

## **3-D Film Production from Script to Screen**



*by Alexander Lentjes of 3-D Revolution Productions*

*Presented at Weymouth University in January 2008*

© 2008 3-D Revolution Productions

## ***Anaglyph sources***

Before I start my presentation, a word about the red-blue anaglyph glasses. You may be looking at your red-blue glasses, thinking: wait a minute, why is this presentation in an antiquated 3-D system and not in polarized 3-D like in a Real-D cinema? Much though I'd love to, I don't have a silver screen at hand, plus a polarizing projection adapter for this projector. But there's nothing wrong with anaglyph. It's been around as long as stereoscopic film itself has and has never gone away because of its versatility, ease of use and cheapness. In fact, Sony Pictures Imageworks still uses it for their 3-D monitor previewing.

A big point that people make nowadays about anaglyph 3-D is that they think it causes discomfort and headaches. True, it is not an ideal format in terms of colour and separation, and your brain will attempt to compensate for the colour filters by turning your vision blue and red, inversely to the glasses. But it is misuse of 3-D, not the presentation format, that causes real headaches.

And then what's more important: that very few people get to see stereoscopic 3-D, but in perfect polarized projection, or that many, many more people are exposed to 3-D in a format of lesser quality. Anaglyph is by no means a bad presentation format and it enables 3-D presentation on Film, on Television, on the Web and in Print as it works in an active projection fashion and passively. This cannot be said for polarized projection or, indeed, frame sequential presentation.

One important, but often overlooked factor of 3-D imagery is the fact that your eyes are trying to converge on imagery that appears to be in front or behind the screen, while they should only be converging on the actual screen itself. This definitely causes discomfort and should limit any 3-D presentation or 3-D screen time to 10 to 15 minutes, unless shallow depth 3-D is used.

## ***Introduction***

Hi, my name is Alexander Lentjes, and I run my own animation production company called 3-D Revolution Productions, where I also do 3-D stereoscopic consulting. Through this company and its website [the3drevolution.com](http://the3drevolution.com) I have aided and consulted quite a few independent 3-D film and short productions, film and animation alike.

How did it all start? Well, after producing my stop-motion/CGI animation graduation film in 3-D and putting it online in 2000, I kept receiving e-mails with questions about how to do 3-D for film and animation. This short, by the way, was only the third ever stop-motion animation short in 3-D in the history of film making. The other two titles are *Motor Rhythm* of 1939 and *The Adventures of Sam Space* of 1955. The very first stop-motion feature is currently in production for a 2008 release: *Coraline* by Henry Selick.

It is somewhat strange that there are not more 3-D stereoscopic stop-motion titles, because the two are such a natural marriage. The volume of stop-motion, when

captured in proper stereo 3-D, is a feast to the eyes. It's like the models really come to live – even more than they already do! Then again, only 20 titles of the 220 or so properly released feature and short titles in existence are animated. So proportionally speaking, it makes sense to have only 3 stop-motion titles in 3-D.

3-D film knowledge is hindered by an enormous amount of disinformation and smoke & mirrors put up by 3-D hardware manufacturers and stereographers. So I decided to provide the information on my website for free, and it very quickly received thousands of hits every day. Since then I have researched every aspect of 3-D, especially in relation to film making. Besides running an animation production company, that is.

### ***3-D film education***

On my website I give away a hell of a lot of information on 3-D filming and projection and I subsequently get an average of about 4500 hits a day. So 135,000 website hits every month, tell me something about the huge hunger for information on 3-D film production methods and a yearning for 3-D film content education. 3-D is big and every news item about current 3-D film production spawns a new wave of interest from consumers, prosumers and professionals.

I feel it's about time a stereoscopic film school or 3-D film program at a film school is introduced where a new generation of 3-D filmmakers can emerge. Film production company-wise, there is the same need for education on the possibilities and pitfalls of 3-D. Especially because 3-D is a complex medium with many technical and creative parameters - that can all go horribly wrong. Because he who does not know the past is doomed to repeat its mistakes. And I will be showing you some examples to illustrate what I mean.

3-D stereoscopic film education should not just be about how to put two cameras together, but also about how to use these two cameras to produce tomorrow's 3-D cinematic masterpieces. Are you just creating a 3-D space or are you actually using it? As with technology, 3-D is a craftsman's tool, and a hack's toilet paper. And when it comes to the history of 3-D movie production, there have been a lot of hacks around.

