PRINCIPAL LARGE FORMAT

THE OLD VICARAGE, LEIGH ON MENDIP, SOMERSET, ENGLAND BA3 5QG

3D GLOSSARY

(capitalised terms within descriptions are defined elsewhere in the glossary)

BIOLOGY

BINOCULAR VISION
A vision system that utilises a pair of forward looking eyes. Humans have this, enabling them to judge distance.

BINOCULAR DISPARITY
The difference between the views from the left and right eyes.

STEREOPSIS
The ability to perceive in a third dimension, to have a depth sense. A by product of Binocular Disparity.

HUMAN INTEROCULAR
The interpupiliary distance in humans; a wide spread of values but approximately 2" in children and 2.5" in adults.

ACQUISITION

STEREO PAIR OF CAMERAS
Two vertically aligned cameras, in either a Side by Side Rig or a Mirror/Beam-splitter Rig.

CAMERA INTERAXIAL
The distance between the centres of the two lenses used in any 3D filming set up.

SIDE BY SIDE RIG
Two cameras placed side by side. With special lenses some professional Side by Side rigs are able to achieve a minimum distance between the centres of the two lenses of around 2.75" (smaller, if miniature camera heads are used).

MIRROR OR BEAM-SPLITTER RIG
Two cameras. One looking forward through a 45° half silvered mirror and the other looking up or down for 50% of the light reflected from the same mirror. Required if Interaxials of less than the approx. 2.75" of some Side by Side Rigs are needed. Mirror Rigs can go down to zero Interaxial by moving one of the cameras on a geared platform. Normally a stop of light to both cameras is lost in the process and some colour correction may be required.

STEREOGRAPHER
Person with mathematical or intuitive knowledge of the 3D process. In particular, the interactive relationship between Convergence, Interaxial and focal length. Often Stereographers use a spreadsheet to determine where an object will appear on the Z Axis given the focal length of lens, distance of object from camera, amount of Camera Convergence, amount of Camera Interaxial and the theatre geometry. Some keep it all in their heads! There are now a number of Stereo Calculators available.

APPROACHES TO 3D FILMING

Z AXIS
The Y Axis is up and down, the X Axis is side to side and the Z Axis is forward and back.

CAMERA CONVERGENCE
The toeing in of one or both cameras in a Stereo Pair so that, in combination with the Interaxial setting, the optical axes of the cameras align somewhere on the Z Axis; at the point of interest, in front of the point of interest, or behind the point of interest. Where the camera axes align the images on the screen overlap and a single image is seen. Across the entire X axis this is called the Screen Plane.

CONVERGENCE POINT
Where the axes of the toed in cameras align on the Z Axis.

CONVERGING LENSES
A configuration where one lens is offset with respect to the film plane. E.g. IMAX Solido.

DYNAMIC (CAMERA) CONVERGENCE
Camera Convergence taking place during a shot. This necessitates a Side by Side or Beam Splitter Rig with the appropriate motorisation.

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SHOOTING PARALLEL
Acquiring stereo images without Camera Convergence. The axes of the cameras remain parallel to each other, at whatever Interaxial is chosen. Such images will need Re-positioning in Post in order that the infinity point is behind, rather than at or in front of, the Screen Plane. If Parallel shot images are not Re-positioned then 100% of the resulting overlaid images will be in front of the Screen Plane.

SHOOTING CONVERGED
There are 2 ways to Shoot Converged. Either by Camera Convergence or by using Converging Lenses, such as can be found on the IMAX Solido twin strip 15perf 65mm camera or the Gemini twin strip 8perf 35mm camera.

ORTHOSTEREO
A capture style achieved by shooting with the cameras parallel, with wide angle lenses (matching as close as possible the viewer's field of view of the screen) and a 2.5" (eye match) Interaxial. Orthostereo recreates in both depth and scale what it was like in front of the camera. It is the default methodology for films originating in the IMAX 3D format (it is however a choice, not obligatory). With correctly shot IMAX images (i.e. not getting too close to the subject) infinity can be placed at stereoscopic infinity by moving the projectors apart by 2.5".

3D PROJECTION AND VEIWER PERCEPTION

STEREO WINDOW
The edge or boundary that surrounds the three-dimensional image.

SCREEN PARALLAX
The on screen horizontal distance between corresponding image points.

THE SCREEN PLANE OR WINDOW
Where objects appear as if they are on the physical surface of the display screen, as in 2D. There is Zero Parallax at the Screen Plane as the left and right eye images are exactly overlaid.

ACCOMMODATION
The focusing of the eyes on any given subject. When watching a film the eyes always focus on the Screen Plane but have greater depth of field the further the viewer is from the screen.

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EYE CONVERGENCE
The toeing in of eyes in order that the brain perceives a single image, rather than two separate images, when the optical axes of the eyes align on any given object.

POINT OF CONVERGENCE
The intersection of the two images. At this point there is Zero Parallax and the subject at the Point of Convergence appears on the Screen Plane.

