housing, may be seen on internal lens surfaces. Normally, dust that can get inside during normal operations usually will not adversely affect image quality. Of course, if the housing or seals are damaged such that a large quantity or coarse foreign matter enters, the lens must be returned to the manufacturer (StereoVision) for repair.

Only StereoVision has the necessary special equipment to repair, align, and collimate StereoVision lenses. Any lens in need of repair or alignment must be returned to StereoVision International, Inc.

11. Unusual And/ Or Adverse Field Conditions

Although some very pleasing images may be recorded with a locked down camera under ideal studio conditions, the very realism afforded by filming in 3-D may often permit a visual impact in unusual situations which adds a dynamic feeling to a film of an order that simply cannot be achieved under any circumstances in an ordinary flat film.

Fluid camera movements, actual or visually implied danger in the subject matter, and special effects can all contribute to the audiences' feeling of involvement. Each of these, however, imposes certain obligations upon the production staff, director, and operator(s) to take extra measures to insure the safety of all personnel and equipment involved, as well as the continued proper operation of that equipment.

While shielding of the equipment, such as with clear plastic windows, metal cages, etc., is often a good precaution, there are instances where no reasonable amount of protection will guarantee absolutely safe operation. Therefore, great care and preplanning can be extremely vital.

First and foremost, a total awareness of unusual or even potentially adverse conditions is absolutely essential. Use of chemicals and solvents in the vicinity of the camera can result in airborne particulate matter travelling a surprising distance and resulting in serious damage to equipment. Very high and low temperatures and humidity can create serious problems. Wind, sand, dust, water, grease, paint, and many other things have ruined conventional flat lenses on productions, and the very tendency for more of these hazards to be present in 3-D films exposes the complex 3-D lenses to more than the normal share of them.

12. Packing, Transporting, and Shipping of Lenses

StereoVision should be notified by telephone and verified by letter, and approve any shipping of StereoVision lenses, or any transporting other than agreed upon in the original contract. Special arrangements must be made regarding the insuring of lenses during use, transport, and/or shipment.

Primary packaging of lenses will be in the foam-lined cases supplied by StereoVision for the specific lenses. Check all cases and make certain that all slides and other items which were with the lenses when received are included and packaged in the case in the same orientation as originally received.

For purposes of unguarded transport, latches should be secured and covered with adhesive tape.

For shipping by common carrier (such as Federal Express), the cases should be surrounded by a minimum of 3'' of postal approved plastic bubble pack, or foam rubber, or similar cushioning material, and securely sealed in a minimum of 200 lb. test corrugated cardboard carton.

Addresses of both the shipper and the recipient should be placed: (1) inside the lens case, (2) outside the lens case, but inside the card board carton, and (3) outside the cardboard carton. The address label on the outside of the carton (3) should be protected by covering it with clear mylar adhesive tape. Be certain to insure the shipment for the amount agreed to.

If the lens(es) is to be shipped such that they might be received at other than normal business hours or days, telephone and, if possible, written information to that effect should be forwarded to the intended recipient before shipping. The complete phone number, with area code, of the recipient, should appear on all three address labels.

All customs clearances for both directions must be obtained before any lenses leave the United States.

13. Other Miscellaneous Functional Operation Considerations

Care should be taken that light flare does not directly enter the lens during the filming of back-lit scenes. Although optically the effect is no different than that which occurs when light flare enters a conventional flat lens, the visual effect in 3-D can be quite disturbing. The reason is that the flare will usually enter one of the two stereo lens elements at slightly different angles and with greater intensity through the optical path of the one set of elements than the other. Whenever the image intended for the left eye differs, even slightly from the image intended for the right eye by any factor other than horizontal parallax, the result is a visual conflict, which not only looks unnatural, but can cause visual discomfort, and if prolonged, headaches for the patrons.

In shielding the lens from flare with flags, matte box cards, shades, etc., care must also be taken that no part of either of the two stereoscopic images is occluded. Both upper and lower images on the viewfinder groundglass must be examined carefully, as any shading that appears in one image, but not identically in the other, can result in visual discomfort similar to that caused by flare: If the image on one side is either significantly lighter or darker than that on the other side, especially if it is partially so, will result in dissimilar visual discomfort effects.

Practice all operations, and study the following usage portion of this manual thoroughly before attempting to film a 3-D production for the first time. Review it on subsequent productions, and check with the 3-D consultant for new, changed, or updated information.

Judicious use of the services offered by the 3-D consultant on all productions (not just the first one) will enhance new creative ideas and can result in a continuing high level of quality.

Various formats and configurations have been used throughout the lengthy history of the 3-D motion picture. Today, the most practical and successful 35mm format is that of the single-film dual Techniscope* image in the "over-and-under" configuration. There are some very valid reasons for this form becoming pre-eminent in the industry. Well over half of the theaters in the United States are equipped with "platters" and a single projector for each feature in each auditorium, as against the double projector system that was common in the industry a few years ago. Single-film presentation eliminates the former problems associated with synchronizing two different projectors. The horizontal aspect ratio (shape) of the image more closely conforms to the shape of the majority of the theater screens in use today. Other considerations relating to film handling and costs also are factors.

Although several manufacturers make equipment that produces images of approximately similar size, they are not all exactly the same, and therefore rarely interchangeable. 3-D camera lenses by one manufacturer should not be used on the same production as lenses by another manufacturer unless both verify that indeed they are interchangeable, otherwise additional optical printing will be required.

StereoVision 3-D lenses use symmetrical image spacing! The StereoVision lenses produce images whose centers are.374'' from the center of the top image to the center of the bottom image of the stereoscopic image pair. This spacing is exactly symmetrical, and conforms to the sprocket hole pitch of the film (2 x the pitch of.187''=.374''). This permits several possibilities for the cinematographer which are either not possible or very difficult with any other spacing. This spacing also permits the maximum possible film area to be used for maximum resolution and light transmission. Lab costs for titles and optical effects can be far less than any other 3-D system.

Any special effects which require adjustment of the film by one half of a stereo pair may be done without special printing on an optical printer. Some of these are the left-right reversal of the image (such as when a vehicle that enters the frame from the left is supposed to enter from the right to match continuity), and any of several “pseudo stereo” effects.

When filming a 3-D motion picture, all parts of both images of the stereoscopic pair must be observed at all times. Since a true 3-D optical system has several operational characteristics which are somewhat similar to the manner in which the two human eyes operate, this must be taken into consideration whenever the StereoVision lenses are used. In a real life situation, depending upon the position of the observer, portions of a background in a scene are usually obscured by objects in the foreground. However, since we view the scene with two eyes which are laterally displaced from each other, each of our eyes sees a slightly different view from a slightly different angle than the other eye sees. The result is that portion of the background which is obscured by a foreground object as seen with one eye will be slightly different than that portion of the background obscured by the same object as seen by the other eye. Thus, it is quite possible for objects or portions of objects in the background to be visible with one eye and not the other.

Much the same thing can and often does occur when filming in 3-D. For this reason, it is necessary to check both the top and bottom images on the groundglass in the camera viewfinder at all times to avoid the possibility of inadvertently revealing a part of the background which should not be seen by the audience.

An example is where an object is supported by a support behind it which is not supposed to be seen. If only one of the two images is examined, it might seem to be totally hidden, even though it is revealed from the viewing position of the other image.

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* Technoscope is a registered trademark of the Technicolor Corporation.

For much the same reason, both images should be examined during the editing stage as well as during the cinematography.

Choice of camera angles can enhance the visual perspective of a 3-D film to even a greater extent than with a flat film. Just as with a flat lens, a 3-D lens equipped camera may be raised and lowered, and tilted up and down with very good results. On the other hand, rapid lateral tilting should be avoided, especially where there are recognizable horizontal or vertical objects in the scene. With intelligent operation, this rule may be bent in some circumstances for a special visual.

Except for certain rare special effects, picture in formation that is seen in the left eye image (top image on groundglass) should have identical characteristics (exposure, contrast, color, highlights, shadows, etc.) to those seen in the right eye image. Also, although the angular perspective may differ laterally (in a normal 3-D image, the left eye sees slightly more of the left side of objects in the scene, and the right eye the right side), vertical perspective must be identical in the two images. That is, one eye-view must not view the scene from a position that is either higher or lower than the other eye-view. Any differences between the left eye-view and the right eye-view other than the normal lateral parallax will cause visual discrepancies which: (1) reduce or eliminate the 3-D appearance of the image (the image tends to flatten out), (2) make the image look unnatural (unequal left and right eye images are rare in real life, so such an image on the movie screen is interpreted as disturbing, or a mistake),and (3) causes eyestrain, headaches, and other visual, psychological and, in terms of eye muscles, physical stress. Dissimilarity of the two images of a stereoscopic pair are the cause of nearly all audience discomfort and customer complaints regarding the viewing of 3-D movies. None of these problems are inherent in the 3-D process itself; all of them may be completely eliminated by care, observation, and where necessary, correction on the part of the operator and assistant(s). Whenever there is any possibility of doubt, no matter how slight, the advice of the 3-D consultant should be sought, as discrepancies which are only marginally detectable through the viewfinder can produce noticeable errors in the projected image. Other seemingly disturbing characteristics may not affect the film image at all, due to either being out of the picture area (camera viewfinders usually show a somewhat larger area than will be allowed through either the printer aperture or the projector aperture) or being of such a nature that the characteristic is not recorded in the imaging or printing processes due to inherent attributes of normal film stock, processing chemistry, and printing lights. Only extensive experience can provide the answers unequivocably.

Although there are a multitude of causes for image disparity, a few of these are all too common, being seen frequently in the majority of the 3-D motion pictures which have been exhibited in recent years.

Vertical displacement of the two images, or parts of the images, is often a function of the particular design and/or construction of the lens system. Unlike some other designs, StereoVision lenses are designed and constructed to have zero vertical parallax. Normally, vertical displacement errors need be of no concern when using StereoVision lenses, as they simply do not occur with properly functioning StereoVision lens. (Vertical displacement error can easily be checked by comparing the relative position of both images on the camera 3-D groundglass). If, however, there is reason to believe that the lens has been damaged (subjected to shock, vibration, or other mishandling), it should, of course, be returned to StereoVision for checking, realignment, and recalibration.

Shadows, or dark areas, which appear in one image of the 3-D pair but not in the other (or to a different degree in the other) are most often due to shading from an obstruction in the optical path that is sufficiently close to the camera to affect the images unequally. Some of the more common causes will be discussed next.

A flag or barn door shielding a fill light that is close to the camera may appear to be out of the image area in one image, but appear in the other; therefore, the need for closely examining both images on the groundglass. Also, such an obstruction that appears to just clear the image area on the groundglass, may appear within the image area on the film. The reason is two fold: the groundglass tends to be less discriminating than film primarily due to the higher contrast of the image normally recorded on film and the viewfinder ocular (eyepiece) permits viewing of the groundglass from only a centrally located position, thereby tending to mask density differences near the edge of the frame from those light rays which are traversing the camera lens(es) peripherally. From the standpoint of the camera operator, the safest procedure when removing such an obstruction, is to move it a little farther out of frame than appears necessary when observing through the cam era viewfinder.

Other sources of such obstructions include lens shades and mattes, and foreign matter on the front or rear lens (exposed) surf aces, the f/stop slide, any filter, or within the camera itself (between the lens and the film). Never use black tape on the lens shade in an attempt to reduce flare, etc., without being certain it is not shading the image at all.

Lens shades must be the specific shade provided for the specific lens by StereoVision. Any additional shading should only be attached or used with the explicit instructions and checking by the 3-D consultant.

Mattes, such as binocular cutouts, keyhole cu touts, etc., again should be implemented only with the advice of the consultant, who can insure that both images are affected equally and properly. For example, if a keyhole mask is used, the image should be monocular (both images identical), as an individual actually looking through a keyhole can only do so with one eye, and would see a flat image in real life). A pair of binoculars in real life provides a 3-D image, but only in those parts of the image where both left and right images over lap. A matte image simulating such a view in a 3-D movie should duplicate the effect. Properly done, such effects are not only dramatic, but lend a touch of both realism and wonderment such that the audience's feeling of participation is enhanced far beyond what might be expected from a simple verbal description. When use of a stereoscopic instrument, such as binoculars or a stereomiscope, is depicted in a 3-D film, the opportunity for close simulation of the real life experience requires close attention to details. One such scenario would be the following:

An actor is shown raising a pair of binoculars to his or her eyes. A cut is made to the first simulated view representing the scene as seen through the binoculars; out of focus and misconverged. Cut back to the actor, this time as a closeup shot of the actor 's head, the binoculars, and the actor 's hand on the thumbwheel, adjusting it. Cut back to the simulated view, showing the image coming into focus and convergence. Done properly, with fairly rapid cuts, the effect will look very natural, very realistic. ï

Some other effects, techniques, and caveats will be mentioned in the remaining portions of this manual. 3-D opens a whole new world to the alert, creative, writer, director, and cinematographer. It is, however an extremely complex subject, and anything beyond the necessarily brief treatment afforded by this manual should be referred to the experienced advice of the consultant. With care, anything that may be imaged in a flat film may be imaged in a 3-D film; any effect duplicated (although the exact method may differ); and with usually more effective results. Often it is possible to do things in a 3-D film that simply cannot be done in a flat film.

USING THE STEREOVISION CAMERA LENS

1. Some General Considerations regarding 3-D Cinematography

A properly made three dimensional motion picture is the closest experience to real life that most people who see it will ever perceive. However, this process, which can be so marvelous, also requires complex new skills and should not be treated as a "gimmick." 3-D is challenging, but artistically the most rewarding of all the visual arts. Every 3-D film must always be comfortable to view. The extreme realism of good 3-D, however, tends to vividly reveal any errors in the 3-D technique of cinematography. When such errors occur, they may not necessarily be understood by the audience. However, they will be immediately felt as something that is not visually comfortable, or even worse, causing annoying visual discomfort or even pain in the form of eye-strain and headaches. It is most unfortunate that it has not been widely recognized that none of these problems are necessary. 3-D motion pictures can be filmed with equipment and techniques currently available, which have a lot of exciting visual "depth", and at the same time are very comfortable to view. The patrons can actually feel rested after seeing a properly filmed (and properly projected) 3-D motion picture. The 3-D film would not be treated as a "gimmick" as has often been the case, but as a viable professional technology that greatly enhances the audience's visual participation in the story and enjoyment of the film.

The purpose of a theatrical motion picture is to provide entertainment value for which the patrons are paying at the box office. Therefore, the need for a good story and quality acting, combined with expert cinematography, is prerequisite for any film, flat or 3-D. A poor movie will not be transformed into a good movie by filming it in 3-D. But a good movie can be much more enjoyable if <u>correctly photographed</u>, <u>properly printed</u>, and <u>properly projected</u> in 3-D. The tools for doing this are available from StereoVision. Whether or not the high 3-D image quality level which the StereoVision lenses are capable of is realized will depend primarily upon the technique of the users. An understanding of the principles in this manual plus careful adherence to the advice of a qualified and proven 3-D consultant can make this possible.

