Preservation & Technical Services
3D Technology - Internship Project

NATIONAL FILM & SOUND ARCHIVE

ABSTRACT

This research project is aimed at exploring current digital 3D technology in cinema and television in order to assess its impact on the National Film and Sound Archives' collection.

PURPOSE

3D in the audiovisual context is not a new concept; however recent technological advancements in the digital arena have seen a quick rise in the use of 3D exhibition, both in cinemas and television; and will be a fast emerging aspect of what the NFSA collects. The purpose of this project is to explore current 3D technology and surrounding influences (both cinema and television derivatives) to increase the NFSA's knowledge of what is a subset of the bigger 'born digital' sector. This will help the NFSA assess and develop ways of predicting growth, acquiring, storing, preserving and playing back 3D collection items in the future.

DEFINITIONS

S3D – Stereoscopic 3D –This is the effect used to create a 3D effect. Images are recorded using separate cameras or lenses from slightly different perspectives to mimic the left and the right eye. The two images are then projected simultaneously. With the aid of 3D glasses (either passive or active – see below for description) the light signal is filtered then the correct image is sent to each eye. This gives the effect of a third dimension, the illusion of depth as if the image is coming out of, or reading into the screen. It is meant to replicate how we experience and see the real world.

DLP—Digital Light Projection

Delivery method for displaying 3D stereoscopic image [1]

a. **Checkerboard –** Left and Right eye images are divided into grids and then arranged in a checkerboard pattern. This is the format used by all Mitsubishi DLP rear projection, as well as older 3D ready DLP and plasma models from Samsung. New Blu-ray players will not output this format (except Panasonic's DMP-BDT300 and BDT350); Mitsubishi offers a converter and to allow compatibility between a new blu-ray player and their line of 3D ready TV's.
b. **Over/ Under (Above/ below or Top and Bottom)—**Embeds the two images one on top of the other in the same frame. Full HD output by new blu-ray players use over under format. Two 1920x1080 images (plus 45 pixels in between for blanking) are built into one signal that has 1920x2205 resolution.
c. **Side By Side –** Embeds stereoscopic video signal side by side in one frame. This is the current method used by satellite/cable broadcast companies and operators to transmit 3D signal, it requires some loss in resolution to fit both images in the same frame. For example a 1280x720 frame holds two 640x720 images. This format has the same resolution as 2D signal, and a side by side 3D image uses the same bandwidth, which is why it is the desirable choice.

[1] For all definitions: Rem Santos-Tura, *The ABCs of 3D key terms you need to know*, August 2, 2010, http:// 3dguy.tv (accessed September 13, 2010).

d. **Frame Sequential –** The 3D signal is alternately flashed the full image for each eye. New 3D ready TV's use this display method.

Convergence Point – The point at which depth is perceived. Convergence is where the line of view from the two eyes (or cameras) crosses.

Parallax – The displacement of an object seen from left and right eye not on a line with the object.

Pulfrich Effect – signal timing between the eyes

D-Cinema – Uses a jpeg2000 password protected security key

E-Cinema – Uses Mpeg 2 non security protected

Resolution

a. 2K (12 MB each Frame) – 2000 lines of horizontal resolution (roughly 2TB per hour of film footage in conventional cinema – double that for 3D cinema)
b. 4K (up to 60 MB each frame) – 4000 lines of horizontal resolution
c. 1.3K – 1300 lines of horizontal resolution.

Ghosting – When the image for the left eye would creep over into the right eye (also referred to as crosstalk)

Flicker – When the viewer can detect the open and closing of the active shutter on active glasses.