ZERO PARALLAX
Where the left and right eye images are exactly overlaid on screen.

FUSING THE IMAGES
The act of Converging the Eyes on the left and right eye images displayed on the screen and the brain successfully interpreting the two images as a single entity.

NEGATIVE PARALLAX
On screen the left eye image is to the right of the right eye image. Whilst the eyes focus on the Screen Plane (with a depth of focus in front of the Screen Plane) the eyeballs have to Converge in front of the Screen Plane in order to Fuse the Images into a single entity. The resulting images appear as if they are in front of the Screen Plane and out in the theatre space.

POSITIVE PARALLAX
On screen the left eye image is to the left of the right eye image. Whilst the eyes focus on the Screen Plane the eyeballs either converge, are parallel or diverge behind the Screen Plane, depending on the amount of Positive Parallax and the viewer distance from the screen. The resulting images appear as if they are behind the Screen Plane.

DIVERGENCE
If Positive Parallax exceeds the eye Interocular then the viewer will outwardly rotate their eyes in order to Fuse the Images into a single entity. The images will appear behind the Screen Plane but with excessive Divergence will be hard or impossible to Fuse.

DEPTH BUDGET
The combined values of the Positive and Negative Parallax. Most often given as a % of screen width. 3% total (1 behind/2 in front for film; 2 behind/1 in front for TV) is a good rule of thumb.

DISLOCATION OF ACCOMMODATION AND CONVERGENCE
In the real world we Converge our Eyes at the point at which we focus or Accommodate. In a 3D film we always focus on the Screen Plane BUT Converge either in front of the Screen Plane for Negative Parallax "out of the screen effects" or at the Screen Plane for the Convergence Point. The eyes either Converge, are parallel or Diverge behind the Screen Plane for positive parallax "depth" effects. Depending on an individuals' depth of field, and distance from the screen, images with even large Negative Parallax values can make comfortable viewing. The narrower the dof, and closer to the screen, the less comfortable the experience.

3D EFFECTS

HYPERSTEREO
By using camera Interaxials larger than the average human Interocular of 2.5" in theory the resulting images display objects that appear smaller than they are in reality.

HYPOSTEREO
By using camera Interaxials smaller than the average human Interocular of 2.5" in theory the resulting images display objects that appear larger than they are in reality.

MINIATURISATION
The on screen effect of using Hyperstereo is that objects appear smaller than they do in life. Theoretically this is a linear effect. Shooting with an Interaxial of 5" theoretically makes an object look about half its normal size.

GIGANTISM
The on screen effect of using Hypostereo is that objects appear larger than they do in life. Theoretically this is a linear effect. Shooting with an Interaxial of 1.25" theoretically makes an object look about twice its normal size.

RE-POSITIONING IN POST (HORIZONTAL IMAGE TRANSLATION)
For example moving the left eye left decreases Negative Parallax so objects don't come so far off the screen. Within the Positive Parallax there is a corresponding movement of the right eye to the right and so care must be taken not to induce the problem of Wall-eye. As well as Re-positioning objects on the Z Axis Re-positioning in Post is also a tool for smoothing the edits in terms of the 3D. The Parallax of an incoming shot is pushed/pulled so that the object of interest is at the same position on the Z Axis as the previous shot. The cut is executed (with the eyes temporarily converging at the same point across the cut – thus reducing eye strain and fatigue) and the Parallax is then ramped back to whatever the next shot requires.

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PROBLEMS AND SOLUTIONS

VERTICAL MISALIGNMENT
Where the horizontal lines of the two images are misaligned and one is higher than the other when exactly overlaid.

IMAGE SIZE DIFFERENCES
If the prime lenses are not exactly matched or zoom lenses do not give the same image size for a given focal length then the Image Size Differences will need to be normalised in post.

KEYSTONING
Vertical Misalignment at the edges of one or both eyes as a result of Camera Convergence. A squared grid shot at an angle becomes a grid of trapezoids or Keystones. When two such images are overlaid Vertical Misalignment occurs except in the middle of the frame. With the limited amount of Camera Convergence used in most instances the Keystoning is not enough to result in uncomfortable viewing.

BREAKING THE FRAME
If an object has Negative Parallax and is bisected by the edge of the frame then that object is Breaking the Frame and there is a visual/brain conflict. How can something be both in front of the Screen Plane (as suggested by the Negative Parallax) yet at the same time behind the Screen Plane, suggested by the fact that the subject is only partly visible? In life, the right eye sees MORE through the left hand side of a window than the left eye. For 3D displays, if a part of an object bisected by the edge of frame is in front of the Screen Window (with Negative Parallax) then the right eye is seeing LESS than the left eye. This is because in Negative Parallax the left eye image is to the right of the right eye image and thus there is more of the left eye on image on screen. This is not how we see in life and results in confusion and loss of the 3D illusion.