It is well to bear in mind that, although Stereoscopic movies are potentially the most marvellous and enjoyable of all visual media, they also require, by far, the most exacting technique.

2. Planning and Preparation

Planning and preparation are important with any f lm. With a 3-D film, they are even more so.

Yet, this is the very area where most 3-D films have suffered. The proper time to bring the 3-D consultant "on board" is not the first day of filming. It is as soon as the story concept is first considered. Sometimes it is valuable to hire the consultant at intervals (on a day-rate basis) even during the writing of the screenplay, to advise the writer(s) of ways in which economies of production may be realized through the writing of scenes such that they may be filmed with a minimal of ancillary equipment and/or production time. Even experienced screenwriters may not be aware of all of the cost effective procedures that are specific to 3-D productions. Properly executed, a screenplay can make use of these procedures without diminishing the quality of the production. In some cases production value will actually be enhanced with no loss to the story. Proper understanding of the possibilities extended by the 3-D process can offer ways to use the dimensionality of the image to clarify continuity and other aspects if properly written into the script in the first place.

During pre-planning, storyboarding, financial conferences, all production meetings, and pre-production, the 3-D consultant is a valuable ally. It is far less expensive to use the expertise of the 3-D consultant on the feasibility of a contemplated shot or effect than to fussily try to make it work after it has been written into the script.

3-D films have been made where there was little or no use made of a consultant. In nearly every such case, the 3-D quality of the film, eye comfort and production value have suffered. Added costs incurred due to re-shooting of scenes, additional optical printing, and other expenses, would have paid the consultant's fee many times over, even if production costs only were considered.

3. Choice of Film Type

Modern color films are available to the cinematographer in three major light sensitivity (speed) categories from both domestic and foreign manufacturers.

Choice of the film or films to be used on a particular production will, as with conventional flat motion pictures, be predicated on several criteria. However, there are certain considerations regarding 3-D productions specifically, which may weight the decision, especially when the choice of film speed is borderline.

As pointed out earlier, 3-D imaging benefits considerably from as much depth of field as is possible. This indicates small aperture T/stops, which in turn require either more light or a greater sensitivity of the film to the light which is available.

Although the differences associated with different speed films (granularity, resolution, contrast, D-max, etc.) still exist, the gap between high speed and moderate speed films is narrower today than ever before. In terms of image quality, the major recent research and development has been directed toward the high-speed, fine grain emulsions, with the result being a quality level that is approaching that of films of more moderate sensitivity.

Therefore, a consideration of using some of these higher speed emulsions is due, even though it may have been out of the question only a few months ago due to the severe quality limitations of what was then available. In any case, just as with flat films, be sure to thoroughly test any film that is to be used for the first time, to make certain that all of the image forming properties of the particular film meet the criteria of the anticipated production. Remember, sharp images are far more desirable in 3-D even at the expense of slight increase in granularity. We strongly advise using Eastman 5245, 5248 or 5287 for exteriors and 5296 for interiors.

4. Choice of Lens Focal Length

Lens choice considerations in flat photography, such as composition, perspective, field depth control, angular coverage, and relative object size as depicted in the image, all are factors in 3-D photography as well. In addition, there are other considerations when filming in 3-D.

Lenses used in conventional photography are usually classified in one of three major categories: wide-angle, normal, and telephoto. If frequency of use is to be considered, in 3-D the shorter focal length lenses covering the wider angles would have to be considered the “normal” lenses, with the longer focal lengths used in those instances requiring their special characteristics. We strongly recommend the 24mm or the 32mm lens for most 3-D filming.

Consideration of the basic parameters which are most desirable in 3-D filming will show why this is most often likely to be the case.

With maximum depth of field being a very important goal in most scenes, the shorter focal lengths will affect the greatest control at any selected T/stop, consistent with subject distance. Of course, if the subject distance is changed so that image size is held constant, depth of field will also remain constant. However, in many typical situations, the camera/subject relationship is maintained at a fixed distance, under which condition the shorter focal length will indeed yield a greater effective field depth. As a general rule, the 32mm lens renders ”normal” perspective. Thorough pre-production experimentation is advised. Image splitting is a very important factor that is all too often ignored. Image splitting is caused by excessive parallax for foreground and/or background elements of a scene. There are several parameters which define the limits of allowable maximum parallax in any particular scene, which are described in other sections of this manual. However, all else being equal, the shorter the focal length, the less parallax that will be imaged. The reason is that shorter focal lengths not only magnify the image less than longer focal lengths, but the parallax has less magnification as well.

Composition is another factor. When-filming in 3-D, depth must be considered in the composition, as well as height and width. Depending upon the subject matter and interrelationships within the scene, realistic depth relationships of objects in the scene will usually be easier to control, and appear natural over a much wider range of seating positions in the theater, when wide angle lenses are used. For example, a telephoto shot which would appear satisfactory from a seat at the rear of the auditorium, might appear distorted from other positions: flattened-out to someone near the front seats in the theater. The short focal length camera lenses would allow much closer and further seating from the screen before distortions would become noticeable.

The maximum useable film area yields an image with an aspect ratio of 2.35:1, with different theaters cropping this image by different amounts to fit their particular screens. Using this ratio as a guideline, it is possible to relate 3-D lens focal lengths to flat lenses of the same focal lengths. The rule regarding coverage is: the width of the image will be the same as the width of an image created by a flat lens of the same focal length, and the height of the 3-D image will be the same as the height of a flat image created by a flat lens of about twice the focal length. For example, a 3-D lens of 32mm focal length will provide an image that is the same width as that provided by a 32mm flat lens, and a height that is the same as the height provided by a 64mm flat lens. Since the 3-D image on the film is somewhat smaller than the 1.85 flat image, it is advisable to keep the camera closer to the subject than for ”flat” photography. This will enhance the sharpness and the 3-D effect.

5. Field Size and Aspect Ratio On the Groundglass and Theater Screen

As stated previously, the maximum coverage on the film yields an approximate aspect ratio of between 2.35:1 and 1.85:1. For this reason, this amount of coverage should be anticipated during filming, with no shading or untoward elements entering the picture area for this coverage, as there is always the possibility (indeed, likelihood) that some theaters will show nearly the entire available film area.

On the other hand, many theaters, especially the popular ”mini” theaters, crop the image severely to f it their smaller screens, which also often have much smaller aspect ratios (often as little as 1.66: 1 or even less). For this reason, important image components should be restricted as much as possible to a “safe action area”, much as if the film were planned for television broadcast as well as theatrical distribution.

Although the typical camera groundglass will show an image area that is somewhat larger than the area that is allowed by the projector gate, this is taken into account by the outline scribed on the special 3-D groundglass available from StereoVision.

6. 3-D Depth Range

The amount of “depth” obtainable in a 3-D image is limited by several factors, of which parallax is only one. In attempts to exaggerate the apparent depth range, and bring objects “further off of the screen” very wide parallaxes are often attempted. Very often, the result is not what was intended; sometimes the very opposite: the images split apart and appear as two very annoying flat images in the plane of the screen. This is a waste of time and money.

A thorough know ledge of the characteristics of a 3-D image is necessary to determine what the actual limits of parallax are in any specific situation, and to yield maximum depth appearance.

First, since parallax is the most obvious factor in determining stereoscopic depth, it is desirable to determine what the widest allowable parallaxes are in a scene. Contrary to common belief, these are not constant. Although tables have been computed and formulae generated for this purpose, they cannot be considered an absolute guide in all circumstances. This is not to say that such calculations are not useful. They serve a very valuable function in developing starting points for determining where convergence should be set for certain ''typical'' situations, much as light meters and color temperature meters serve as starting points for determining exposure and filtration. However, like the use of meters, the calculations must be tempered with experienced interpretation and analysis as applied to the situation at hand, and depend greatly on the nature of the subject matter.

When using any prepared charts as a basis for determining the range for setting 3-D lens convergence, it is wise to verify that the charts have been correctly calculated. Several charts have been published which are in error. See responsibly published books and articles and compare.(Lipton, Williams, Spottiswoode, Levon ian, Symmes, etc.) The advice of the 3-D consultant should be sought to verify that any chart is correct. These articles and books would not have been published if stereoscopic cinematography was not a serious matter requiring responsible professionalism.

It has been noted recently that one supplier of camera equipment, in an effort to quickly sell-off their inventory of complicated and obsolete 3-D camera lenses, has attempted to minimize the complexities of stereoscopic cinematography. They even suggest that the use of these erroneous charts is all that is necessary, without any need for a qualified consultant !

This can result in a large percentage of the photography causing audience eye discomfort at best and, at worst, severe eye strain !

IMPORTANT!

Some of the variables which have a pronounced effect on the allowable depth range include: color, contrast, subject motion, camera motion, size, edge characteristics, sharpness or softness of the image, exposure, texture, focal length of lens, camera position, recognizable patterns, familiarity of the audience with the subject matter, length of scene, length of edit, projection system used, lamphouse on the projector, efficiency of polarizers used in projection, seating position of the viewer, and even the average age of the members of the audience.

In general, positive parallax limits tend to vary less than negative parallax limits, and while affected by all of the above named variables, tend to be affected to a proportionally lesser extent than negative parallaxes. Therefore, it is often (but not always) useful to first consider positive parallax, and once this has been determined, to do whatever is necessary to get as much depth range, which will then determine the closest allowable objects in a scene that will fit within the allowable negative parallax. In real life, the widest positive parallax ever experienced is that when looking at effectively “infinity“ located objects, typically stars (or for all practical purposes, even the earth horizon).

In this instance, the eyes are essentially parallel in terms of lines of sight or optical axes, yielding a positive parallax of typical l y about 65mm or 2-1/2 inches.

With most human beings, a very slight divergence (caused by positive parallax values in excess of 2-1/2'' on the screen), though rarely experienced in real life, is possible. This fact is very useful in the 3-D motion picture, where every bit of added range is desirable.

Therefore, a maximum positive parallax of about 5'' (7'' in very low contrast or other special situations) is usually tolerable on the theater projection screen. This maximum positive parallax should usually be reserved for exterior scenes where the image depth extends back nearly to the horizon. To look natural, scenes with closer backgrounds, such as indoor scenes, should have a maximum positive parallax that is proportionately less, so that the scene will look natural when intercut with exteriors.

The proportion may be calculated from common range-finding formulae, although with experience it is quite possible to estimate with a reasonable degree of accuracy.

Once the maximum positive parallax has been determined, the convergence point or plane is located. This may be the key subject, or any point chosen for maximum range that does not exceed the previously determined positive parallax, provided it is consistent with the other characteristics of the 3-D picture. It must be determined before filming that this chosen convergence does not violate any other parts of the image. For example, if everything works, but there is an object sufficiently close to the camera to result in excessive negative parallax, something must be changed. This can be the convergence, if there is still enough allowable range or possibly even the position of the camera or the object itself.

When determining how much screen parallax is represented by how much parallax on the camera groundglass, a useful number is 300. For example, if an allowable screen parallax is 5'', divide 5 by 300 to yield.016+," or about 1/64'' on the camera groundglass. The markings on the reticle may be referred to for easily determining this, as in the accompanying illustration.

The apparent depth in a scene, including how “far out” the image of an object may appear to be is determined by several factors in addition to parallax. For purposes of determination, the actual parallax may be thought of as a not too rigid structure to which apparent depth may be loosely tied. With this in mind, consider the following ways in which apparent depth and depth range may appear to be ''stretched," even after convergence and parallax limits have been determined.

Certainly, strong ''depth cues," such as have been effectively used to enhance apparent depth in flat paintings by artists for centuries, are valuable in their ability to enhance even further the depth appearance of a 3-D image. Some of the more common of these will be discussed in following portions of this manual. It should be obvious that intelligent screen writing, art direction, scene construction and painting, and prop design are vital.

Under certain circumstances, previously determined limits may actually be extended if certain knowledge of how the 3-D image is resolved is applied.

Choice of both lens and shooting angle (often interrelated) can add range. Motion, especially of the camera, is extremely important, as depth can be more than doubled in some situations through this technique. This will also be discussed more extensively later.

Even with a locked-down camera, it is possible to carefully change convergence while a scene is being filmed, to redirect the audiences' attention (as with follow-focus) or to simulate the effect of changing the apparent range. With a moving subject and/or camera, it is possible to achieve entirely different depth effects through follow-convergence, reverse-convergence, or precess-convergence, with or without any combination of focus change, provided it is done with extreme care, and only when all factors mentioned above are taken into careful account.

With 3-D,the creative possibilities in depth control alone are far more extensive than may be covered here, and lies within the expertise of a qualified 3-D consultant.

7. Focusing

Is focusing more critical in 3-D than with flat films? In absolute terms, no. Any error not the very slightest amount, however, that might go unnoticed in a flat film, will usually be seen instantly upon projection of a 3-D film. There are two major reasons for this. The visual depth allows for instant references and visual comparison throughout the scene. In 3-D, depth of field range is a very important factor, fuzzy backgrounds or foregrounds being very disturbing. Remember, 3-D does not work well unless the image is very sharp, preferably the

AVAILABLE IN TWO SIZES
8 IN. (20 CM) AND 14 IN. (35 CM) DIAMETER

entire image; foreground, main subject and background. This fact is rarely understood by even very experienced cinematographers.

To aid in focusing, especially with the very critical wide angle shots, the star target is absolutely vital.

When focusing on the major subject, make certain that there is sufficient depth of field so that all definable objects in the scene are sharp. To check this, place a star target next to the closest and farthest definable objects and check their sharpness on the groundglass, preferably with a viewfinder magnifier set for maximum magnification, if the camera is so equipped.

Remember, for best 3-D use the smaller “T” stops. Avoid filming at openings larger than f/11 for 32mm focal length and f/8 for shorter focal lengths. If necessary, adjust the focus, or use a different T/stop, or take whatever measures are necessary to insure maximum depth of field, including using faster film (ASA 500 pushed or flashed to ASA 1000).

Always make the final focus check with the shooting T/stop in place. Never focus with lens wide open unless the shot is to be made at maximum “T” stops. Always stop down at least T/8 when focusing for T/8 shots or smaller apertures.

8. Converging

Although focus and convergence are separate operations, there are man y instances where they will be identical. This is more than coincidental. It is likely that if all of the convergence parameters have been satisfied, and there is sufficient depth range, the convergence will be set at or near the main subject, which is often where focus will before much the same reasons.