HOW 3D IMAGES ARE CAPTURED

applies to both TV and Cinema technology

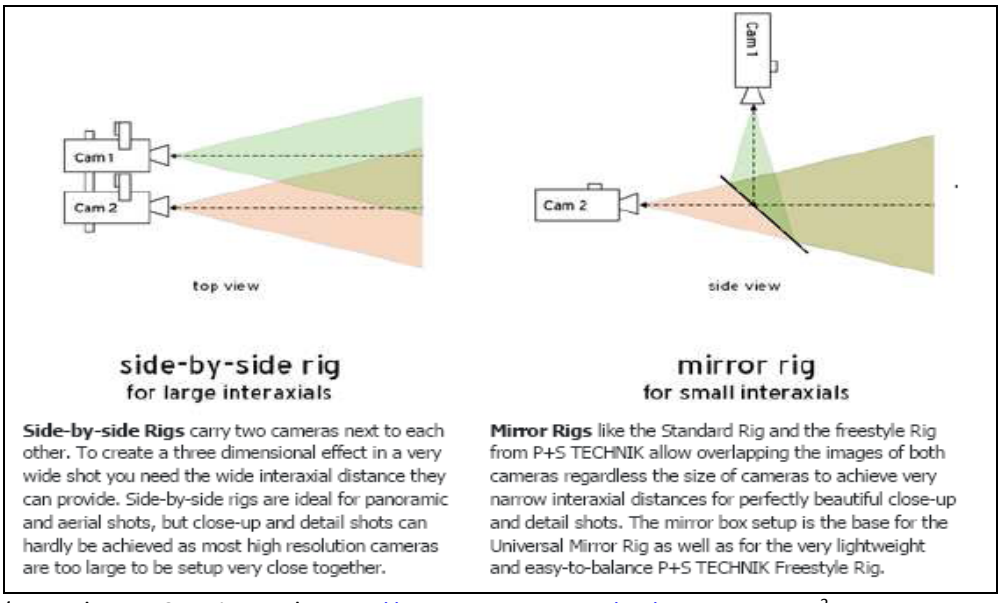
"3D content is captured by shooting and rendering (dimensionalising) two eye views with a horizontal parallax offset giving a left and right eye view."[2]

There are several ways to capture the depth field

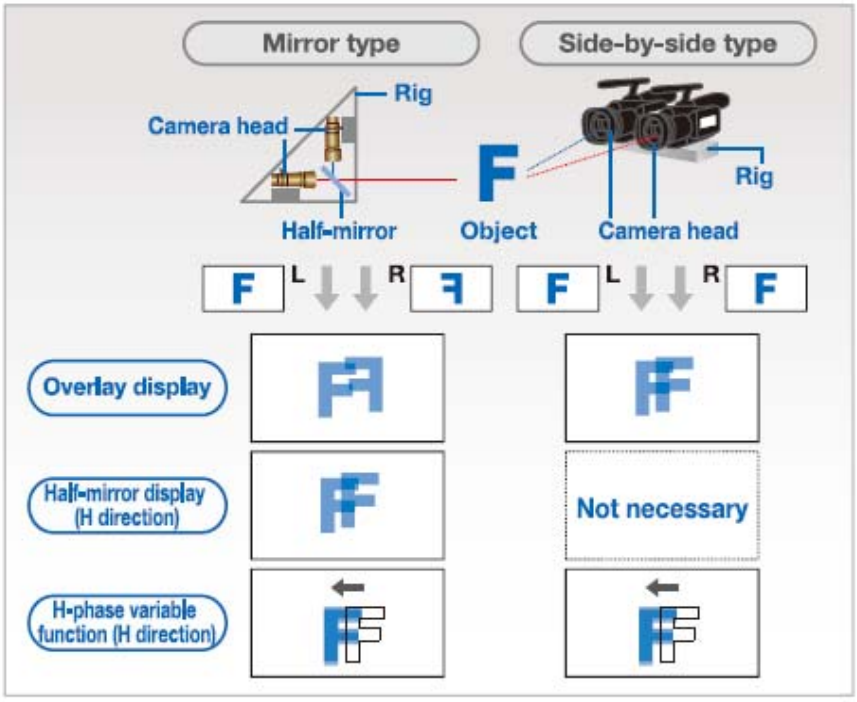
- By Calculation- used in computer animation. All the information already exists in three dimensions so it is simple to derive the 2 perspectives.
- With 2 cameras using one of the two camera rig set ups either tandem or with the Mirror Rig. This records the two perspectives.
- Using a stereoscopic camera with two lenses in tandem (the professional Panasonic AG-3DA1 or the consumer level Panasonic HDC-SDT750 camcorder).

3D films deliver one image for each eye, for this reason they are composited/ rendered at double that, 48 frames per second vs. the standard 24 frames per second.

[2] Mark Horton, "s3D MXF - Looking at Stero3D TV in a file based world," *Content + Technology Magazine*, Sept/OCt 2010, Page 24.



(How does a 3D Rig work, http://www.pstechnik.de/en/3d-basics.php)[3]



(Panasonic Brochure)[4]

[3] P+S Technik, *How Does a 3D Rig work*, 2010, www.pstechnik.de/en/3d-basics.php (accessed Aug 23, 2010).

[4] Panasonic, "Panasonic 3D Professional," *Panasonic Ideas for life*, April 2010, http://pro-av.panasonic.net (accessed September 8, 2010).