CROPPING MASK
A device to deal with objects that are Breaking the Frame. A Cropping Mask (applied in post) places a thin, solid, mask on the left of the left eye image or the right of the right eye image in order to disguise the conflict on which ever side the object is breaking frame (and simultaneously if there are objects breaking frame both left and right). This makes the images easier to watch.

FLOATING WINDOWS
Similar to Cropping Masks but used to subtly effect the apparent position of an object on the Z Axis. Solid black bar placed on the left of the left image and right of the right image to bring the window into audience space, and vice versa to move it back into screen space. Floating Windows are often dynamically faded in, may exist on one eye only and may be tilting towards or away from the viewer to change the 3D effect.

CARDBOARD CUT-OUT EFFECT
Where objects at the same distance from the camera/viewer look like flat planes with stereo space between them. The Cardboard Cut-out Effect is a result of using long lenses at too small an Interaxial. The use of wider Interaxials can help reduce the effect by giving objects more roundness; but this has to be executed with care, as one can end up with too much Parallax if objects get too close to camera.

WALL-EYE
Wall-eye effect is caused by excessive Positive Parallax, in which the eyes are asked to have Divergence greater than approx 1 degree per eye in order to Fuse the Images.

UNFUSABLE IMAGES
Images with either excessive Positive or Negative Parallax, so that the eyes are unable to either Converge or Diverge on them, and thus Fuse them as a Single Image.

GHOSTING
The on screen effect of image bleed from one eye's image to the other eye's image. This occurs particularly when shooting in high contrast situations or shooting objects of a light colour in front of a dark background.

SORTING IT OUT IN POST
The Producer's fall back position, maybe!

Phil Streather
3D Producer and Consultant

Principal Large Format is a production company dedicated to developing and producing: 3D Giant Screen (IMAX) features, 3D Theatrical Documentary features and 3DTV. PLF was founded in 1998 by present CEO Phil Streather.

Throughout 2012 Phil was a consultant to BBC World Wide's natural history super brand BBC Earth. In his capacity of Director of Giant Screen and Museum Films he advised on all aspects of their move into the Giant Screen 3D business. At the same time Phil started working with the BBC Natural History Unit as Stereoscopic Supervisor on the ground breaking *Tiny Giants 3D*, which delivered in 2014. Phil has finished his consultancy with BBC Earth and is currently in development on a Giant Screen 3D film about bumblebees, with the working title *The Bumblebee Queen* (www.bumblebeequeen.co.uk) and a Giant Screen 3D film about the sea with the working title *Mysteries of the Mediterranean.*

In 2010 Phil produced *Carmen in 3D* from the Royal Opera House (presented by RealD and Royal Opera House), which played in 1500 3D cinemas worldwide in Spring 2011. In the same year Phil was 3D producer and stereographer on *Meerkats 3D*, produced by Oxford Scientific Films in association with PLF, for National Geographic Channels/Sky 3D, which aired on Sky 3D October 2011 and played ion giant screens from 2012. Also in 2011 Phil produced *Madam Butterfly 3D* from the Royal Opera House (presented by RealD and Royal Opera House), which played in UK cinemas March 2012.

In 2009, in association with Centre Screen Productions, Phil produced the groundbreaking 3D film for the Merlin Entertainments London Eye 4D Experience, now seen by over 15 million visitors. In 2008 PLF bought the UK's first P+S Technik 3D mirror rig for 3D HD capture and produced elements of the 2008 Sky 3D TV proof of concept, particularly *Gladiators*.

In 2003 PLF also produced the 3D film elements for the successful touring version of Andrew Lloyd Webber's musical *Starlight Express.* His 2003 IMAX film, *Bugs! 3D*, narrated by Judi Dench, has won many awards, including the prestigious Panda Award for Best Large Format Film at the Bristol Wildscreen Film Festival and the Best Special Venue Program award at Jackson Hole 2009 for the Digital 25 minute version. *Bugs!* was a Semi-Finalist in the Documentary Short Subject category of the 2004 Academy Awards® Competition.

In 1999 Phil was the Individual Producer on the groundbreaking IMAX 2D drama, *Legend of Loch Lomond,* for Dunbartonshire Enterprise, Scotland and in 1997/8 Phil produced *Wildfire - feel the heat,* in IMAX 2D, for Discovery Channel Pictures.

Phil regularly chairs/produces/participates in panels, sessions and master classes on 3D at industry conferences such as: NAB, IBC, Jackson Hole Wildlife Film Festival, Wildscreen Film Festival and the Edinburgh International Film Festival. In January 2011 Phil ran the National 3D Training Programme at BAFTA/Twickenham Studios, funded by Skillset and Sky and a regional Skillset programme in Bristol in February 2012 (www.advanced3d.co.uk).

TEL: +44 (0)1373 813 301 FAX: +44 (0)1373 813 379
phil@plf.cc www.plf.cc