The convergence poles may not only be used to set the specific location of convergence, but also to aid in determining parallax limits, since their images may be seen and measured (by reference to the reticle) on the groundglass.

9. Exposure

In general, the best exposure for a flat film will not necessarily be the best exposure tor a 3-D film. It is always better to slightly over expose and under print 3-D prints. Also the best print for a flat film will not be the best print f or a 3-D film. The print should be slightly thinner than normal ”flat” saturation. A 3-D film should never be underexposed; if there is any possibility for error, it should be on the over exposure side. Then when timed at the lab, you will notice that 3-D will then be sharper and more comfortable top view. Likewise, a print should never be printed too dark, although too light a print can cause problems too, especially if there is insufficient shadow detail. It should not be printed so as to loose D-max (solid blacks). The cameraman should examine the developed negative of this first 3-D test films to be certain he has gotten a slightly dense image. Avoid thin exposures! Do not trust the work print. Look at the negative. Shadow detail is very important for good 3-D.

Due to viewing conditions which are affected by the polarizers, the image quality may often be enhanced if prints are very slightly (one or two points on the red printer light) warm, and one to two points thin. Remember, 90% of the theatre projector lamp housing are under-lit for good 3-D. Dark photography and dark release prints make the problem even worse.

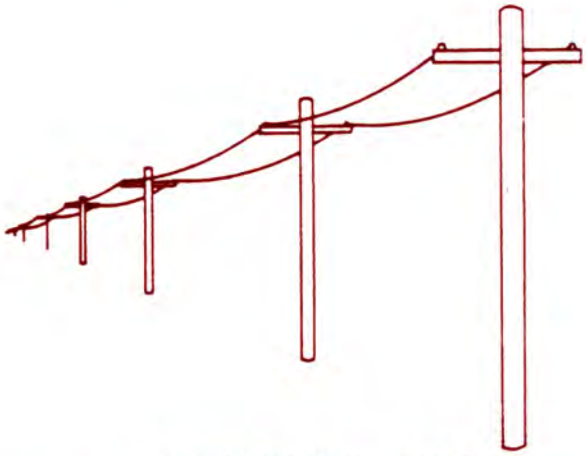
10. Lighting

For scenes of somewhat limited depth, as interiors, closeups, intimate scenes, lighting may usually be the same as with flat cinematography, but avoid high contrast or burned-out highlights.

However, when the depth range is large, care must be taken that the lighting does not (A “SPOT” LIGHT METER IS HIGHLY RECOMMENDED TO BE USED IN CONJUNCTION WITH THE USUAL INCIDENT TYPE METER) unintentionally limit the intended range. In general, the greater the parallaxes desired, the lower the lighting ratio should be to maintain visual fusion of the images. Very bright objects should be placed in convergence if possible.

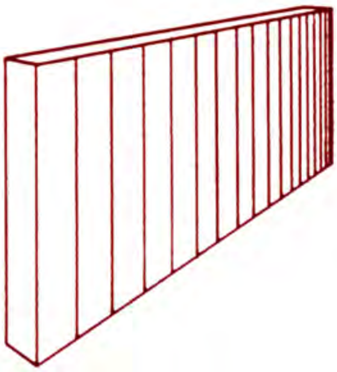
EXTRA-STEREOSCOPIC DEPTH CUES

-CONVERGING LINES-

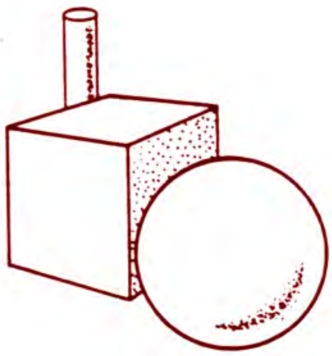


-DIMINISHING SIZE-

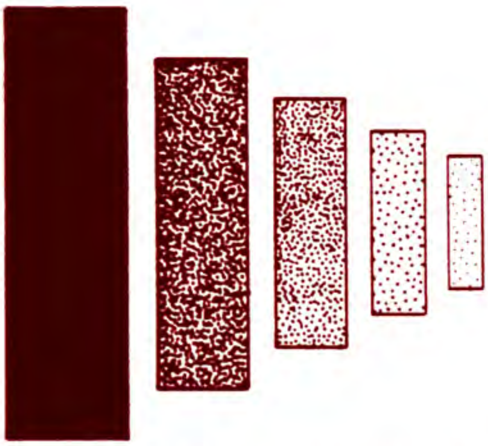
ALSO NOTE DIMINISHING DETAIL AS DEPTH INCREASES



-FORESHORTENING-



-OCCLUSION-



-DIMINUATION OF TONE-

"ATMOSPHERE"

ADDITIONAL DEPTH CUES:

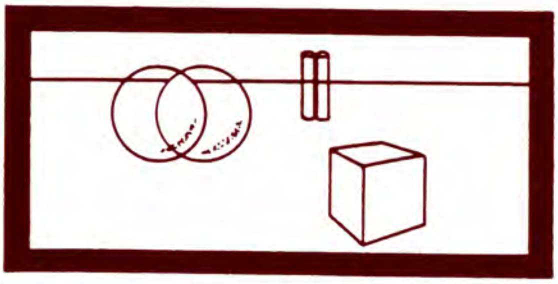
1.) LIGHT AND SHADE
2.) TEXTURE
3.) COLOR
4.) MOTION PARALLAX
5.) COMPARISON WITH FAMILIAR OBJECTS.
6.) DIMINISHING DETAIL

PROJECTION OF 3-D DAILIES

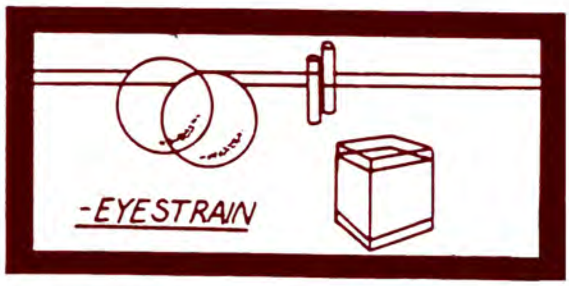
"STEREOFLEX"™ 3-D PROJECTION SYSTEM

(CHECK IMAGE ALIGNMENT WITHOUT WEARING 3-D GLASSES!)

SAMPLE SHOT PROJECTED,
AS SEEN WITHOUT 3-D GLASSES



PROPER VERTICAL ALIGNMENT
--EASY TO VIEW



VERTICALLY MISALIGNED-
ADJUST KNOB SO IMAGES ARE SAME HEIGHT

For many scenes, fill light should be just slightly stronger than in a comparable flat scene, as shadow detail may be lost through the somewhat selective light reduction effect of the polarizing vïewers.

1O. a) Composition

Composition of subject matter (along with camera movement) is probably the most important factor in achieving effective 3-D cinematography. Naturally, if the subject being photographed does not already have a reasonable range of depth cues, it cannot be expected to have depth. Strive to always have some subject matter reasonably close to the camera, some less close and some far. This may require resetting actors, props, lights, etc. By keeping the camera moving, even if ever so slightly, will enhance the depth effect and make the image more comfortable to view.

1O. b) Camera Movement

Along with composition, please remember that constant but very slow camera movement, (maintaining subject position) will stimulate the retinal images of each eye and create a fascinating sense of reality that can never even be approached in 'flat'' (non-3-D) cinematography. This depends greatly on a very clear understanding of all the factors covered in this book.

11. Contrast

Image contrast is a subject which may most easily be dealt with if approached from the effect that contrast has upon the projected image.

It has been said that contrasty pictures, high-key or low-key lighting, night scenes, moody scenes, etc., will not work in 3-D. In many cases they have been attempted with very poor results. Yet, there have been a few notable examples where they have worked exceedingly well. A brief description of the effect of the projection/viewing system may help to show some of the reasons why, and indicate ways in which such scenes may be successfully designed and photographed.

The theory of polarized projection is based upon a concept of cross-cancellation, whereby the polarizing filters in the viewing glasses worn by the members of the audience cancel the unwanted image. That is, the polarizing filter in front of the left eye will allow transmission of the left image while blocking the right image, and the other filter over the right eye should do exactly the opposite. This is because the image on the screen (both left and right eye images are projected simultaneously) are already polarized, having passed through similar polarizing filters located in the light path at the projector.

In practice, this works in this manner, but not completely. The more efficient a particular type of polarizing filter is (the higher the extinction ratio), the less light overall it will pass. Thus, although in a controlled laboratory situation polarizers may be used to produce very high extinction ratios for excellent 3-D images of even very contrasty material, the picture would be much too dim if these were used for the large pictures typical of theatrical projection. Even though very bright lamps are used in the theater projector lamp house, it should be kept in mind that the image on the film is magnified some 300 times in projection. Therefore, less efficient polarizers, which do pass more light, are required in theatrical exhibition.

Because they are less efficient, not only do these polarizing filters pass more light, but they do not cross-cancel nearly as well. A very light subject adjacent to a very dark background will, due to parallax, often appear projected upon the screen in a different physical location for the left eye image than the same object will be for the right eye image. Since cross-cancellation is not perfect, a faint image of the left eye view of the subject will be seen by the right eye, and vice-versa. How pronounced this false or “ghost” image will appear to be, or if it is detected at all, are dependent upon several factors, of which image contrast is a very important one, as
is the effect of parallax, previously discussed.

From the standpoint of the 3-D cinematographer, the most immediate effect of contrast, is to narrow the possible depth range. The more contrasty an image is, all other factors being equal, the less parallax (both positive and negative) is allowable. Good 3-D requires good fill light so that shadows do not go black.

Taking an extreme example, a night scene with a totally black background and light sources (such as streetlights) appearing in the picture, the narrowest of all depth ranges will be experienced. Yet, this range can be made to appear very deep, even in this extreme situation, with the proper techniques.

Although it should be recognized that parts of the image may have to be severely restricted, this is not true of everything in the picture. Also, since there are no visual references in parts of the picture due to the very blackness of the background, references may be set up to direct the eyes of the audience in such a manner as to give the visual impression of an extreme amount of depth, and if done right this functionally works very well.

Taking this example of light sources against a black background, if convergence is set such that these source(s) are much in front or behind the screen plane, the spurious images will be so strong that instead of a single light source in depth, what will be observed by the audience will be two lights for each light source, each very flat.

The way to prevent such an undesirable effect is to set the convergence very close to or, preferably, at the plane of the light sources.

It may seem that this is often not possible, due to the necessity for placing the light sources either very close or very fat. But, recall that there is no existing reference in this example. By placing less contrasty (but still visible due to very subtle highlighting) objects in the scene in other planes, it is possible to create new references to achieve exactly the depth effect and depth relationships sought, even though actual convergence is on the light source(s).

If the light source(s) is to appear to be close to the camera, place small but visible references of lower contrast (perhaps lit as if receiving light from the aforementioned source(s) in the scene behind the source. If the source is to appear far from the camera, the references, possibly rim-lit, should be in front of the source(s).

Even such a great distance as the horizon or infinity may be represented with very little actual parallax, if it is remember that in real life the visual parallax for infinity is only about 2- 1/2''. A star field can appear very effectively realistic if imaged with a convergence of only.008'' parallax on the groundglass and film, which will result in about 2-1/2'' positive parallax on the screen. This is much smaller than the 5': to7 '' maximum parallax stated earlier, but is required by the extreme contrast of this special situation. Although the star field by itself will work quite well with this amount of parallax in this situation, the effect may be further enhanced with a close reference, preferably a low contrast object in the foreground located such that it will appear in front of the screen. Examples might include space vehicles, satellites, planets, or even just the earth horizon itself. Certainly, if it is simply a night sky in an earthbound picture, any foreground objects will suffice: buildings, trees, props, actors.

Other techniques, such as apply to 3-D cinematography in general, may be also applied (such as motion) in much the same manner, so these will not be repeated here, as they are discussed else where. One fairly occurrence does, however, deserve mention at this point. A moving bright light source against a dark background, such as a pyrotechnical effect that is to be aimed at the camera (and, of course, the audience). Such effects tempt the cinematographer to use wide parallaxes for “maximum depth”. In actual practice, the use of narrow parallaxes and a restricted depth range will, paradoxically, create the visual impression of even greater depth, with the impression of coming even further off of the screen, and less chance of splitting into two flat images. This is because the use of other much stronger depth cues may be implemented to create and enhance the desired effect and, again, the control of visual references can direct the audience's attention wherever necessary to place the light source visually where it is intended.

11. a) Lighting

Lighting is especially important for good 3-D. Rule number 1 is, never under-light the background more than two stops. Background detail is very important for causing the viewers eyes to scan detail in the background as well as foreground details.

Rule number 2 is never under expose. Attempts to use normal studio or location lighting will usually result in disappointing 3-D. First of all without an abundance of clarity in all of the subject matter, the viewers senses will be confused and probably stressed. Why? Because 3-D is dealing with two separate and different images to the brain, just like in real life. On the other hand, 2-D or flat images are sending two separate but IDENTICAL images to the brain. The brain is then sensing "flatness", no problem.

However, if the brain sees two different views of a subject (as in real life) and identifies the images as "real", all the rules that can be broken in non-3-D cinematography no longer apply. The brain's memory immediately connects and all image anomalies become disturbing. In real life, for example, we see into shadows, we automatically focus on all subject matter that our eyes look at. If any of the stereoscopic images on the screen are not photographed sharply, our brain is confused and becomes stressed, since this never happens in real life! Although this adverse effect can be minimized, to some extent, by under-lighting the background, we do so at risk of minimizing the stereoscopic depth! Light for maximum; maximum detail, including highlights and shadows!

12. Color

Color plays a considerably greater role in 3-D motion pictures than the aesthetic value attributed to flat films.

One of the original goals of photography itself was to impart a greater realism to an image than could usually be obtained with the artistic media available at the time. Each of the subsequent steps, motion, sound, widescreen (peripheral vision effects), color, multi-channel stereophonic sound, and 3-D, have been attempts to deliver to the senses added cues to further enhance the realistic appearance of the image and yield a greater feeling of participation and enjoyment to the entertainment experience.

When color and 3-D are combined, as is the case with most modern 3-D films, this serendipitous effect can be very pleasing, as both the color and the 3-D aspects will tend to enhance each other. Provided, of course, that this co-opting of enhancement is correctly done.

Certain artistic and psychological principles regarding color can be very useful in the painting of scenery and props and the lighting of a scene. One of the strongest of these is the concept that warm colors (reds, oranges, yellows) tend to appear closer, and cool colors (blues, greens) seem to be further away. This concept even extends to pastels and muted colors: tans will appear closer than greys. Brilliant blue colors which approach the UV spectrum can be disturbing to some viewers.

Lighter colors will seem to be closer than darker colors. A light tan will seem closer than a dark brown of the same colorimetric hue.