Because 3-D hasn't been around for longer than 2 years per fad – in 1923, '53 and '83, 3-D direction is still in its infancy. Just like the directors of the 1920s who were discovering the benefits of utilizing cuts, 3-D is still being discovered by today's producers, directors and editors. And therefore it is often still used in a very childish way – with actors literally chucking pies at the camera – think of the very recent 'Meet the Robinsons'.

### ***Historical Success of 3-D Film***

One big factor of 3-D in a historical sense is that there was an enormous spike of major Hollywood 3-D film releases in 1953 and '54, followed by a dramatic fall of 3D stereoscopic production and releases in 1955. The reason for Hollywood to go 3D

in late 1952 was the introduction of the television in 1953. People stayed away from cinemas and film producers panicked. Something had to be done to get people back into movie theatres and 3-D was going to do just that. So over 120 titles were released in 3-D in those two years alone. That is a true industry switch-over, not just a fluke. And studios invested heavily in proper 3-D camera rigs and processes to produce the best 3-D cinema possible.

Quality standards were high, often higher than has ever been the case with live-action 3-D film and video production since. But 3-d film production halted in 1955, so what happened? Was the technology so bad that people got upset with the results? No, certainly not. It was the lack of creative use of 3-D and the failure to use 3-D in a way that enhanced the narrative, the story and the character interaction. 3-D was an add-on and it did not enhance the cinema going experience in a fundamental way. So people turned away from cinemas again, making Hollywood blame 3-D as a whole and not their childish and often preposterous use of 3-D in poor stories and ridiculous plots.

The second boom of 3-D happened in 1983-84 and was fuelled by innovations in the area of 3-D optics. Single camera 3-D filming was suddenly possible with the new 3-D camera adapters such as StereoVision. Hollywood told itself that the boom of '53 and '54 failed because of technical difficulties and high production costs of twin-camera shooting and projection. So surely, using single-camera filming and single-projector projection would mean 3-D was here to stay this time around.

However, the same mistakes were repeated when the kinds of stories told in these 3-D movies were exactly like those of 1953-54. Trash, pulp, horror, slasher, exploitation and cheap eye-poking gimmick shots, all over again. Not surprisingly, the success of 3-D cinema in the boom of '83 was short lived and in 1985 3-D production was back to 1 to 2 productions per year.

From 2003 onwards there has been a new increase of 3-D film production, mainly pushed onwards by IMAX 3-D releases, the advent of HD and its cheaper production costs and just because another decade had passed and a new generation of film professionals was never told what had happened exactly 20 years and 40 years before. Ignorance is a fantastic way to have the same issues happen over and over again. The technology may be digital now, but the stories told in 3-D movies are yet to escape the childish and exploitation level and if 3-D cinema doesn't get much better in a creative sense quickly, it's 1953 and 1983 all over again very soon.

### ***Cinemascope / Cinerama***

How does 3-D film weigh up to 2-D cinema? Great examples in comparison to stereo 3-D are Cinemascope and Cinerama. There is no real narrative reason to shoot in 'Scope or 'Rama other than to establish wide vistas and different, wider framing possibilities. Both Cinemascope and Cinerama did not offer an enhancement of the basic premise of cinema, being audio-visual storytelling. And at the centre of storytelling lie characters and their interaction, rarely truly motivated by their surroundings and backdrops.

The cinema-going audience is willing to pay more for a different cinema format, on a repetitive basis, when it offers enhancement to this basic storytelling experience, but not when it is just a distracting add-on. So Cinerama could not sustain, and disappeared from regular theatres, while modern filmmakers frame films for smaller aspect ratios when using aspect ratios over 1.85.

Of course, IMAX took over from those two formats and focussed its content on wildlife and nature documentaries, the ideal subject matter for vision-wide cinema. And now IMAX itself is on its way out as well...

### ***3-D Script to Screen***

So let's talk you through the 3-D production process from script to screen. A proper, effective 3-D film is planned to be 3-D from stage one, the script. This is because it will allow for effective 3-D mise-en-scene and flow of 3-D storytelling. Sadly, not many 3-D films are made this way and poorly thought out 3-D is added on just before shooting commences, resulting in disappointing 3-D.