1. TECHNICAL SPECIFICATIONS – 3D CINEMA

1.1 Types of 3D technology for cinema exhibition, how does it work and the main differences

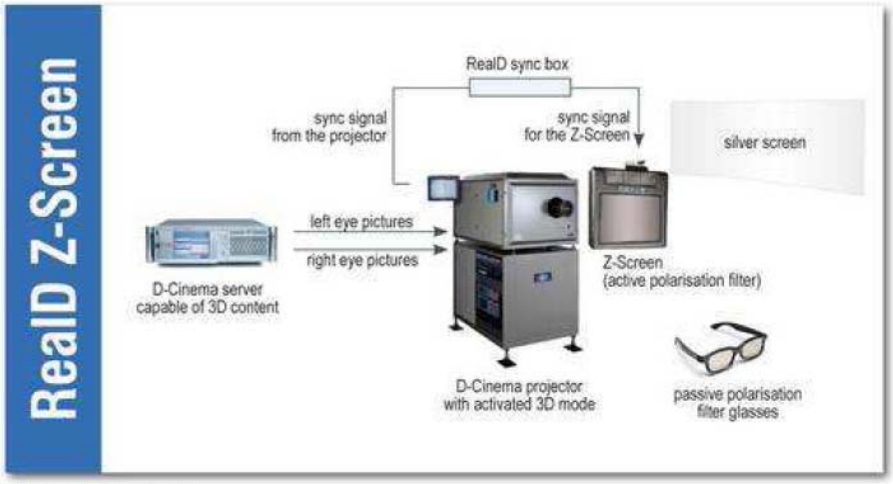
Early cinema relied of two projectors to show the left and right images in conjunction with red/ blue or red/green glasses. Today in Digital cinemas one projector is used that projects interweaved images, and use one of the systems below for separation.

Types of technology for cinema exhibition[5]

1.1.1. **RealD** (The most commonly used in cinema for projecting 3D films.)

Polarisation Filter System with Active Polarisation Filter: RealD

An active polarisation filter is placed in front of the D-Cinema projector's lens. This filter polarizes the light waves of the stereoscopic subframes in a different way per eye. The lenses of the passive 3D glasses are polarised accordingly so they let only pass the right eye picture or the left eye picture. As a conventional matte white screen would neutralise this polarisation, a silver screen is required.



Klicken zum Vergrößern

(Digital 3D systems http://www.kinoton.de)[6]

How does it work?

- Requires a single projector fitted with an active circular polarizing filter.
- Uses a Z-screen, this is a permanent device that rotates the light polarization in alternating circles to display the images for each eye.
- Displays images at a rate of 144 frames per second.
- Polarization filter system with Active Polarization Filter.
- Require passive circular Polarization glasses.
- Can be retrofitted over exciting Digital Projectors.
- An active polarization filter is placed in front of the D- cinema projector lens and projects polarized light onto a silver screen. The polarizing filter convert linearly polarized light to circular polarized. When vertical and horizontal parts of the image are projected onto the silver screen the polarizer slows the vertical beam, effectively making the light appear to

[5] Kinoton, *Digital 3D Systems*, www.Kinoton.de (accessed Sept 09, 2010).

[6] Ibid.

rotate. This rotation allows you to move your head without losing the 3D effect.

- Glasses are disposable.

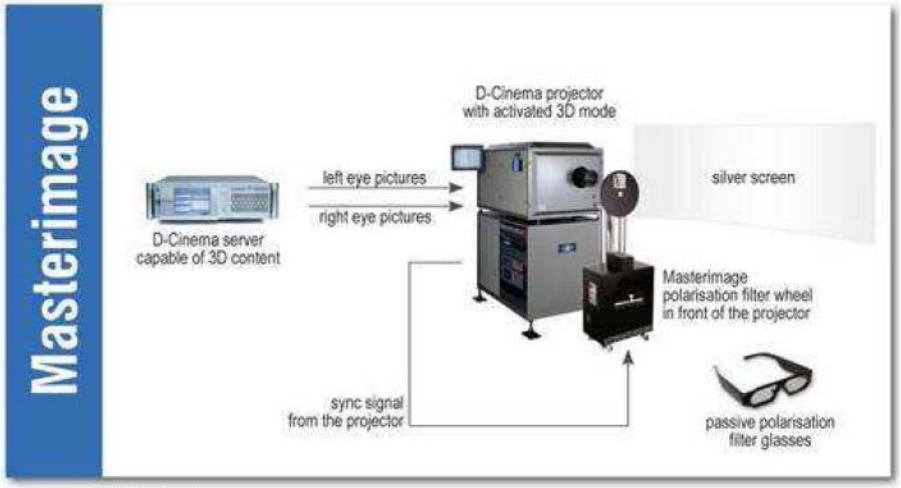
What equipment is required?