A practical example: a bright red object in front of a dark blue background will appear to be much closer to the camera and the audience than a dark blue object in front of a bright red background, even when the actual 3-D parallax in the two scenes is identical!

Taking the example from the previous section on contrast, color can be used to bring the image of a light source against a dark or black background much closer than if that source is neutral.

Actual parallax may be widened a bit if the color of the light source is anything other than neutral (white). Color lowers the effective contrast, and also tends to mask the fringing or ghost image observed through the polarizers. With color, there is some dye density in the light source area of the film, whereas a clear white produces an area on the film where there is no dye, and therefore no density other than that of the film base itself. If the surrounding background is black, all three dyes in the film are concentrated to maximum (the release print has 100% D-max for all three colors) and the maximum possible contrast situation exists. Only a small amount of color can improve this situation considerably. The colors that tend to cause the most problems with 3-D films are white, silver and black. Light yellows, and dark blues can also restrict parallax limits. Whenever feasible, avoid large amounts of white and large amounts of black or dark blue or dark brown.

The maximum visual brightness consistent with the lowest actual contrast will occur when the color of the light source is very close to the color of one of the three dyes in the release print. The colors of these dyes are: magenta (a bright pink-red), yellow, and cyan (a blue-green). Secondaries, which are a mix of equal parts of the primary dyes will provide the next brightest image in terms of visual response. They are: red (the opposite of cyan), green (the opposite of magenta) and blue (the opposite of yellow). The purest red obtainable on release print film will be composed of equal parts magenta and yellow. Likewise, the purest green will be of equal parts cyan and yellow, and the purest blue of magenta and cyan.

Combining this condition with the previous stated condition, it becomes apparent that a light source of pyrotechnic effect in the scene can be made to appear closest to the audience if it is magenta, yellow, or red, since both conditions are satisfied simultaneously. An orange color would work better than neutral (since the color does have lower contrast) and better than blue or green (since it is a warm color) but not as well as the other three, because of the inequality of dye distribution, which tends to mute or muddy the image.

For areas behind the plane of the screen, cool colors are preferred, since they tend to make the light source appear even further back.

In the area close to the screen plane (approaching zero parallax),the choice of colors broadens considerably. If the light source(s) can be restricted to an area at or very near to the screen plane, nearly any color may be used, including neutral (white, or clear film).

For purposes of clarity, the preceding explanation involved an extreme situation. The general concept, however, applies to all 3-D scenes, even those exhibiting very low contrast, such as haze or fog scenes. In real life, distant objects such as mountains that are miles away will tend to appear to recede even further due to the bluish haze caused by the intervening atmosphere. A set that is dressed with predominantly warm colored props in the foreground and mainly cool colors in the background will appear to have much greater depth for the same choice of convergence and parallaxes than a similar set and props colored the reverse. Of course this rule does not have to be adhered to religiously: Variety is always welcome, and maximum depth appearance is not always necessary or even desirable for the mood or effect of a particular scene. But an awareness of the possibilities can provide a greater capability for most effective use of color and 3-D together.

Some other effects of color in 3-D cinematography, as well as the effects of polarizers on the viewed perception of color will be covered in the section on makeup.

13. Texture

The use of texture implies sufficient resolution in a photographic system to clearly resolve the texture. Therefore, this discussion will necessarily assume that the measures have been taken to achieve the maximum possible sharpness over the widest possible range in the image.

Texture, like color, is important to a 3-D film beyond the aesthetic effect which it has in a flat film. For, it is through the judicious use of texture that much important 3-D information is conveyed.

Comments have been made about some 3-D movies, that actors and objects appear not as fully rounded three dimensional objects, but rather as cardboard cutouts placed in different planes within the scene. These undesirable effects have been caused by a lack of texture, either because of poor image sharpness (which can be caused by u se of poor quality lenses or misuse of good quality lenses) or by poor or inappropriate lighting.

Keep in mind that the viewer's eyes are constantly scanning the images on the screen (up to 30 scans per second)! This transmits millions of “bits” of information to the brain (up to 30 million per second)! The <u>differential</u> of the left and right eye “bits” is what enhances the 3-D.

Texture is absolutely necessary to produce a three dimensional image. A flatly lit matte white (or matte grey or matte black) sphere will appear in a 3-D film as a perfectly flat disc. Only when it is sufficiently textured, or lighting is such that high lights and shadows delineate form, and resolution is sufficient to depict that texture and form, will the sphere appear truly round in al l dimensions as it actually is. Remember, <u>do not underexpose</u>. It is far better to overexpose 3-D one full stop than to underexpose 1/2 stop!

Likewise, if there is enough system resolution with good modeling to the lighting, so that the pores of the skin, or at the very least the structure of the face defined by shadows that fall on the skin is clear, an actor will also appear to be a realistic fully-rounded human being, rather than a cardboard cutout.

Dimension in a 3-D film, as in real life, is partially determined by the parallax difference which can be detected by an observer between an object or part of an object and another object or part which is a different distance from that observer. The very subtle but numerous differences in the visual information that the left and right eye images transmit to the brain must always be enhanced as much as possible, including rotating the subject or dollying the camera around the subject very slowly.

If there are more detectable points (visual references) in a smaller area (as within the confines of a single object), that object will appear to take on more depth, dimension, form, and consequently, realism. A rough-hewn rock will appear much more dimensional than a smooth cube; a gravel road more than a bituminous highway.

This is not to say that the lighting must be contrasty to bring out these details. Contrast, by itself can be detrimental to the 3-D effect if improperly implemented, as pointed out previously. Although judgment must be exercised to use lighting appropriate to the scene, for many subjects where depth and dimension are major considerations, cross lighting combined with sufficient fill to prevent shadows from going black often give the most effective results. Cross lighting or side lighting delineate fine details which aid in giving the observers (audience) parallax references, as well as cast appropriate shadows to reveal form, while the fill preserves shadow detail, further adding visual references to the shadow areas while maintaining contrast at a level suitable for the required depth range throughout the entire scene.

This is not to say that high lighting ratios are never permissible. But, when the drama of tone of a scene require such ratios to enhance a particular mood or for aesthetic reasons, much greater care must be taken to insure that form or valuable texture are not lost.

The very form of a texture itself may be important in a scene. When parallaxes are considered, random form textures, especially if fine like sand, permit much wider parallaxes than regular or large textures, such as a brick wall. There is no limit at all to parallax when texture is nonexistent, as with a blue-sky background, but the amount of allowable parallax severely limited if there are strong vertical elements in the texture of the background. A two of telephone poles in the background will split apart if they are too far behind the plane of convergence when shot with too long a focal length lens.

Consider texture as a useful tool for the 3-D cinematographer to use creatively in the building of the 3-D image. Recognizing the subtleties and nuances of every characteristic of the subject are the primary challenges to achieving optimum 3-D results.

14. Makeup

People who are involved with the making of a 3-D movie for the first time are often surprised that there are differences in the makeup requirements for the actors than those of similar flat films. Actually, the reason has little to do with the film or lenses or the way in which it is shot, or even, in general, the film's being shot in 3-D. It has mainly to do with the manner by which the film will ultimately be projected and viewed, especially in which the image will be visually interpreted.

To begin with, consider what happens to the film image when it is projected. Obviously, the projected image will not be as bright as conventional projection, since some light is lost in the optics of the projection device, and a lot of light is lost through the polarizing filters. Remember, the projection light passes through polarizing filters twice: once through the filters in the projection device immediately in front of the projector, and a second time through the filters in the viewing glasses worn by the members of the audience.

The light absorbed by the polarizing filters is not perfectly neutral, nor is it perfectly linear. The result is an image which has been described as “somewhat bluer”. Only, it is not quite the same as if you were to put a blue filter in place. This would affect all parts of the image reasonably equally. The polarizing filters are much more selective in their effect, differentiating both as to amplitude and frequency. That is, different parts of the image will be affected differently depending upon their relative brightness (relative to other parts of the scene) and their relative hue.

Considering relative brightness, there are some differences among different polarizing filters. In general, these differences are most prominent in the densest areas of the image, where very low light levels may exhibit the characteristic cool, or blue shift with some filters, or a warm, often brown shift with others. Fortunately, this area of the image where there rarely is color detail important to its interpretation in relation to the picture as a whole; also, this is an area where visual acuity and color interpretation among different people varies considerably, therefore any slight deviation will usually pass unnoticed. Fortunately, also, most polarizing filters have very similar characteristics to each other in the way they affect the normal density and highlight areas of the projected image. Throughout most of the scale of brightness the image of a neutral subject such as a grey card tends to be reasonably neutral, just slightly cool (toward blue). Highlight areas exhibit a very slightly more blue tendency, but this is in the area of just barely being detectable when compared to middle densities. So much for the effect on neutral subjects. With cool colors such as blue sky or green grass, the effect is almost unnoticeable throughout the scale. It may be there, but the masking effect of the strong base color is such that any differences in these areas are not that noticeable.

It is with the normally warm colors: reds, yellows, tans, and, of course, the skin colors, that the coloration effect of the polarizing filters is most visually pronounced. Since both warmth of hue and areas of less density are more strongly affected, the effect of a blue shift will be most noticeable in warm pastel colors. Skin tones tend to be warm pastel colors. Therefore, they are usually affected to a more pronounced extent than other areas of an image.

Flesh tones are the one color reference which will be instantly recognized by most people in the audience. Of anything in the picture, this is one area which people can readily relate to themselves and those whom they see in everyday life. Therefore, even people to whom color value is a remote concept will usually be quite critical of "unnatural appearing" skin. A director or cinematographer may know that a particular tan colored jacket is a reddish tan and not a greyish tan as seen through the polarizers, but the audience will not know this, or probably for that matter care. But, if the face of an actor appears washed out and bluish, the audience will interpret the actor 's appearance as being rather ill and anemic. A survey would show this interpretation to be quite universal. One solution might seem to be to alter the color with a color filter, or to change the printing lights for a "warmer" print. Unfortunately, neither of these methods are selective as the polarizing filters are. The net result of any such attempt would be to muddy that beautiful green grass and blue sky, as well as neutrals and many other areas of the picture (although in general, a release print that is very slightly, say one point red, will be more visually pleasing that one that is slightly too cyan).

The best approach is to be selective when the image is created. And that means makeup. A base that is darker and warmer in tone than normal is advised for both male and female actors, the correction being more pronounced on the male actors. How much darker will depend to a certain extent on the lighting and the environment of the scene, but as a start, try two shades darker than would normally be used in the particular scene. Entire films have successfully been made with a “Tahitian” makeup that imaged on the screen as a fairly normal acceptable skin tone.

Finishing of the makeup usually will be more effective if it is quite a bit more glossy than normal. The reason for this is that the highlights will add more modelling to the shape of the face and thus, more natural dimension. Review of the section on texture will make the reason for this more clear.

In any case, if this is the first 3-D film of this type with these actors, a film test of the makeup should be made before production begins. This test should be viewed by projection (preferably in a “typical” theater, not just in a lab screening room) with the normal polarizing filters and viewing glasses, not just on a Moviola or editing viewer. It is also important that the test be shot with backgrounds that are representative of those actually to be used in the production.

15. Subject Motion

Both speed and direction can drastically alter the visual effect of a subject that is moving. For purposes of description, we will consider only major directions in reference to the screen, with the understanding that other directions such as diagonal will exhibit characteristics which are a composite of the characteristics of the major directions and proportional to them. Technically, these are known as vectors, but for practical purposes it should be sufficient to recognize that in between motions may be assumed to have less severe effects visually than the motions which are in the major described directions.

First we will consider the visual effect known as “strobing”. Strobing is a characteristic of the motion picture process, and appears in all films, not just 3-D films. However, it is usually more noticeable in 3-D films for several reasons.

Strobing is characterized by the visual effect of a jerky stepped motion of a moving object rather than the smooth motion we would expect in real life. Since the motion picture is in actuality a series of still images, certain motions in the projected image severely strain the capability of the brain to smooth out the stepped sequence of images into a continuous flow as intended. Also, any defects in the film transport systems or shutter synchronization of either the camera or the projector will cause or exaggerate strobing. With over-and-under single film 3-D systems, the shutter direction can even effect strobing, with cameras having vertically traveling shutters sometimes making strobing appear more pronounced than cameras with horizontal shutter travel.

Under certain conditions strobing may be detected in any direction of subject travel, but it is always most severe when the subject is moving transversally (left or right across the screen). Strobing tends to be more pronounced with vertical sweep camera shutters.

In terms of the subject, the severity of the strobing will also be affected by the speed at which the subject is traveling, the distance of the subject from the camera, the direction the subject is traveling, the proximity of the subject to the convergence plane, the shape and texture of the subject, the color and brightness of the subject in relation to the color and brightness of the background, image contrast, sharpness of the subject, and motion blur (a separate characteristic, but related to sharpness). The last point is a result of the camera framing rate plus the camera shutter angle in relation to the subject speed as imaged on the film frame.

Strobing will tend to increase with the lateral speed of the subject up until that speed is sufficient that the smoothing effects of motion blur mask the stepped characteristics. If the subject is moving fast enough, such that detail is obscured, it is sometimes possible to augment the effects of motion blur by also bringing the subject slightly out of focus. This has to be done with care to avoid having any parts of the image which are nonmoving, as in the foreground or background from going out of focus, which is very disturbing in 3-D.

The less contrast, in terms of both brightness and color, that there is between the moving subject and the background, the less noticeable will strobing be.

Since strobing is most severe with lateral motion, sometimes a change of camera position will lessen the effect dramatically.

The visual effect of strong vertical lines will frequently aggravate strobing, especially if they are on the subject. A running actor wearing a vertically striped shirt, or a series of coaches in a moving railroad train invite problems. To a lesser extent, verticals such as fence posts or telephone poles behind the moving subject can act as visual references which will make strobing more obvious.

Vertical motion of the subject rarely will strobe, unless the images are out of phase or out of sync. However, rapid vertical subject motion will incur “time parallax“ which can result in “vertical strobing”, especially with vertical sweep camera shutters. -

Likewise, front-to-back motion rarely causes problems. This direction of subject motion is not often used, but it is very effective in 3-D. The few cautions regard splitting, which can occur if the motion is extremely slow at the start of the shot. Splitting is unlikely at the end of a normally converged shot of this type, since the subject will most likely be closer than visual infinity, which should already have been set to have less parallax than would cause problems.

Back-to-front motion, the so-called “coming at you” effect, is the one most likely to cause problems. When the subject starts from somewhere in the scene and moves toward the camera, the available depth range is most likely to be exceeded. Attempts have been made to make the subject appear to “come out further” be extending the parallax. This is exactly the opposite of what should be done, since this foreshortens the available depth range, and the image of the subject splits apart even sooner.