To write and do production design and layout for stereoscopic film sequences, one will obviously first have to know what the subject matter will be. Like a charming psychopath killer on the loose, hunting for teenage girls at night, or perhaps a rampaging shark on the loose, hunting for any humans in and near the water. Or maybe precisely calculated murder, plain supernatural killing or alien space monster-related deaths. It's all possible in 3-D.

I feel that the predominant use of 3-D for horror movies ties in with the primal reaction that volumetric images still have on us. It is still a unique, very real experience, and a medium that really benefits from this emotion is horror. And 3-D is also still a medium in its infancy, and is thus being used for very basic, primal stories.

In two ways stereo 3-D film is closer to theatre than cinema:

- Because of its life-like representation of the world
- And because of its preference for first-person camera work, creating a sense of being there at the performance. However, in its subject matter it is often closer to a sort of modern variety show, a nickelodeon or a theatre of freaks.

### ***3-D on TV***

So, besides sharks and aliens, what is 3-D used for right now? On TV and in print, 3-D is currently mainly used for specials and promotions. Using 3-D like this will draw new viewers to the show when glasses are distributed in a TV Guide. Famous examples are 3<sup>rd</sup> Rock from the Sun, Medium, Home Improvement, Shark Week, Rugrats and Dr. Who. These are normally anaglyph 3-D sections, while 3<sup>rd</sup> Rock from the Sun and Discovery's Shark Week used Pulfrich, and Nickelodeon used ChromaDepth for its Rugrats 3-D episode sequences.

All these techniques dictate a particular type of story. Why is this section suddenly in 3-D and why is the protagonist wearing 3-D glasses, if he is? Pulfrich demands horizontal movement on various planes or a spinning camera, ChromaDepth demands the use of the colour spectrum, and anaglyph limits the time and the amount of parallax that can be used due to its ghosting side-effects on television. So stories need to be moulded into some form to facilitate these peculiarities and it's not too surprising that using dream and hallucination sequences, nightmare, fantasy and ghost stories, are the most popular way of doing this.

### ***Theatrical cinema 3-D***

In most theatrical 3-D films, the entire film duration is in 3-D. The strong point of putting on your 3-D glasses for a 3-D part is that it makes that 3-D section very special and exciting. While having a complete film in 3-D without going to and from 2D makes the viewer unaware of the stereo because the brain adjusts to the 3-D and gets comfortable with it.

That is, unless off-screen 3-D, strong 3-D setups and special 3-D camera moves are employed. This is a strong case for over-the-top 3-D, employed at key moments in a film. Otherwise, the audience won't notice they are watching a 3-D film after about 10 minutes! Of course one can go over the top as well, as seen in films like 'Comin' at Ya', 'Treasure of the Four Crowns' and, more recently, Spy Kids 3-D, where every shot tries to poke out your eyes. It's all about balance.

Technically, there is the before mentioned issue with 3-D and the unnatural things it makes the eyes and brain do. Because stereoscopic imagery fools the brain into thinking the eyes are looking at an actual volumetric image, the eyes attempt to scan the image and converge on various plane depths. However, the actual image and its convergence point are on the cinema screen. This unnatural situation can make the eyes and brain tired very quickly. This is the biggest argument for very calm, shallow depth 3-D and going to and from 2-D to give the eyes and brain a rest.

### ***3-D distraction***

Creatively, the 3-D needs to pay off to actually be worth all the trouble and still integrate with the story being told. Because, narratively speaking, there is no good reason to poke stuff in the eyes of the audience. Normally, that only takes the viewer out of the story and reminds him that he is watching a 3-D movie.

Overall, the dimensionality easily distracts the viewer from the story and its characters. This way, the viewer is removed from the experience of enjoying the story and has to switch brain sides to enjoy the technicality of the 3-dimensional spectacle. And herein lies the paradox of 3-D film: you need the off-screen effects, but they can take the viewer out of the movie. Subtlety needs to be employed. This is something special-effects-driven movies without a good plot have in common with stereoscopic cinema, and its audience may be wooed in the first few minutes, but will be unimpressed by the whole thing at the end of the movie.