- Passive circular polarization glasses.
- ZScreen.
- Active Polarization filters.
- Requires a silver screen for projection as a conventional matte white screen neutralizes polarization.

1.1.2. Masterimage

Polarisation Filter System with Polarisation Filter Wheel: Masterimage

The light waves of the stereoscopic subframes are polarised differently by a rotating polarisation filter wheel placed in front of the lens. Appropriately polarised 3D glasses complement this system. A conventional matte white screen would neutralise this polarisation, so a silver screen is required.



Klicken zum Vergrößern

(Digital 3D systems http://www.kinoton.de)[7]

How does it work?

- Stereoscopic sub fames are polarized by a rotating polarization wheel that is placed in front of the lens. Uses passive circular polarization glasses.

What equipment is required?

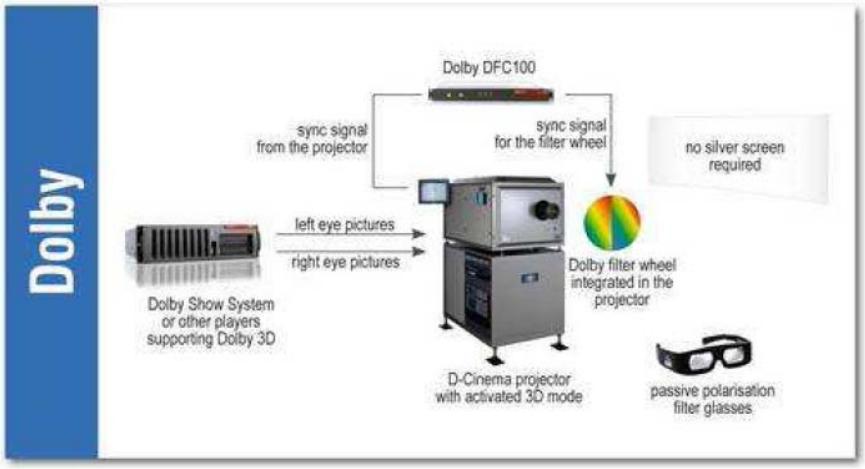
- Silver Screen.
- Passive polarization glasses.
- Rotating polarization wheel.

[7] Ibid.

1.1.3. Dolby

Filter Wheel System: Dolby

A rotating filter wheel assembly integrated in the D-Cinema projector slightly shifts the spectral position of the light waves for the RGB primary colours of the right eye and left eye pictures. The filter lenses of the corresponding passive 3D glasses are tuned to the resultant colour shift, so each eye can only perceive one of the two projected 3D subframes.



Klicken zum Vergrößern

(Digital 3D systems http://www.kinoton.de)[8]

How does it work?

- Based on full spectrum wavelength multiplexing technology licensed by Infinitec, Germany.[9]
- Makes use of color filter wheel – the wheel is divided into two parts, each filtering different wavelengths of red, green and blue. The wheel spins approximately 3 times per frame which is fast but not too fast so as to induce nausea.
- Requires the use of passive glasses that only allow light waves aligned in a certain direction to pass through each eye effectively filtering out the red, green and blue wavelength.
- A rotating filter wheel installed in the projector and synched with the frames.
- Either alternates pictures or uses dual projectors.
- May require color correction post processing.

What equipment is required?

- White Screen.
- Rotating filter wheel assembly to be installed to existing projector which can be retracted for 2D viewing.
- Dual projection set up also available with this technology that can accommodate larger screens.
- Passive multi-wavelength glasses