Considered in terms of depth ranges, several things can be done to lengthen the apparent distance over which a subject may travel when moving from back to front.

The more rapidly the subject moves, the more extended the range will become, since the eye has less time to let the eye muscles relax from the activity of following the subject motion and the brain has less time to process the depth cue information. As explained previously, decreasing contrast and increasing color saturation will also aid the eye muscles in tracking the disparate images of the stereo pair as they separate. We recommend that whenever practical, camera speeds be slightly increased for rapidly moving subjects, especially when near the camera. Thirty to 36 frames per second instead of 24. This usually improves the 3-D perception as it reduces blurring and often looks more “natural” than “normal” speed.

Use as much of the range that is available. This may seem obvious, but it is surprising how often attempts are made to bring a subject close when the subject is starting from a position that is already relatively close, such as the screen plane, or even closer. There simply is not that much range of parallax separation left before the image splits. In general, all other characteristics being equal, the further back the starting position, the closer to the audience the subject may appear to come.

Use color to advantage. A warm colored subject against a cool colored background will be easier to bring closer, and it will appear to be closer at its closest point than it actually was. Also, there may be nothing wrong with changing the color of the subject as it moves forward. If a stage setting is generally lit with cool colored illumination, the subject, starting in the background will also be lit in cool color. If a spotlight or kicker with a warm colored gel is aimed such that the light does not reach the background, but only covers an area in the foreground through which the subject will travel as it comes forward, only the subject will warm in color as it approaches the camera, thereby increasing the color contrast the closer it gets, and extending the available depth range. Properly done, this color shift will not be noticeable as such, only as an added depth cue.

Dollying the camera can extend the range available, and this will be covered in the next section.

FOLLOW CONVERGENCE

With a fixed camera, the convergence can be still be altered during the shot. You do not want to “follow convergence” in the strict sense, since this would keep the subject in the same image plane. What should be done is a “follow with precession”. That is, if convergence is moved in the same direction as for following the subject, but at a slower rate than the subject, the net effect will be to narrow the parallax shift as the subject moves closer, thereby allowing the subject to come closer to the camera before the image splits. Since the image of the subject will be much larger at the last frame, for the same amount of parallax, the subject will appear to have moved much closer. This technique is especially valuable when the subject is required to move slowly, which, as has been pointed out, foreshortens the available travel range with a fixed convergence. Large objects usually cause less problems in splitting than small objects, up to a limit. That limit is reached when the subject touches any edge of the picture as projected on a screen. There are conditions whereby this limit may be successfully exceeded, especially when the subject is moving rapidly enough, or is moving somewhat diagonally, not just back-to-front.

In any case, certain safety factors may be applied to minimize the undesired loss of dimension due to splitting. One of these is to limit parallaxes such that neither positive nor negative parallax exceeds the cross-section of the subject. In the case of back-to-front motion, positive parallax at the start of the motion should not exceed the factors expressed previously for non-moving backgrounds. Negative parallax for the closest position may be considerably more than that for a stationary object, since the eyes will instinctively track an object moving toward the observer, especially if that motion is very rapid. However, it should usually not exceed about 2 feet on the screen (about.080'' on the groundglass, slightly more than 1/16'') at the closest point (final frame) for rapidly moving subjects. Obviously, it would not be possible to accurately check this during the filming, but it can be checked beforehand by placing one of the convergence poles at the closest position and measuring the parallax. Follow convergence should not be done too <u>rapidly</u>. The audience's eyes must be given time to accommodate.

As with still subjects, objects moving toward the camera should be kept sharp and well defined with appropriate lighting throughout the travel range. Also, as with still objects, texture aids tracking, as it gives more visual references for the eyes to “lock on to”. For example, an arrow with a rough hewn flint arrowhead can come further off of the screen than a smooth bladed knife in an equal situation.

Consider all factors including subject shape in applicability to this particular subject motion. For equal conditions, a Frisbee, which has a total cross-sectional area similar to that of a baseball, could be in theory brought further off of the screen, since the shape more closely conforms to the shape of the screen, and it would not touch the edges of the screen as soon as the baseball would. In actual practice, it usually would be easier to make the baseball appear to come out further, since it would normally be traveling at a much higher rate of speed than the Frisbee. Of course, in an actual situation, both objects will probably exit frame at one, or at most two, edges of the screen before it is all that close anyway, due to the difficulty in attaining the accuracy of propulsion necessary to keep the object in exact frame center all of the way to the closest position.

Before leaving the discussion of subject motion, it should be pointed out that since in a 3-D movie the screen, other than the very edges, ceases to be a very strong reference as to distance. Therefore, subject motion is usually visually referenced to other objects in the scene. If the foreground to background range have props, actors, scenery located at different distances, these serve as excellent references to which subject motion and relative distances are visually compared by the audience and the appearance of a greater travel range is considerably enhanced. Also, objects closer than the background serve as visual references in terms of relative parallax, such that the subject can be brought further forward without apparent splitting if it occludes background items that are closer in parallax as well as distance, since these rather than the extreme furthest plane of the background will serve as visual references for the eyes. Remember, the audience's eyes are constantly and rapidly scanning every part of the scene. All these visual cues are being fed instantaneously to the brain. Like all visual perception, these images are being compared to memory.

Also, motion, direction, and speed are referenced to other moving objects in the scene. Multiple actions in a scene can usually be advantageous, with a couple of major exceptions. The visual distraction caused by secondary objects moving in the scene can reduce the effective range of depth possible when objects are moving toward the camera. These primary objects will tend to split apart sooner, since the eyes are distracted from following them as intently. When there is a counter-motion to a laterally moving object, the effect of strobing is intensified. An example would be a road or highway as viewed from the side, with automobiles traveling in opposite directions. If the cars are going equal speeds, the cars in the far lanes seen between the cars in the close lanes, the effective strobing will be twice that observed if the cars were all traveling at the same speed and direction in front of a static background.

16. Motion of Camera

Camera motion, when carried out smoothly and appropriately to the scene, can be an extremely valuable technique in a 3-D film. The moving camera imparts to the realism of the 3-D image a sense of audience participation that is rarely possible to attain in an ordinary flat film. The audience is treated to the capability of moving about and through a scene much as if they were actually there. The camera becomes their eyes.

In addition, the moving camera makes use of certain optical and perceptive visual cues which are often used to impart a pseudo sense of depth to flat films, especially those shot in some of the non-3-D widescreen processes. These traveling illusions combined with the peripheral vision simulation of the widescreen can sometimes be very convincing in fooling the brain into interpreting relative motion in a flat picture as depth. When these effects are combined with a true widescreen 3-D image, the visual effect can be truly marvelous, even astounding.

It may be necessary to increase camera speed from 24 FPS to 30 or 36 FPS to enhance the 3-D effect on some camera moves.

3-D CAMERA MOVEMENT; DOLLY OR STEADICAM

Any of the existing methods of smoothly moving a camera dolly, crane, camera car, helicopter, Steadicam, etc. can be used as well as new methods invented by creative cinematographers all the time.

Motion in any direction may be implemented, although as with a moving subject, strobing is possible with rapid lateral motion. A very slow, sideways dolly, especially if on a diagonal can, with care, be very effective. Moving around and through a scene, especially a scene with a lot of depth cues. The Steadicam has proven to be an excellent tool for this purpose. Steadicam*shots in 3-D gives the audience the feeling of truly “being there”.

3-D camera movement in a slow circular fashion, around the main subject can enhance stereoscopic perception very substantially.

Aerial photography from conventional aircraft, helicopters, and even hot air balloons can create a real thrill, provided that they are done from relatively low altitudes. Just as in real life, the impression of depth diminishes with distance.

All sorts of moving platforms may be used for the 3-D lens equipped camera. Do not hesitate to experiment.

All of the techniques which apply to locked-down cameras may be used with moving cameras, including changing of convergence and/or focus during the filming. A camera dollying back from a scene can extend the range of depth and distance over which an object may travel toward the camera without image splitting. The net result is that of an object coming much further out of the screen toward the audience than would otherwise be possible.

The special instance of the laterally moving camera, where the camera is following the subject at the same tracking speed as the subject, calls for an exception to the depth of field rule.

Since the background would be expected to be blurred due to motion in this situation, it is not only permissible, but highly desirable to use a narrow depth of field to blur the background even further. This will materially reduce strobing and simultaneously reduce the tendency for the background image to split apart when the background is some distance behind a close main subject.

An example would be where the camera is attached to a platform mounted on the side of a vehicle, and the main subject is the driver of the vehicle, with the background being seen whizzing by beyond the window on the far side of the vehicle. This is why it is so important to use a qualified 3-D consultant who can help to predict the amount of visual attention or distract ion the background will cause, thus detracting from the quality of the shot. With his assistance, don't hesitate to experiment.

17. Camera Angle Tilting Point of View

A 3-D movie has been compared to a stage play, primarily due to the realism it imparts to a scene. In many respects, it has advantages over what can be done in a stage play. One of these is the capability for establishing and then at any time changing the angle from which a particular scene is viewed. The simultaneous use of more than one camera with more than one lens can add a real useful range of creative control.

** Steadicam is a registered trademark of Cinema Products, Corp.*

Tilting of a camera up or down while keeping it laterally level can be done either to change the angle and/or perspective, or during a shot as a valid means of imparting motion to an otherwise locked-down camera. Of course, in some circumstances, combining tilting with other camera motions, such as in a moving crane shot, can be extremely effective. A slightly lower than normal camera position tends to increase the dimensionality of most subjects.

In general, lateral tilting of the camera is to be avoided however. This is because the realism imparted by 3-D establishes the camera as an audience POV in most instances, and people don't normally walk around with their bodies or heads tilted at an angle. There are, however, a few legitimate situations where such lateral tilting is believable. When the camera is mounted in a vehicle that the audience is aware would normally tilt: a race car on a banked track, an aircraft banking through a turn, a roller coaster or other amusement park ride that would normally impart a tilt to the rider.

Whenever practical, it is advisable to follow the main subject that is passing the camera rather than the subject simply pass the camera. This tends to enhance the 3-D since the main subject will then remain sharp rather than be a non-dimensional blur.

18. High Speed and Low Speed Camera Operation

Over cranking and under cranking of the camera can be a very useful technique, provided that it is appropriate to the action and is not overdone. Like many effects, the temptation is to use this technique too often, and the impact of the effect wears off, much as overuse of the aiming of moving objects at the audience is all too often overdone.

Used sparingly in a believable manner, the use of camera speeds either higher than or lower than normal can create a visual feeling that is very dramatic. The use of these speeds do require some cautions, however.

Slower than normal camera speeds require very smooth motion on the part of the subject, and if the camera is moving, very smooth motion of the camera. Strobing can increase due to higher subject or background speeds.

Higher than normal camera speeds require more light than normal to maintain the necessary depth of field, of course. By slowing the action down, some types of “off-the-screen” effects tend to work better. However, it is not advisable to slow down subjects that are expected to move rapidly, such as speeding cars.

19. Special Considerations Regarding Sound Systems Used With 3-D films

Since 3-D imparts added realism to the picture, it is only fitting that every effort be made to use a sound system with the film that will also do the most to augment the sense of realism in the sound.

Certainly a low noise high-fidelity system such as Dolby* is to be recommended. What may not be apparent is the distinct contribution that a surround-sound stereophonic system can do.

When an object is located or moves within the apparent realm of the theater auditorium (in front of the screen), the sense of being located closer to the audience than the screen plane is enhanced considerably if the sounds of that object or actor are made to seem to also eminate from a position closer to the audience than the speakers located behind the screen. Human senses tend to like to work together, and if the sound of an object moves out into the auditorium, the eyes will automatically follow the image of that subject.

So strong is this visual/aural coordination, that surprisingly wide parallaxes will be visually accepted under these conditions. In other words it is possible to actually extend the depth range and bring an object further off of the screen (closer to the audience) when the sound moves with it.

In real life, our brain directs our eyes to follow sounds. If a sound source moves, our eyes will track that object causing the sound automatically, instinctively, instantly.

In terms of directing an audience's attention, the combination of a 3-D picture with a 3-D (stereophonic surround) sound system is the strongest tool yet in the hands of a creative director.

** Dolby is a registered trademark of Dolby Laboratories.*

20. Enhancement of the 3-D Image

The normal intent and purpose of stereoscopic cinematography (3-D) is to produce as realistic and natural an image as possible. However, as with any artistic medium, there are times when it is desired to enhance the image for a surrealistic result.

Certainly, various means of image enhancement may be employed on the optical printer. However, the possibilities for in-camera enhancement should not be ignored.

By enhancement, reference is made to systems and methods for changing the basic image in principal photography, not special visual effects which will be discussed in the next section.

Any of the means of image enhancement such as latensification, special film stocks, special processing, etc., that are done with flat photography could be used with a 3-D film. In addition, there are some things that can only be done in 3-D motion pictures which will enhance the visual impression.

Colored gels of differing hues are sometimes used on lights illuminating textured surfaces from different sides in flat films to better delineate the texture. In a 3-D film, a similar technique may be used to actually color raised areas of a textured surface one color and depressions another. The depth of the texture will be greatly enhanced when viewed in 3-D.

By using differing amounts and qualities of lighting in different parts of a scene in the range from the closest to the farthest points in the scene, distinct separations of areas will occur, which will increase the apparent distance from the closest to the farthest point.

Moving of the lighting from one area of a scene to another during filming, and following either or both focus and convergence to the area being lit at the particular moment, can forcefully redirect attention from action in one part of a scene to action in another.

Silhouette of objects or actors by lighting the background behind them, and converging on the background, then bringing up foreground lights while filming, simultaneously shifting convergence from the background to the now fully revealed subject can be very dramatic.

Converge on the very front of an actor's face, or even a few inches in front of the face. Then, while filming, fade in a rim light arrangement while simultaneously shifting convergence to a point just behind the actor's head. The actor will appear to emerge from an aura of himself. This visual impression is especially convincing in close-up, or semi-close-up.

When two scenes or edits have drastically different planes of convergence and they are to be cut together, start changing convergence at the end of the first scene or edit. Then the two scenes will cut together without a noticeable jar to the audience. With this gentle shift, you have the choice of any kind of cut from a crash cut to a complete lap dissolve.

Sharp, well lit smoke, wisps, (back-lit), haze, and water spray will produce depth effects in 3-D very much more impressively than in flat films. Hazy “fog” atmosphere should be avoided, as this will tend to diminish the 3-D effect.

With long shots, such as distant vistas, inclusion of carefully selected foreground items will enhance the 3-D image considerably, and serve as a reference to visually compare and show how far away the background really is.

Use of brief relatively flat scenes with very little depth immediately before a scene with a lot of depth, or any effect involving 3-D, will enhance the impact of the depth in the effect.