Also, when watching a 3-D movie that does not perform the usual bag of out-of-the-screen tricks, its audience will question the need to shoot the film in 3-D in the first place. But then is colour always used in a functional way in film and should most films be shot in black & white and silently if they don't exploit colour and sound? Even more, people who argue that all 2D movies should be made in 3-D from now on can be asked the question if a statue is always better than a painting, just because it is volumetric...

### ***Integration of 3-D***

Proper integration of 3-D can serve important functions:

- Heightening fear and suspense as seen in 'Shrek 3-D',
- Giving a sense of claustrophobia as in 'Dial M for Murder',
- Showing the touchable cuteness of fluffy alien sidekicks as seen in 'Captain EO'
- Getting closer to the protagonist as employed in 'Metalstorm' and 'Jaws 3-D' –
- And of course getting drawn into a magical fantasy world like in the 'Polar Express'.

### ***The 3-D camera factors***

So how is the 3-D camera used to create the look and feel of the 3-D image? The interaxial, or interocular, is used to increase or decrease the perceived size of the filmed scene. So a large interaxial will reduce a scene to perceived miniature size, as if seen by a giant, while an interaxial below 65 mm flattens out the 3-D considerably, creating cardboard cutout results.

When longer focal length lenses are used, a wider interaxial can reduce the cardboard cutout results. And when shooting far away objects, a wide interaxial is key to keeping this object volumetric rather than appear flat. At 70 to 75mm, objects look a bit rounder than in real life, and this interaxial can be used to create a more volumetric look. Although, as mentioned, objects will appear to be smaller as well. There are formulae for the interaxial value related to the object distance and depth, but, as with all things 3-D, stereographers just can't agree on a single standard. Pre-viz can be a real solution to determine the best interaxial, rather than employing distance spreadsheets.

### ***Convergence***

Convergence, then, is used to determine the location of the filmed object in theatre space. The place where the cameras converge sets the stereo window, which is the perceived location of the screen. The use of convergence is one of the most controversial and hottest debated issues in the stereographic world. 3-D photographers, as opposed to 3-D film makers, are of the opinion that convergence should never, ever be used. And this is why: The danger of converging cameras is that a limited depth of scene needs to be used, or divergence will occur. This is the outward rotation of the eye, an unnatural and painful happening. Also, converging

cameras produce keystone, which results in vertical parallax at the edges of the image. Another headache experience.

But why then is convergence used on films and not on photography? Mainly because it is easy to grasp and quick to set up. But also because parallel camera setup results can depend on screen size and distance from the screen. And a stereo base shift, or recenteration, needs to be employed to position the scene in depth. Converging 3-D always results in the same Z-values related to the screen, compressing or extending in correlation to the distance to the screen.

### ***Stereo base***

As touched upon just now, the stereo base, or frame distance, can be moved about in post to bring a scene forward into theatre space or move it back into screen space. This is the only way to control the location of objects in depth when shooting with a parallel camera setup. Of course, a wider image needs to be employed to start with, because the image sides get cut off and a smaller frame results from a stereo base shift. This is why stereo photographs are very often of a tall, vertical format.

The stereo window itself, when visible, can also be placed in depth, but this is a rarely used tool to control depth of scene and screen objects. A combination of these three parameters determines the look of the 3-D image as much as depth of field, focal length, aperture and lens size do. They are the set of tools of the conscious 3-D filmmaker.

So does one already describe interaxial, convergence and stereo base values in a movie script? Yes, absolutely! It will convey the image in the writer's head to the storyboarders and ultimately to the director of photography, and the director himself. Just as traditional descriptions of camera moves do.

### ***3-D storyboarding***

A proper 3-D film production will prepare for the stereoscopic shoot with 3-D storyboards and pre-viz. This is the only real way to determine what 3-D setup will be used on the shoot, and for animation, what camera setup should be laid-out. Also, selecting locations, set dressing and shot preparation are impossible without knowing interaxial, convergence, stereo base and stereo window amounts because they determine the required position of the actors and props and the permissible depth of the scene.

### ***Good 3-D use***

Of course, the usual good 3-D image rules apply in storyboarding and during shooting.