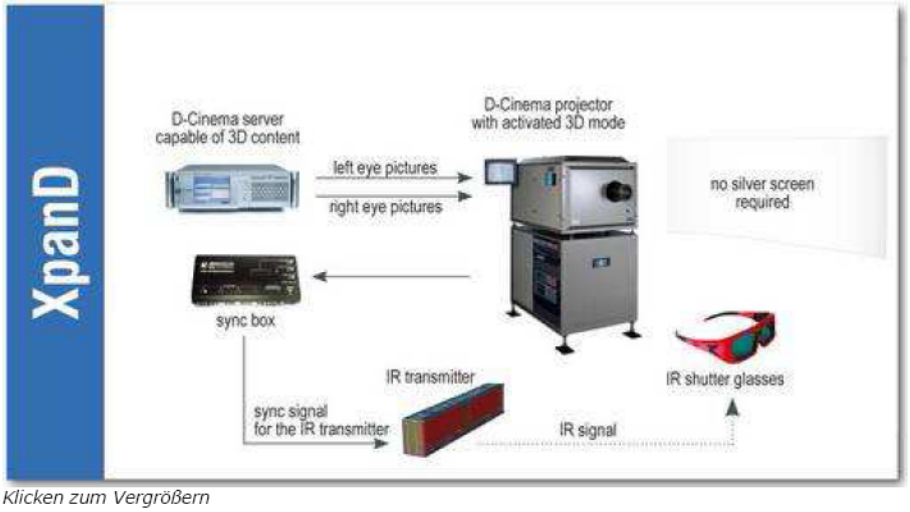
[8] Ibid.

[9] Autodesk, *Types of stereoscopic Delivery*, 2010, http://usa.autodesk.com (accessed September 01, 2010).

1.1.4. XpanD –

Shutter Glasses System: XpanD

The D-cinema projector signals a special sync box whether a right eye or a left eye picture is projected at the moment. The sync box controls the active shutter-glasses by infrared communication, dimming their lenses alternately so only one eye at a time can look at the screen. If the picture for the left eye is projected, the right glass becomes opaque, and vice versa.



Klicken zum Vergrößern

(Digital 3D systems http://www.kinoton.de)[10]

How does it work?

- Projector with a special synch box to deliver left and right eye image.
- The synch box controls the active shutter glasses by communicating via infrared signal to tell them when to turn off and on the left and right lens depending on the image that is being projected.
- Allows only one eye to see the screen at a time.
- When the left image is projected the right lens is switched off (turn opaque) and vice versa.

What equipment is required?

- Active LCD shutter glasses.
- Infrared transmitter.
- Synch box.
- Active Polarization filters.
- Conventional white screen.

1.1.5. IMAX – Large format 70mm Uses analog (film) projection (the only system that uses analog). Two projectors with polarizing filters are used to display s3D films. IMAX is making the switch to DLP but will still use dual projectors to avoid reduced light and resolution. Dual digital projection will also have a polarizer on each lens and the audience wears passive re-usable polarized glasses.

[10] Kinoton, *Digital 3D Systems*, www.Kinoton.de (accessed Sept 09, 2010).

Imax also offers Studio technology for converting 2D to 3D (DMR- Digital Re – Mastering).[11]

"The systems project in 3D mode at 144 Hertz – that is two times 72 Hertz (each picture displays three times for both left and right channels). At this high frame rate, the controllers installed in devices pre 2008 (1.2 inch chip) are no longer able to process the full pixel count, so systems only use 1628x880 pixels.

Both Dolby and RealD require a certain amount of pre-processing of the movie material in order to avoid errors. In the future, as required by the DCI standard, this processing is supposed to take place directly at the projection stage. 3D movies have a maximum of 2048x1080 pixels, in the movie theatre, and both images are stored independently of one another."[12]

Glasses

- **Polarization –** Passive system that controls the type of light that reaches each eye. Light has been polarized differently for each eye.
    - **Horizontal/ Vertical –** These glasses use vertical and horizontal polarizer's to filter light oscillating in the respective direction. And direct the two separate signals to the viewer's eyes. This can work either using 2 projectors to project each image onto one screen, using two screens with a mirror system, or a single projector alternating the polarized images one after the other. The last option is to use filters within the LCD screens, taking advantage of polarizing filters that these screens already have.
      Advantages – cheap glasses, decent picture quality
      Disadvantage - can cause ghosting as a result of head tilting, requires silver screen

    - **Circular Technology used by RealD and Masterimage –** separates images to clockwise and counterclockwise polarization. Commonly used in Digital cinemas. Same general principal as linear polarization.
      Advantage – cheap glasses, higher quality.
      Disadvantage – requires silver screen.

- **Wavelength Multiplex Glasses – Technology used by Dolby Digital** Developed by German firm called Infinitec. This is a passive system that uses color filters. Defines a specific band within each color. So that both eyes receive Red, green, blue.
  Advantages good picture quality, easy to upgrade and install color wheel on existing projector.
  Disadvantage Expensive, can cause some color distortion, requires some extensive color correction in post production phase.