Carefully positioned mirrors or other reflective surfaces in a scene can add a lot to the depth impression. These will have to be positioned such that they do not reflect anything into the field of view that should not be seen. Check carefully both images in the viewfinder. Also, check that lighting reflects off of these surfaces equally in both images. Unequal reflections, especially of highlights, can be very visually disturbing.

21. Considerations If Special Effects or Post-Operations are Anticipated

In a conventional flat motion picture, any principal photography in which optical effects are going to be added requires very careful preplanning and execution, in order that all image parts will match, that every element will be exactly positioned as to the horizontal and vertical location in the picture.

With 3- D, the very name <u>third dimension</u> points out the need for consideration of the third dimension - depth - when principal photography or background plates for effects are shot.

As such, much more care in the planning and shooting of these first elements, the principal photography or plates, is required. In order that this positioning of all elements be accurate and believable, it is <u>imperative</u> that the principal photography which will be combined with any subsequent elements by shot <u>first</u> before any miniatures or other items are to be shot.

The special effects 3-D consultant must have work prints of the background elements first in order that very critical measurements may be made on them, so that the other elements can be shot in a manner by which the depth on them will match. The reason that this is so critical is that not only will it be necessary to establish the exact position of the subsequent element in the three-dimensional space relating to the background, but the actual three-dimensional perspective on these elements must match as well. Also, since it is in 3-D, parts of the background may well become middle ground or even foreground, and the image parts must interrelate precisely.

This much is necessary for 3-D in a still image. Since, however, this is a motion picture, these elements are usually coordinated and interrelated for different characteristics on each frame.

In terms of planning a motion picture for which optical effects are to be combined in 3-D, it is usually wise to schedule any background plates to be shot at the very beginning of the production. Then, effects can be shot simultaneously with the remainder of the production, usually a very efficient approach in terms of both time and costs. It should be pointed out, however, that with such an approach, a separate 3-D consultant will be required for special effects, just as a separate consultant would be used on each unit when there is more than one unit shooting simultaneously on principal photography.

For this purpose, a system and consulting service specifically designed for special visual effects is available. The Stereoscope system is a special effects system which may be contracted for separately. Stereoscope offers many special effects capabilities in full natural 3-D, and is fully compatible in every respect with the StereoVision system. When special effects in 3-D are anticipated, it is recommended that the background plates, which usually have requirements similar to those of other principal photography, be shot with StereoVision lenses and the elements for the effects be shot with Stereoscope as was successfully done recently in the science fiction 3-D film, “Metalstorm”. This is because each of the two systems is designed for optimum performance in their own areas. The capabilities of the Stereoscope system are quite different from those of StereoVision, and utilization of this combination will provide outstanding results in the most cost-effective manner. Like StereoVision, the StereoScope system is a single-film, single-camera system which allows effects to be shot in a single-pass for each element, thereby saving both time and film, and minimizing the possibilities for error, which are much greater with double-camera or double-pass systems.

Stereoscope offers, among other features, variable convergence, variable interaxial over a wide range, continuously variable lens focal lengths over a very wide range of long focal lengths (including 3-D macro and telephoto), capabilities for blue screen, front and rear projection, animation (including rotoscoping in full 3-D), and many other effects: Further information on Stereoscope is available from John A. Rupkalv is, (818) 848-9601.

22. Lab Services and Projection of Dailies

Choice of laboratory should be predicated on the same factors which would be considered in that decision for flat film if the projection of dailies is to be done at a screening room <u>other</u> than that provided by the lab. If dailies <u>are</u> to be projected at the lab, their screening facility should be checked before any contract is written for the lab services. The reason is that while processing of 3-D footage may be done by nearly any qualified lab, meaningful screening of 3-D dailies requires special capabilities.

In general, the closer the work prints and release prints are to what would be optimum quality for a flat print, the better they w ill be as 3-D prints. All of the qualities associated with excellent flat prints, such as sharpness, color balance, good highlight and shadow detail, fine grain, solid blacks, etc., are just as desirable for a 3-D print. The major dangers are 3-D prints that may be too dark or too cold in tone. A print that is slightly light and slightly warm would be preferable to one that was the other direction, but in any case the timing should be very close to "normal". However, it may be about 2 to 3 "printer points" lighter than normal.

Screening requires as close a simulation of the manner in which prints will be viewed in the theater as possible. The first question is whether the screening room (either at the lab or elsewhere) is equipped with a silver screen. Matte white, pearl, beaded, or other screen surfaces will <u>not</u> work, since they depolarize the image, rendering it into a pair of flat images instead of a single 3-D image as it should be. Viewing dailies flat rather than in 3-D is a nearly useless waste of time, since any error in 3-D will not show up until it is seen in 3-D.

Only <u>clean</u>, <u>high-grade 3-D polarized viewing glasses</u> should be used to view dailies or to screen 3-D films for trade evaluation. 3-D glasses that are soiled will cause a totally false impression of the film.

StereoVision can equip any screening room that has a silver screen for 3-D by the simple installation of Stereo Flex™ or other StereoVision 3-D projection optics on any professional 35mm projection equipment. The use of StereoVision 3-D projection lenses and standards for projecting dailies or trade screenings is part of StereoVision's producer agreement. It is strongly recommended that during production and prior to a lab release print run, that one or more local theaters be chosen to test screen the film. These should be "typical 3-D theaters" so that it can be determined how the picture will appear to the public and whether or not the print is too light or too dark. The 3-D consultant can be of valuable assistance here so that optimum 3-D results can be achieved.

The screen and auditorium should be large enough so that the screen and seating distance will be very close to that in a normal theater.

23. Editing

Editing of 3-D films in general will be similar to that of conventional flat films, with but a few exceptions. Provision should be such that both upper and lower images of the 3-D pair may be seen simultaneously. If one image is covered, it should be made easy for the editor to uncover that image to check both images before the final cut.

Special systems are available whereby the images on a Movieola* or a flatbed editing bench may be viewed in 3-D. Such a capability allows the editor to match cuts such that adjacent edits blend together smoothly in terms of depth; that there are no sudden unintentional jars due to drastic differences in convergence points from one edit to the next. Just as editing a color film from black and white workprints would be very risky due to the possibility of color mismatches from one edit to the next, editing a 3-D film from a flat workprint (or a 3-D workprint that is viewed flat) is equally risky.

WHAT TO DO IF A PROBLEM SHOULD A RISE

As with any precision product, adverse conditions may cause problems or alter performance so that the product no longer operates within original specifications.

Should a problem arise, first analyze the situation carefully and logically. Make certain that the problem is not caused by something obvious and simple to correct, such as a piece of adhesive tape on a lens shade or filter holder.

If the problem is such that it may not easily be corrected in the field, call STEREOVISION at: (818) 841- 1127. Usually, the 3-D consultant will be available to place this call for you and take whatever correction steps are necessary.

Should the lens require return to the factory, StereoVision will advise as to the exact procedure applicable to the specific situation. A general description of this procedure may be reviewed in Section 12 of the Functional Operating Instructions -Packing, Transporting and Shipping of Lenses.

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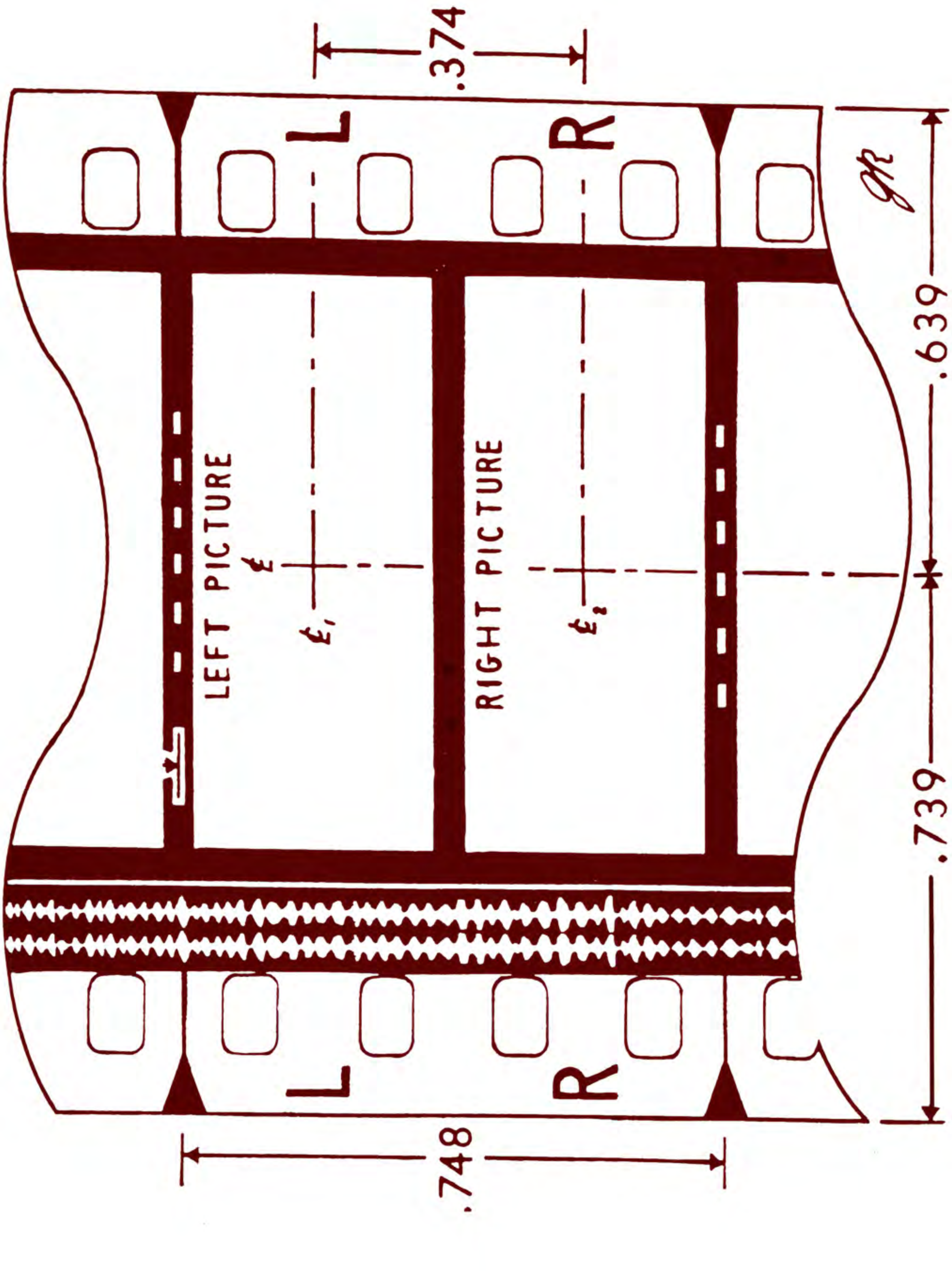
* Movieola is a registered trademark of Magnasync/ Movieola, Inc.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DEFINITIONS OF STEREOGRAPHIC TERMS

Some of the terms used in this manual are relatively uncommon in general usage, as they apply specifically to stereography (the science of three-dimensional imaging) in the optical and allied fields. Therefore, these terms are defined as they are used in this manual.

The scientific or technical definitions of some terms are quite lengthy and complex. For purposes of clarity, they have been abbreviated to the form that they appear herein. This brief form should be sufficient for the use for which this manual is intended. It should be understood that there are variants and special conditions under which the definitions may not always be directly applicable. If these occur, the 3-D consultant will advise accordingly.

Amplitude - The extreme range of a fluctuating quantity. In the case of polarizing filters, this is the range of light transmission through these filters at any specified frequency, for a specific polarizing material. **See also Frequency**.

Anaglyph - Originally, any 3-D system using 3-D viewing glasses of any type. Now, specifically, those systems using colored filters, as opposed to those using polarizing filter. For high quality 3-D motion pictures, polarizing filters are far superior to the colored filter anaglyph type viewing glasses. **See Polarizer**.

Analyzer - In regard to polarizing filters, the analyzer is a polarizing filter which is used to block most of the light which has passed through a previous polarizing filter, known as the polarizer. In a 3-D projection system, the analyzer filter in the viewing glasses cross-cancels the image for the opposite eye. Analyzers are identical physically to polarizers; they differ only as to the position in the system, polarizers being first, analyzers second. **See also Cross-cancellation, Polarizer.**

Aperture - An opening; in photography, an opening or openings through which light may pass, such as the opening in a T/stop slide or the opening in the plate immediately in front of the film and film gate in a camera or projector (aperture plate).

Binocular - As seen with two eyes. An instrument with two eyepieces arranged such that it is possible to look through both eyepieces simultaneously to view the images presented stereoscopically, as when viewing through a binocular microscope. The term is most commonly used in connection with a type of viewing instrument which provides both magnification and an extended stereo base through folding of the light path prismatically of a pair of matched telescopes (as opposed to a pair of field glasses which are a pair of matched telescopes and an unfolded light path}. Thus, consideration of the basic design concept of these two very common optical instruments, the field glasses and the binocular may help clarify the distinction between interaxial and interocular. With field glasses, the interaxial and the interocular are identical. Only relatively close objects may be seen stereoscopically through field glasses. With binoculars, the interaxial of the objective lenses is wider than the interocular between the eyepieces, thereby permitting the stereoscopic viewing of objects at much greater distances. **See also Interaxial, Interocular, Monocular.**

BNCR mount - The most widely used current lens mount on professional motion picture cameras and lenses. It differs from the older BNC type mount only in the back relief for clearance for the reflex mirror in reflex type camera. BNCR is the designation assigned originally by the Mitchell Camera Corporation, the initials referring to the camera for which it was originally designed, the Blimped Newsreel Camera, Reflex.

Collimate - To make light rays parallel. That procedure by which parallel light rays are utilized to align an optical system.

Colorimetric - Of or pertaining to the measurement of color, especially as measured on a color imeter.

Color Value - See **Value.**

Conjugate Ratio - The ratio of object to image of a lens for both distance and magnification.