You will, for example, want to:

- avoid high contrast scenes such as nighttime shots with bright lights,
- Use well-lit scenes,
- Use multiple planes of props and backgrounds,
- Depth-set actors and important objects with a background plane,
- Have enough texture on large surface planes,
- Shoot tunnels and other deep, eye-guiding backgrounds,
- Use geometric objects and patterns,
- Use volumetric props, costumes and background objects
- Travel with the camera, but not too fast
- And make sure there are enough small objects to come out of the screen, for a good reason.

Why small objects? Because of the size limiting image-cone that 3-D creates in front of the screen. The closer you get to the camera, the smaller an object has to be to stay within the frame – just like with regular film. And because you don't want the object coming out of the screen to touch the sides, as this creates retinal rivalry and great discomfort, you will be limited to using a small size object to get close to the audience. Spears, arrows, knives, axes, gun barrels, drill tips, arms, fingers, skulls, bees, snakes, tentacles, tails, asteroids, fire balls and water drops. Now you know why.

### ***Recording vs. projection format***

The most frequently asked question I get in my e-mail inbox is whether the chosen projection format of the intended 3-D project relates to the method employed to shoot the 3-D film. It does not. The one thing that does matter is the intended projection screen size, as that will dictate the allowable stereo base and convergence amounts.

For example, using convergence on a film shot for IMAX will result in much too large positive and negative parallax values, and divergence, and this means an IMAX-size headache. But the use of a smaller stereo base for a computer screen will result in disappointingly flat images and unsatisfying 3-D. And you've just thrown away a heck of a lot of money. So in short, shooting in twin-strip, over-under, side-by-side, or any other 3-D format does not relate to the way you project the material, like polarized, anaglyphically, in ColorCode, field- or frame sequentially or on a plain Victorian stereoscope. Post-production will take care of that. With the exception of ChromaDepth and Pulfrich.

### ***Editing***

When you get to editing a 3-D movie, you will find that shots don't always match in sequence. And in this case you can't just blame the editor. One can't cut between very different interaxials and convergence points as the brain is focussed on a particular depth per shot. As James Cameron has pointed out about his discoveries on 3-D editing, much quicker edits can be achieved when the point of convergence is

matched from cut to cut. Ideally, this is already reflected in the 3-D storyboarding and pre-viz phase.

A stereo base shift can be employed in post to allow for this correction, by using a wider frame to start with or by blowing up the material and shifting it horizontally, but it is a limited amount. 3-D film making just means more pre-production planning! So get a stereographer involved from day one of your production.

### ***Depth of field***

I personally do not subscribe to the popular idea amongst stereographers that full depth of field has to be achieved in every shot for successful 3-D. In narrative stereoscopic film, limited depth of field can be a powerful tool that mustn't be discarded in favour of a completely clean look. Citizen Kane and Casablanca wouldn't be the same if they had used full depth of field at all times! In fact, when focussing on out-of-screen objects, the background needs to go blurry or divergence will take place when trying to focus on both planes at the same time.

Closely related to this, because of the way eyes distinguish different depth planes, only a small portion of the available depth in an image can be focussed on at any given time. Limited depth of field can help in easing this problem, but shallow depth of scene is the best way to prevent eyestrain.

So this drive for full depth of field and the subsequent need for insane amounts of lighting comes from the fact that the 3-D in movies has traditionally been worked and controlled by technical people. Of course it is not absolutely necessary to have full depth of field – that is a creative decision. But when technicians make creative decisions, it is usually a technical look that results.

### ***Animation vs. live-action***

The one thing that separates 3-D stereoscopic computer animation production from live-action is the absolute camera control, which means that stereo camera settings and moves can be used that are virtually impossible to achieve in live-action.

Also, of course, camera parameters can be changed at any point during production and this offers a huge advantage when editing shows stereo base and convergence sequence problems. With live-action, results of convergence and the interaxial distance cannot be changed in post.

The biggest issue with live-action 3-D filming is getting the interaxial down to 65 mm and below. In live-action this is only possible when optical grade half-silvered mirrors on a very precise rig are used, because in a dual camera rig the lenses just can't be put closer together than 70 mm. Prime lenses, anyway. This is seen on IMAX's Solido camera at 71 mm and James Cameron's Reality Camera System, now called Fusion 3-D – a rig that even uses shaved lenses to get to a 70mm interaxial. In animation, however, any interaxial value is no problem at all.