- **Active shutter Glasses –** Most common type of glasses used with 3D TVs which rapidly turn on and off each lens, synched to the 3D signal to deliver the correct image to each eye. Requires double the refresh rate (120 Hertz or above), slower rates causes flicker. Glasses are synched with a transmitter box in the TV and battery powered. At present each TV manufacturer have proprietary glasses. Alternates the light in either eye, uses

[11] Autodesk, *Types of stereoscopic Delivery*, 2010, http://usa.autodesk.com (accessed September 01, 2010).

[12] Ulrich von Loehneysen, *3D Technologies for Cinema and TV Explained*, April 05, 2009, www.televsions.com (accessed September 6, 2010).

high refresh rates, to achieve an accurate level of synchronization with LCD and LED monitors.

Advantages excellent picture quality and 3D effect.
Disadvantages -- Potential health risks due to this high refresh rate, some viewers may notice some image flicker which can cause nausea and eye strain.[13]

1.2 Post Production path

Conventional Digital Cinema production path[14]
A film is shot and can take one of two paths, that being film or digital. For the purposes of this report I will focus on the digital path as this research is only concerned with digital s3D films. Once the film (2D) has been shot the footage is edited resulting in a digital intermediate (DI – complete master) from which a DCDM is produced followed by a DCP which is the format used for screening in the cinema.

Shoot → Edit → DI (complete master)→ DCDM → DCP

Digital 3D cinema follows the same path but will result in 2 image files as it is captured using two cameras (Please see *'HOW 3D IMAGES ARE CAPTURED'* on pages 2 and 3 for description).

1.2.1 How does it differ from conventional film and digital cinema?

The difference between conventional digital postproduction and 3D is the 3D stream produces two times the image files resulting in double the data information (double the memory). These image files are then put into frame sequential format and projected at twice the frame rate.

1.3 What are the intermediate and delivery formats for the different 3D formats

At present the most common format is 2K D-Cinema. The digital intermediates will require further investigation regarding the file formats ex: Cineon, DPX etc.

2. TECHNICAL SPECIFICATIONS – 3D TELEVISION

2.1 Types of 3D technology available for TV broadcast

Displaying 3D images

To create 3D images 3D TV systems have focused on the delivery of two different pictures to the viewers eyes. This requires two channels (one for each eye). There are two options for doing this, you can either half one dimension or double the complexity (twice the resolution). To address this you can hide one part of the signal using glasses (directed beams for each eye) or use directed beams that are specific to each eye.[15]

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[13] Daniel Long, *Science's health concerns over 3D films*, April 20, 2010, www;crn.com.au (accessed August 27, 2010).

[14] Danny Dawson, interview by Kelly Lynn archer, , *Post production path for film and digital cinema*, (September 14, 2010).

[15] Ulrich von Loehneysen, *3D Technologies for Cinema and TV Explained*, April 05, 2009, www.televsions.com (accessed September 6, 2010).

At home 3D viewing differs from viewing in the cinema for a few reasons; these are the viewers distance is closer to the screen and the screen is also smaller. As a result images made for the big screen must be adjusted to maximize the 3D effect in this new environment. Presently at home 3D viewing relies on frame sequential presentation and active lenses synched with the TV set.

LG will soon be releasing the first passive 3D TV sets for home viewing. This may be more appealing for large group viewings as the glasses are less expensive. This technology would use polarized light technology and passive glasses to filter the light waves. TV sets which employ this technology are presently used in hotels, pubs and clubs that broadcast 3D sports events. It is speculated that this technology may be more expensive then the active shutter system, but nothing has yet been released regarding pricing. [16]

How does it work?
The 3D signal will still be broadcast over the same frequency as conventional 2D television using side x side → interlaced 3D technology. The broadcast image is projected via two separate projectors in the television which overlay the image to give the stereoscopic effect.

The image is created by flashing up to 60 frames a second onto the screen. Pictures are then converted into a 3D image by battery powered glasses that are wirelessly linked to the TV.[17]

What are the differences?
If TV broadcasting were to be treated the same way that video centric broadcasting was there are any number of issues that may need to be dealt with. These include, synching the two views, and ensuring the two difference in view is maintained (convergence point), as well as maintaining and managing the media.