Convergence - To bring coincident points in the left eye and right eye images of the stereoscopic pair together in register in a common plane. In photography, that plane will be the film plane in the camera; in projection, that plane will be the theater screen. Convergence is often confused with toe-in, but the two terms are not exactly the same. Toe-in is one method of achieving convergence, but convergence is not always toe-in. (**See Toe-in**.) StereoVision lenses achieve convergence through lateral movement of optical elements, thereby eliminating toe-in distortion (there is no keystone distortion with StereoVision lenses). Any point at which the StereoVision lens is converged in the convergence plane will appear in the plane of the theater screen when the projection system is properly aligned. Convergence moves the entire scene, but does not affect stereo perspective. **See also, Stereo Base, Stereo Perspective.**

Cool Colors - Colors which are low in frequency (bluer in hue), and are located on the left side of the visible spectrum as normally represented. Cool colors include blues, violets, cyan, aqua, turquoise, and most greens except for very yellow greens, and all of the hues in between these. Cool colors tend to be regressing (appear to make objects which are colored with them seem farther away). **See also, Warm Colors.**

Cross-cancellation - That property of polarizing filters, whereby light will be selectively absorbed by two such filters for the least possible transmission through the combination of the two filters, when they are crossed such that the axis of polarization of each is at 90^o to the other. In a theoretically perfect polarizer, no light at all would pass through such an orientation. In actual practice, there is a small amount of leakage. **See also, Ghost I mage.**

Cyan - See **Dye.**

Densitometry - The science of the measurement of optical density of a material such as photographic film, in order to determine the ability of the material to prevent the transmission of light.

Depolarization - To depolarize or reduce polarization. That property of a material or optical device which tends to reduce or cancel the effects of polarization, as with a non-silver projection screen, or certain projection optics. Partial depolarization may allow some stereoscopic relief, but the depth range will be foreshortened, and ghost images will be severe, as will image splitting.

Depth - A dimension extending in a front-to-back direction, as opposed to height and width. As such, height and width (as of a flat motion picture screen, or images of objects projected flat upon the screen), are ref erred to as the first and second dimension (as in two dimensional), and depth as the third dimension (as in three dimensional). Stereoscopic still photographs are three-dimensional; stereoscopic motion pictures are actually four-dimensional, since they are capable of recording and exhibiting the fourth dimension, which is time.

Depth Range - In a stereoscopic motion picture, that range from the closest object which can be resolved without splitting in a scene to the farthest object which can be resolved without splitting in that scene.

Device - That which is formed by design, usually an integral unit, as opposed to a system, which is a set or arrangement of units. A stereoscopic camera lens may be referred to as a device.

D-max - In densitometry, D-max (sometimes called Delta-max) is the maximum density present in a specified processed photographic film. In the case of a theatrical release print, it represents the most dense blacks achievable in the shadow areas of the picture when all three dyes in the film emulsion are totally saturated.

Dye - A coloring matter or colorant of a specific hue. In modern photographic color films used in the motion picture industry, there are three dyes which in various combinations form the color image: These are magenta (purple-red), yellow, and cyan (a blue-green). On the photographic color wheel, magenta is between red and blue, and is the opposite of green; yellow is between red and green, and is the opposite of blue; cyan is between blue and green, and is the opposite of red.

Dye Density - In densitometry, the density of one or more dyes at a specific location in the image on a photographic film. Since the collective densities of the dyes at that particular point determine how dark an image will appear at that location, the darker a picture appears to be, the greater the dye density is said to be. The amount of dye density at any point in a release print is determined by a combination of the original camera exposure, the processing of the negative, the printing light exposure (print timing), and the processing of the release print stock. Any errors in any of these can result in a muddy or poor quality print unsuitable for 3-D exhibition.

Emulsion - The photosensitive part of a photographic film, consisting of gelatin, silver, dyes used for increasing sensitivity, sometimes preservatives and hardeners, and in the case of color films, the color dyes, color selective dyes, and, in the case of chromogenic films, couplers. Nearly all films currently in use for theatrical filming and exhibition are chromogenic.

Extinction Ratio - The ratio between maximum transmission and maximum extinction (density) of a pair of crossed polarizing filters. The higher the ratio, the more efficient the polarizers are said to be. The increase is non linear: a slight decrease in maximum transmission will produce a very great improvement in cross-cancellation.

False Image - See **Fringing, Ghost Image.**

Flat - Any film that is not in 3-D. The term has frequently been misused to refer to any film not in scope (anamorphic widescreen), but this implies that such processes are 3-D. Actually, scope films are just as flat as any other. Only true stereoscopic films are really 3-D.

Focal Length - See **specific type, as long, normal, etc.**

Follow Convergence - A procedure whereby convergence is changed during filming to keep a moving subject in convergence as it moves closer to or farther from the camera. Such a procedure will keep the subject at the plane of the projection screen, and the background and foreground will move forward or back relative to the subject. If this is carried over a very long distance, the net effect visually will be of a change in size of the subject converged upon. That is, when the subject is farther away, it will appear smaller than when it is close if it is still in convergence.

Frequency - The number of vibrations or cycles per unit of time. In the case of polarizing filters, this is the range of light color (hue) through these filters at any specified amplitude, for a specific polarizing material. **See also, Amplitude.**

Fringing - The edge of the opposite image seen adjacent to the correct image when a picture is projected. That is, part of the right eye image is seen with the left and and/or part of the left eye image is seen with the right eye. Fringing is the term usually used when the disparity is small, as an outline on one or the other side. As such, it is usually a result of either defective polarizers or a defective or improper projection screen, or too high an image contrast in photography. **See also, Ghost Image.**

F/stop - A lens aperture, the size of which is determined from a formula whereby the diameter of the aperture is the reciprocal of the fraction of the focal length. The design of apertures based solely upon F/stops does not take into consideration the actual light transmission through the lens, as T/stops do. **See also, T/stops.**

Full Scope Aperture - An aperture plate in a camera or projector in which the opening is nearly full height and the width extends nearly from the inside edge of the sound track to nearly the sprocket holes on the other side. A full scope camera aperture measures .732'' high by .864'' wide. A full scope projector aperture measures .700'' high by .838'' wide. A full scope aperture in the camera is the smallest camera aperture that may be used with StereoVision lenses.

Full Silent Aperture - An aperture plate in a camera or projector in which the opening is nearly full height and the width extends nearly from the inside edge of one set of sprocket holes to nearly the sprocket holes on the other side. There is no provision for the sound track, but this is no problem, since the sound track is always masked in the printer anyway. A full silent camera aperture measures. 732'' high by .980'' wide. A full silent camera aperture al lows for utilization of the maximum image area covered by the StereoVision lenses.

Ghost Image - The opposite image seen adjacent to the correct image when the picture is projected. That is, part or al l of the right eye image is seen with the left eye and/

or part or all of the left eye image is seen with the right eye. Ghosting is the term usually used when the disparity is large, as a large portion or all of the image of an object seen on the opposite side. As such, in addition to the causes for fringing, one of "the most common causes is the u se of excessive positive or negative parallax in the original photography. Often, it is a result of a combination of causes, each of which contributes to the total result. See also, Fringing.

Glasses - See **Polarizing Viewing Glasses.**

Horizontal Parallax - The actual measurable disparity on film, or the projected images of that film on the screen, between points of objects imaged in the left eye image to analogous points of the same objects as imaged in the right eye image, in terms of exact horizontal displacement. This measurement determines the exact proportion of the third dimension as a percent of the viewing distance from the screen. As such, the actual distance will vary according to the viewing distance. Also, it should be kept in mind that within the context of the stereoscopic world defined by these parallaxes, the apparent dimensions can, and usually do vary considerably from those indicated by actual measurement, due to a variety of reasons, some of which have been identified in the text.

Hue - That property of a color, which determines the visual response in terms of the frequency or frequencies, which the object or light source of that defined color reflects or transmits. The hue of a color may be ref erred to by its position in the visible spectrum, for example the difference between blue, which is a lower frequency color, with red, which is a higher frequency color. If both colors are of the same saturation and intensity, red and blue are said to differ only in hue. **See also, Frequency.**

Hyper-Convergence Setting - Setting of the 3-D camera lens so that maximum depth range occurs without eyestrain.

Image - The visual representation of an object or a scene, as on a photographic film or a motion picture screen.

Image Splitting - When there is excessive parallax between the two discrete images forming a stereoscopic pair for the conditions under which those images are presented, the images will no longer remain cohesive (appearing as a single 3-D image), but will split apart visually, and appear as a pair of flat adjacent images, whether polarizing viewing glasses are worn or not. This condition is known as image splitting. With incorrect photography it can occur under various conditions in any part of an image, from the closest objects in a scene to infinity. It most frequently occurs when images are directed toward the camera and with distant backgrounds. It is always the result of excessive negative or positive parallax for the conditions that exist. See also, Ghost I mage, Fringing.

Intensity - The Chroma, or purity, of a color. Also, the density of a photographic image as recorded in a photographic emulsion.

Interaxial - The distance between the optical axes of two parallel optical paths through an optical system, or the distance between two points on a line intersecting two nonparallel optical paths, at the intersections, perpendicular to the bisection between these two paths on this line. With nonparallel paths, the interaxial will be different at different points in the optical system. Also, the interaxial can change with in a parallel path optical system if the paths are optically folded. **See also, Interocular, Stereo Base, Binocular.**

Interocular - The distance between a pair of eyes, such as the eyes of a human being or, the distance between the eyepieces of an optical instrument through which a person would look during the normal use of the instrument. Thus, the distance between the eyepieces of a pair of binoculars, a binocular microscope, a stereoscopic microscope, or even a stereoscopic viewfinder, would be the interocular of those eyepieces. The distance between the light paths at other points, such as between the field lenses, or optical parts of instruments that are not normally looked through (such as stereoscopic camera lenses) is the interaxial, not the interocular. **See also Interaxial, Stereo Base, Binocular.**

Keystone Distortion - The distortion of an image, whereby the configuration of that image is changed from rectangular to trapezoidal (in the shape of a keystone of an arch or bridge). This distortion can be introduced by several causes, such as the angle of a camera to a scene, the angle of a projector to the screen, optical distortions and, in the case of 3-D photography, toe-in distortion. StereoVision lenses are specifically designed to eliminate keystone distortion in photography when properly used. **See also, Toe-in**.

Left Eye - That image which would correspond to the image seen by the left eye of an observer viewing an actual scene from the exact position as that of the stereoscopic camera lens. The left eye image is the top image in the camera viewfinder and on the film when the film is oriented such that the images are erect (viewed with the top of the image in the same orientation to the bottom of the image as it was in the original scene as photographed). When the film itself is inverted, as it is while being transported through a camera or projector, it becomes the bottom image of the pair. However, since the film frame is normally considered as being upright similar to the original scene when discussed, it is treated as such for clarity in this manual. Thus, references to the top image of the stereoscopic pair on a film frame will refer to the left eye image.

Long Focal Length - A lens which is longer in focal length than a lens designated as a medium focal length. This includes the class of lenses known as telephotos, although all long focal length lenses are not necessarily telephoto lenses. For descriptive purposes, stereoscopic lenses longer in focal length than 40mm will be considered as long focal length lenses with in the context of this manual.
Long focal length lenses often serve purposes similar to their uses in flat photograph y, such as minimizing distortion in close-ups of actor 's faces, and the enlarging of the images of more distant objects. However, they require more care to avoid image splitting, due to the smaller depth range. When the range can be controlled to keep it with in the necessary limits, some very effective results may be achieved with long focal length lenses. Since long focal length lenses cover a narrow angle of view, their use is usually most appropriate when it is desired to be more selective in the area covered.

Magenta - See **Dye.**

Medium Focal Length – A lens which is longer in focal length than a lens designated as short focal length, and shorter in focal length than a lens designated as long focal length. In flat photography this is also often referred to as a normal lens. However, based primarily upon frequency of usage, it would be inappropriate to designate a medium focal length lens as normal to most stereo cinematography. For descriptive purposes, stereoscopic lenses in the range of 30mm to 40mm will be considered as medium focal length lenses with in the context of this manual. All of the characteristics, including stereoscopic, of medium focal length lenses are in between those for long focal length and those for short length lenses. Therefore, medium focal length lenses are most useful in those situations which share requirements with long and short focal lengths.

Monocular - As seen with one eye. An instrument with one eyepiece, such that it is possible to view the image presented only as a flat image without true stereoscopic depth, such as through a conventional telescope with a single optical path. **See also, Binocular, Monoscopic.**

Monoscopic - Having only a single optical axis, such as a conventional camera lens that is not stereoscopic. Monoscopic instruments normally are capable of only flat imaging, unless the fourth dimension, time, is used to derive the necessary parallax for stereoscopic imaging. **See Time Parallax.**

Negative Parallax - The parallax between the left eye and right eye images of objects that are closer than the point or plane of convergence (closer to the audience than the screen when the images are projected) is negative parallax (that is, less than zero). **See also, Parallax, Zero Parallax, Positive Parallax.**

Non-depolarizing - Any optical device or material which normally does not reduce to a noticeable extent the polarization of light passing through or reflecting off of that device or material, is said to be non-depolarizing. An example is a silver colored projection screen, as opposed to other types of screens, which usually tend to be depolarizing. **See also, Depolarization.**

Normal Focal Length - Lenses of focal lengths which are in the area most frequently used for what is considered to be normal photography. In conventional flat photography, normal lenses are usually also medium focal length lenses. With widescreen stereo cinematography, short focal length lenses usually become the normal lenses. **See also, Medium Focal Length, Short Focal Length.**

Object - The actual subject being photographed, as opposed to image. **See Image.**

Occlusion - Removal of part or all of an image, as through an obstruction in the optical path. For example, the dark area caused by a flag being within the field of either or both of the lenses of a stereoscopic lens would be an occlusion.

Occlusion Device - The lens shade on the StereoVision lenses is also often referred to as the occlusion device, since the design is such that it also serves the function of occluding unwanted parts of the opposite images. Therefore, it should be considered as an integral part of the lens, not an accessory, since it is necessary for the proper operation of the lens. Without the occlusion device, lens performance will be degraded, and extraneous images can appear on the film. The edges of the two images would tend to overlap each other.

Orthostereo - See **Stereo Perspective**.