Then of course there's the pixel-perfect alignment of CGI cameras, which simply can't be accomplished with real cameras. Even the best rig in the world will suffer from thermal expansion under hot studio lights.

Unnatural lens properties can be programmed so that, for example, a non-symmetric camera frustum can be used which enables the use of converging cameras while preventing keystone. But then again this produces non-symmetric horizontal distortion of the image.

This is then the reason why there are so many motion-capture and computer animated 3-D releases in cinemas and slated for production in 2007-2010. Not because motion capture is such a great medium, because who really thinks human emotions translate well onto wax and dummy-like CGI human faces? It's because it offers total control and flexibility. Live-action feature releases in 3-D will, because of this, also be shot with as much bluescreen as possible, witness *Spy Kids*, *The Adventures of Sharkboy & Lavagirl* and the upcoming *Journey 3-D*.

### ***Shooting vs. converting to 3-D***

There is currently a lot of hoohah in the press about 3-D conversion and, not surprisingly, I receive a lot of requests for 3-D conversion of existing film and video material. My opinion is that shooting in 3-D is always better than converting to 3-D. To plan for a 3-D release and consider 3-D conversion as the method employed is a bad idea. Using 3-D conversion for shots where 3-D cameras just can't be employed is a different matter, but principally, conversion can never get the 3-D detail and sharpness of filmed 3-D. And this is why:

There are four ways of converting to 3-D;

- A pure cut-out rotoscoping way,
- Using overall volumetric 3-D displacement controls
- Employing hand-drawn animated depth maps
- And animating 3D CGI depth maps (basically using the Z-buffer).

All these techniques require layer separation and filling of the gaping holes left behind on the background plates. So one gets boiling backgrounds in 3-D conversions – even on *Harry Potter*.

The automatic way simply hopes for horizontal camera and object movement, banking on a time delay between frames and the resulting horizontal parallax shift. This is clearly not a noteworthy technique.

When 3D CGI conversion is employed, rough geometric shapes are used which don't always fit the shapes of the actors and objects perfectly and thus pretty rough 3-D volumes can result. It is simply impossible to get perfect contours unless one is happy to completely re-animate and basically recreate the entire movie in 3D CGI. ILM did this on '*A Nightmare Before Christmas*' and the resulting costs were above an original animated feature production. Even when they sent the manual labour to Hong Kong...

Slight financial madness, but it did its job in promoting the 3-D conversion process as a possible route for 3-D release.

That being said, conversion does give total post control over the 3-D image, so that decisions of 3-D mise-en-scene are very flexible, up to the moment of rendering. In any case, proper 3-D direction needs to be employed whether the 3-D has been filmed or converted.

### ***The Future of 3-D***

You will hopefully agree with me that 3-D film education on a student and a corporate level is vital for the survival of 3-D cinema. Because how is the consumer expected to value the stereoscopic image of the near future if it will be a clumsy, uneducated and unimaginative audio-visual visual product? Let alone a product that causes headaches with its audience!

Whenever I talk to people about 3-D film making, the first thing they say is: "But isn't modern technology going to solve all those problems?", followed by: "I saw a glassless 3-D plasma screen with images in 3-D". But what were those images in 3-D? What is the content? Digital projection is fantastic and HD is a real solution, but problems with 3-D have almost always stemmed from bad use of 3-D, both technically and creatively. It is human nature to blame technology for personal mistakes and stereoscopic 3-D has suffered some of the worst examples of this trait. Tomorrow's camera and projection systems are not going to solve tomorrow's misuse of these systems.

Hopefully, current 3-D releases will stick with proper 3-D filming techniques long enough for a new generation of stereoscopic filmmakers to learn the trade and eventually really exploit the marvellous new possibilities of this closely related, yet very different cinematic art form. Having a digital and even a glassless way of presenting 3-D will never take away the need for decent 3-D content.

Because stereoscopic or not, content will always remain king.

### ***Conclusion***

So - if you need 3-D consulting on your stereoscopic project or if you are in development hell and want to achieve a visually and narratively compelling 3-D production, feel free to contact 3-D Revolution Productions or visit our website.

*www.the3drevolution.com*  
*info@the3drevolution.com*