Mark Horton points out in his article in Content + Technology that "there is already a fluid debate around topics ranging from s3D acquisition, editing, composting, delivery and display and without an image file format standard; this is causing some confusion in the industry."[18] MXF file format is one of the formats that is a contender for use in 3D broadcasting file based work flow especially if transcoding or rewrapping is involved. MXF can easily carry side by side or over under or full HD image information, as well as 3D images compressed to Jpeg2000, DNx, AVC-Intra or other 3D specific compression schemes.

2.2 How is it captured/ shot
3D TV is captured/ shot in the same way that 3D cinema is. Using tandem cameras, a 3D mirror rig, or in the future a 3D specific camera like the Panasonic discussed in Section 1.0.

2.3 The post production path and how does it differs from conventional television

Live to air or direct record (Conventional):
Multiple camera shoot with associated live audio and file footage insert.

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[16] Oliver, *LG bringing 'passive' 3DTV with cheaper glasses by May*, www.news.idealo.co.uk (accessed September 3, 2010).

[17] Kerrin Binnie, *3D TV may be bad for you*, April 23, 2010, www.abc.net.au (accessed August 27, 2010).

[18] Mark Horton, "s3D MXF - Looking at Stero3D TV in a file based world," *Content + Technology Magazine*, Sept/OCt 2010. Page 26

Switched, mixed and live supers and special effects added as required.
Direct link to transmitter or record to storage media or videotape: sometimes encoded/ sometimes uncompressed.
Replay to air from storage may be of pre-authored compressed programs or uncompressed with live compression in the transmission system. [19]

3D live broadcast footage is sent from the cameras to a switch that converts the feed to side by side delivery format, which is then sent out over the same frequency as the conventional 2D broadcast.

Post Produced (conventional):
Program is created in segments for later editing and post production. Each segment has time code and other synchronisation information. Vision and audio may be separate recordings... Dump the source media off to your editing system, segment by segment.

In post, there is usually first an edit process where the video beds are produced with any accompanying audio. In a fully digital system, this may be done through editing low-bandwidth proxy files and the full resolution is rendered later.
Any special effects, supers and additional audio are added until the final program bed is completed. Then render the final product.
Record out to media.[20]

Again with post produced 3D footage it is also managed in a similar fashion. With twice the image information that is then sent via side by side delivery format to the cable box, decoded and projected by the television set.

Synchronous switching of routers was a standard in 3D transmission but now according to the Grass Valley Whitepaper article from April 2010, one interchange format is gaining interest in simplifying infrastructures, by multiplexing two 720p or 1080i HD signals into one SDI feed, though this would obviously double the bandwidth.

2.4 Master formats for the different types of 3D Television?

It is my understanding that the master format for 3D television is the same as for conventional television (either Live to air of post produced), which right now is HDCAM SR. The file will be encoded using side x side display format. This is then received by a TV cable box and decoded by the television itself and halved the resolution.

There is a move towards file-based workflow vs. video based; however no standards have been set yet. Broadcasters are still experimenting to see what will suit their needs the best.

According the Mark Horton's article in the September/ October issue of Content + Technology, "Most s3D (stereoscopic 3D) Broadcast facilities are likely to also be 2D Broadcast facilities (and the same is true for big s3D Post houses). That means it is possible that a Broadcaster will be producing a range of deliverables;

- S3D for conventional broadcast
- HD for conventional broadcast
- HD for web

[19] Greg Moss, interview by Kelly Lynn Archer, *Email regarding Conventional TV post production path*, Email Contact, september 06, 2010.

[20] Ibid.

- SD for conventional broadcast
- SD for Web
- SD for mobile [21]

While it is possible to build a video centric work flow, where computers (or hardware) are running single applications are connected together via SDI routers and backed up by network connections, but this would be cumbersome and could pose potential problems. This is where the alternate file based 3D work flow would come in.

2.5 How is it broadcast?

There are a few options for storing or broadcasting 3D images over a TV channel

- Color them in advance, in the case of red/green or red/blue.
- Use 2 channels, separate data but full bandwidth (above/ below).
- Putting 2 images into one but not combining them— for example side by side, checkerboard, or interlacing.

Approaches to delivering 3D signal

- Frame-Compatible – left and right images for each eye are stored in one TV video frame (either side by side, checkerboard, top/bottom etc). Resolution is half that of 2D so as to fit all information in a single frame. The 3D processor in the TV expands the halved image and displays them sequentially.
- Non-Frame Compatible – Images for left and right eye are delivered in sequential format (same as above). The difference is how the image is transmitted to the TV. Essentially a portion of the data exists outside the 2D frame. One stream is for the left eye and the other is for the right eye, the two streams are meant to be simulcast at the same time as two independent synchronized video streams in full resolution.