Parallax - The displacement between like points on each of the images of the stereoscopic pair. In the case of pairs which are imaged in the over-and-under configuration, this displacement must be measured in the horizontal direction only. Vertical displacement is not part of parallax measurements. **See also, Horizontal Parallax, Negative Parallax, Positive Parallax, Zero Parallax.**

Phase - The sequence of the images of the stereoscopic pair as they are presented. When the top image is the left eye image and the bottom image is the right eye image (as defined under Left Eye, Right Eye), the standard over-and-under configuration stereoscopic image pair will produce a visual representation that is true stereoscopic. When this sequence is reversed (top image right eye, etc.), it is out of phase and the result is pseudoscopic. **See Pseudoscopic.**

Plane of Convergence - When a stereoscopic lens is converged at a certain distance, all points at that distance, not only the subject converged upon, will be in convergence. Therefore, the plane described by these points in common convergence is referred to as the plane of convergence. Although this plane always exists in theory, in practice it can become somewhat distorted, as when the picture is projected on to a curved screen. Fortunately, such a projection distortion is usually a small percentage of the included visual angle perceived by the audience, and may be considered negligible. For purpose of description, this field is still often referred to as the plane of convergence. **See also, Point of Convergence.**

Point of Convergence - That point in space, often an object or a star chart, upon which a stereoscopic lens is converged. Once the lens is converged upon that point, all other points at that same distance from the lens will also be in convergence, forming the plane of convergence**. See also, Plane of Convergence, Convergence.**

Polarizer - Any optical device, such as a Nichol prism, polarizing filter, etc., capable of polarizing light. **See Polarizing, Polarizing Filter.**

Polarizing - The production of polarization, which is a condition of light in which the transverse vibrations of the rays assume different forms in different planes. This property makes modern 3-D theatrical films practical in terms of the image quality obtainable as compared to any other method available at this time. **See Polarizing Filter, Polarizing Viewing Glasses.**

Polarizing Filter - A filter capable of polarizing light. The filters used in most theatrical motion picture 3-D presentations are polarizing filters, both as polarizers (in front of the 3-D project ion lens or device on the projector) and analyzers (in the 3-D viewing glasses). The use of these filters permits the most accurate color, least ghosting, and highest image quality of any system currently available. **See also, Analyzer, Polarizer.**

Polarizing Viewing Glasses - 3-D viewing glasses which use polarizing filters instead of colored filters. Since the polarizing filters are nearly neutral, they do not exhibit the severe color distortion of colored filter type anaglyph glasses. Also, since cross-cancellation is more efficient (a higher extinction ratio) with polarizing filters, the results are far superior. The axes of polarization in modern 3-D viewing glasses are at right angles to each other, in a V-configuration (at 45° to the horizontal). Some types of glasses use circular polarization, but these require matching projection polarizers.

Pole - As an aid to convergence, a vertical pole is used as a reference. This pole can be placed at the point of convergence to converge upon, or at a location in front of or behind this distance to check parallax at other locations. The procedures are described in the text.

Positive Parallax - The parallax between the left eye and right eye images of objects that are farther than the point or plane of convergence (farther from the audience than the screen when the images are projected) is positive parallax (that is, greater than zero). **See also, Parallax, Zero Parallax, Negative Parallax.**

Precess Convergence - If the convergence is adjusted during filming in a manner such that it follows a subject that is moving either toward or away from the camera, but at a slower rate than the subject is moving, this is known as precess convergence. For example, if a vehicle is moving toward the camera and convergence follows the vehicle exactly, the vehicle will remain in the plane of the screen and appear to stand still but just grow in size. If convergence is not adjusted at all, the vehicle will move forward, but the range of movement will be restricted, and if it moves very far the image will split. If however, the convergence is precessed such that it is somewhat ahead of the vehicle at the start and somewhat behind the vehicle at the end, the vehicle will still appear to come forward, but the range through which the vehicle can travel without splitting will be extended considerably.

Pseudo - False, not corresponding to reality.

Pseudoscopic - Opposite to stereoscopic, wherein relief is reversed, such that close things appear to be far and far things appear to be close. The most common causes of this anomaly in 3-D project ion are misthreading and incorrect splicing, such that the left eye (top) picture is in the right eye (bottom) picture position and vice-versa. Although this will produce a pseudoscopic image, it also exhibits reversed parallaxes. Since parallaxes that would be acceptable for negative parallax may be too wide for positive parallaxes, the image may partially or entirely split into unconverged flat images instead of actual reversed relief. In any case, whether the image appears flat or with reversed depth, it will be unnatural, and not truly stereoscopic. The alert projectionist can instantly correct this by simply reframing the images while the film is running. Pseudoscopic images are a completely unnecessary mistake, which can be avoided through proper procedures and simple attention to the film before exhibition. **See also, Phase.**

Pseudostereo - The condition of being pseudoscopic, sometimes referred to as pseudo stereoscopic.

Range - See **Depth Range.**

Reference Pole - See **Pole.**

Relief - The appearance of depth, such that the image of some objects in a picture will appear to be either closer or farther than the image of other objects. **See also, Depth.**

Reticle - A fine-line pattern at the focus of an eyepiece in an optical system. In the case of a camera viewfinder, this is usually etched on to the groundglass for purposes of aiding composition and, in the case of 3-D imaging, for determining parallax and other information pertinent to the stereoscopic image.

Reverse Convergence - A procedure whereby convergence is moved opposite to the direction in which a subject is travelling. The purpose is to exaggerate the rate and distance over which the subject appears to be travelling. This technique has to be effected with great care and may be done over only a very limited range, since it greatly reduces the available depth range. **See also, Convergence, Follow Convergence, Precess Convergence.**

Right Eye - That image which would correspond to the image seen by the right eye of an observer viewing an actual scene from the exact position as that of the stereoscopic camera lens. The right eye image is the bottom image in the camera viewfinder and on the film when the film is oriented such that the images are erect (viewed with the top of the image in the same orientation to the bottom of the image as it was in the original scene as photographed). When the film itself is inverted, as it is while being transported through a camera or projector, it becomes the top image of the pair. However, since the film frame is normally considered as being upright similar to the original scene when discussed, it is treated as such for clarity in this manual. Thus, references to the bottom image of the stereoscopic pair on a film frame will refer to the right eye image.

Saturation - The degree of intensity of a color, as determined by its freedom from mixture with white.

Scope - A widescreen process or film in which the image is laterally compressed and then re-expanded through the use of anamorphic lenses. Most such processes in theatrical use have an aspect ratio of about 2.35:1. This is also referred to as full scope, as some systems do crop the image slightly. Even though the over-and-under type 3-D processes do not use anamorphic, the use of a full scope aperture is possible due to the large image area available. See also Full Scope Aperture.

Short Focal Length – A lens which is shorter in focal length than a lens designated as a medium focal length. This includes the class of lenses known as wide-angle lenses, although all short focal length lenses are not necessarily wide-angle lenses. For descriptive purposes, stereoscopic lenses shorter in focal length than 30mm will be considered as short focal length lenses. These are the most useful for most applications of stereoscopic principal photography, as such being often considered normal lenses for 3-D use. All else being equal, the shorter the focal length a stereoscopic lens is, the less actual parallax for a given distance, and therefore the greater the depth range.

Siemens - The scientific name for the star target. **See Star Target.**

Silent Aperture - See **Full Silent Aperture.**

Slide - See **T/stop Slide.**

Splitting - See **Image Splitting.**

Spurious Images - See **Ghost Image, Fringing.**

Star Target - The target or test chart consisting of radiating lines which expand away from the center, such that black spacing and white spacing is equal at all concentric distances. This target is used for focusing according to the procedure described in the text. It is available in two sizes, the larger of which is most useful with short focal length lenses and at greater distances.

Stereo Base - The horizontal distance between the left and right images of a stereo pair at the entrance or front optical surfaces of a stereo lens or device. The stereo base and the interaxial are identical at this point, although the interaxial may vary elsewhere in the device. The stereo base determines the stereoscopic perspective or depth proportion for a specified focal length lens, which is a constant regard less of the setting of the convergence. **See also, Convergence, Stereo Perspective, Interaxial.**

Stereo Cinematography - Stereoscopic cinematography; the art and science of photographing motion pictures in 3-D.

Stereographic - 3-D imaging; stereoscopic drawings, paintings, computer generated images, etc., as well as photographic, may be considered to be stereographic, as long as they are in true 3-D.

Stereo Perspective – The visual impression of relative portions as interpreted from the viewing of a 3-D image. For example, if a cube which measures exactly six feet on each side is photographed and the resulting image is exhibited such that each side still appears to be exactly six feet, the stereo perspective is said to be normal, and the image is said to be in orthostereo. If the image of this same cube appears to measure six feet high by six feet wide by eight feet deep, the image is in forced stereo perspective. If the same cube appears to measure in the image six feet high by six feet wide by four feet deep, the image is in compressed stereo perspective. Several factors affect stereo perspective. Some of these are the stereo base, the lens focal length, and the distance between the person viewing the image and the projection screen. An image that is designed to be in orthostereo at a specified viewing distance from the screen, will appear to be compressed to a person seated closer to the screen, and forced to a person seated further from the screen. It should also be recognized that stereo perspective is not always necessarily linear. It is entirely possible for one part of an image to appear normal, one part compressed, and one part forced. The causes for this and several other distortions of stereo perspective are varied, and often these distortions are the result of a combination of factors. Since each case requires analysis specific to it, the expertise of the 3-D consultant should be referred to for proper control of the stereo perspective at all times. **See Also, Depth.**

Stereoscope - A 3-D special effects system incorporating devices and consulting services for the production of special effects in a 3-D motion picture. Footage shot in Stereoscope is fully compatible with footage shot with StereoVision lenses. Some of the many effects possible include blue screen, front and rear projection, true 3-D rotoscoping and animation, miniature photography, macrophotography, very long focal length photography, and several other effects. An extreme amount of control and versatility is possible with Stereoscope, due to such features as continuously variable interaxial over a very wide range, and the capability for accepting conventional prime lenses. Further information on Stereoscope may be obtained from John A. Rupkalvis.

Stereoscopic – Three dimensional; true 3-D; having depth characteristics similar to that of the original subject. In order that an image be considered stereoscopic, the original subject depth; an image of a flat painting will not be stereoscopic if photographed with a stereoscopic lens. Also, a <u>means</u> must be employed whereby the scene is imaged from two laterally displaced viewpoints to record the image disparity between these two viewpoints. The most direct means of doing this is through use of a stereoscopic lens. The Stereovision lens performs this function automatically. **See also, True 3-D.**

StereoVision - Manufacturers of high-quality widescreen 3-D lenses for professional cinematography, StereoVision has had more experience in the design and manufacture of stereoscopic lenses for production and exhibition of 3-D motion pictures than any other company. StereoVision lenses have been used worldwide for the production and exhibition of more 3-D motion pictures than any other lenses.

System - An interrelated group of devices and/or personnel for the production of a specific function, such as stereoscopic cinematography system, consisting of cameras, lenses, operators, consultants, etc.

System Resolution - The final resolution of an image as projected on a screen and perceived by the audience under specified conditions. System resolution usually takes into consideration all factors and steps, such as photography, processing, printing, projection, etc., which may affect the resolution of the image. If a particular component is specified, for example, camera system resolution, than system resolution is taken to be limited to those factors and steps associated directly with that component, such as lens, film flatness, operator proficiency, etc.

Target - A test chart or reference used for operations such as focusing and/or convergence. **See also, Star Target, Pole.**

Telephoto - A long focal length lens designed for use only at long conjugate ratios.

Three-Dimensional - Having three dimensions, usually: height, width, and depth. Occasionally, there are: height, width, and time. Under some circumstances, time may be converted to depth. It is possible to be four-dimensional, as in motion pictures in 3-D which also record and exhibit the dimension of time in terms of the consecutive imagery. The term three-dimensional is sometimes expressed as 3-dimensional, or simply 3-D. **See also, Depth, Stereo Cinematography, Stereographic, Stereoscopic.**

Toe-in - A form of distortion that results with stereoscopic optical systems which converge by changing the angle of the optical axes. This produces a pair of images which are unequal and difficult to view, because the left side of the left image will be larger than the left side of the right image, and vice-versa. StereoVision lenses do not toe-in; they use lateral convergence and therefore do not produce toe-in distortion. **See Also Convergence**.

T/stop - A lens aperture which is designed and produced to conform to the actual light transmission capability of a specific lens. **See also, F/stop.**

T/stop Slide - The lens aperture slide used in the StereoVision lenses for controlling the amount of light admitted through the lenses. In addition, the T/stop slide serves as a holder for gelatin filters when they are used. **See also, T/stop, Aperture.**

Time Parallax - Stereoscopic images are usually filmed with a system of two parallel lenses or optical systems such that two different views from two different angles are imaged simultaneously. Such views may al so be obtained with a single lens optical system if they are instead filmed sequentially. Since the parallax required may be obtained by lateral movement of either the camera or the subject or both, the amount of parallax will be determined by the rate of lateral movement between the first and the second exposure. Therefore, a stereoscopic image obtained in this manner is known as a time parallax image.

True 3-D - An image in which an original subject is filmed from two different positions and exhibited in a manner such that the left eye of the observer will see the left image and only the left image, and the right eye will see the right image and only the right image is a true 3-D image. Any system or procedure that does not meet these criteria is not a true 3-D image. **See Stereoscopic, Three- Dimensional.**

Value - Relative lightness or darkness of a color.

Viewers - See **Polarizing Viewing Glasses.**

Viewing Glasses - See **Polarizing Viewing Glasses.**

Warm Colors - Colors which are high in frequency (redder in hue), and are located on the right side of the visible spectrum as normally represented. Warm colors include reds, magentas, oranges, yellows, and very yellow yellow-greens, and all of the hues in between these. Warm colors tend to be progressing (appear to make objects which are colored with them seem closer). **See Also, Cool Colors.**

Waterhouse Stops - Fixed apertures which are individually inserted into a lens in place of a variable iris. Such apertures may be more accurate than the adjustable type. The concept is similar to that used by sluice gates in aqua ducts, therefore the name. **See also, T/stop Slides.**

Wide-Angle - A short focal length lens intended to cover a wide angle of view. Some types of short focal length lenses may crop part of the field, and thus not exhibit wide-angle coverage even though the focal length is short.

Yellow - See **Dye.**

Zero Parallax - An object converged upon will occupy coincident positions on the film (will appear in the same lateral position directly over or under the other image of the object in films shot in the over-and-under format). The image of this object on the screen will appear to be in the same plane as the projection screen. As such, there will be no parallax difference between the two images of the object, and the parallax is zero. **See also, Parallax, Positive Parallax, Negative Parallax.**

CONCLUSION

3-D is not a gimmick. That it has often been treated as such is a reflection upon the naivete' of those supposedly practicing the art. A few notable exceptions have proven that a tremendous potential exists, both in terms of the quality of this wondrous consumer product and the box-office it is capable of generating as a direct result.

Application of the technology currently available, such as the proper use of StereoVision lenses, to the professional filming of consciencious actors depicting high-quality story material, will prove to the industry and the public at large that 3-D is truly a viable professional entity. After a very few such quality 3-D films have been released and properly marketed, 3-D will take its rightful place alongside color, sound, and widescreen as a standard accepted form of enhancing the quality of the motion picture exhibition. In the highly competitive market for the entertainment dollar, the conscientious producer should do no less for the backers, and for our mutual customers, the audience.

The coming years will show who amongst those in the motion picture entertainment profession are the true visionaries, whose responsible yet optimistic spirit leads them to crave beauty, joy, life, and a love and respect for their fellow citizens.

Indeed, these often too rare individuals who place the human spirit above quick profits are those who inevitably will eventually lead the way to the perfection of the ultimate story telling medium “totally controlled optimum three-dimensional motion picture presentations”.

We sincerely hope that the users of our equipment will be inspired by the possibilities and join with us toward achieving this goal.