At present TV broadcasters are using the side x side method for delivering 3D transmissions as it uses the same bandwidth as conventional 2D television. The only requirement is updated firmware on digital cable boxes and a 3D capable television. This method does half the resolution and does not deliver full HD images but is the most cost efficient at present.

PLEASE NOTE: Just because a TV uses a particular display method does not mean it has to receive the signal in that format. The HDMI 1.4 spec requires that 3D TV's are able to accept multiple formats. According to a the 9 July 2010 report in *The Economic Times*, "The HDMI cables that connect set-top boxes to televisions or other screens can detect and support many standards."[22]

2.6 Playback equipment required to produce 3D for television

Active glass technology is the most prevalent technology available for televisions broadcast although LG has just released a passive glasses system which uses the circular polarized lenses. The active system requires the battery powered glasses and a receiver box that is able to synch with the 3D TV broadcast. Passive glasses are more affordable and user friendly for large group events and are what are commonly used in hotels, pubs and clubs to broadcast sporting events. The equipment required to view 3D broadcasts, are your digital cable box with updated firmware, 3D capable TV and 3D glasses.

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[21] Mark Horton, "s3D MXF - Looking at Stero3D TV in a file based world," *Content + Technology Magazine*, Sept/OCt 2010. Page 24

[22] Reuters Ist, *3D could be mainstream in homes in two years*, July 9, 2010, economictimes.indianatimes.com (accessed September 3, 2010).

2.7 Quality differences between normal 2D and 3D television broadcast

The difference in quality of 3D television is that halved resolution. Because the 3D signal is transmitted in side by side format, when it is converted to be viewable the images is half the resolution of a full HD transmission.

3. JUST A PASSING FAD?

3.1 The drivers for 3D technology at the moment.

The speculation in the TV market and film industry is that everything will be 3D ready by 2015. With the success of movies like *Avatar* and FIFA adopting the 3D technology it looks like it is here to stay. At present there are limited programming and DVD options. Most TV manufacturers have developed or will be developing 3D capable TV's. The release of the first professional and consumer 3D video cameras also facilitate more convenient and cost efficient methods of shooting s3D. This new technology no longer sees a need for large cumbersome 3D rigs and the extra crew necessary to operate it. Gone are the days of chunky 3D rigs and complex calculation to ensure quality 3D effects, the new professional Panasonic camera calculates and correct the convergence point on the spot and all in camera.

"Broadcast Australia has modified several of its broadcast transmission systems to support the 3D TV signal, which is encoded using the latest MPEG-4 compression standard and utilises a side-by-side 'frame compatible' 3D transmission technique."[23]

The Nine Network, SBS, and WIN have completed a two month trial of free-to-air 3D programming that ran May to July 2010 in Brisbane, Newcastle, Sydney, Wollongong, Melbourne, Adelaide and Perth. The ACMA required reports of the outcome of these trials and are expected to publish a report in the near future. They are also looking into future 3D trial to experiment with and determine standards that have not yet been set. [24]

3.2 Uptake for both forms of 3D consumption

Public receptiveness to 3D technology has been relatively positive. With the prices for 3D televisions dropping and becoming more affordable over the last two years, and awareness being raised by films like *Avatar* and sporting events, watching 3D could become more mainstream in the foreseeable future. There doesn't seem to be the compatibility war that we saw with VHS/ betamax or the High definition video/Blu-ray, where the film industry had to settle on a standard, no format conflict is foreseen with 3D technology.

3.3 How the creative sector wants to use 3D in their productions

3D is another mode of expression to challenge filmmakers and, there has been an interest in using this technology for years. The release of Panasonics professional and consumer level video cameras which calibrates convergence points in the camera, makes technology this

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[23]Broadcast Australia, *World's first 3D TV terrestrial transmission is on air*, May 19, 2010, www.broadcastaustralia.com.au (accessed August 27, 2010).

[24] Mark Horton, "s3D MXF - Looking at Stero3D TV in a file based world," *Content + Technology Magazine*, Sept/OCt 2010.Page 26

more accessible and some what hassle free. The small size and weight of the camera make it more manageable and moveable than the traditional 3D camera configurations. It can be moved into remote locations and doesn't require additional camera operators. Weddings, documentaries and concerts have already been recorded in 3D.

Panasonic has also released a variety of supplemental equipment that will support 3D productions these include: a digital AV mixer, 3D LCD Video monitor which uses circular polarized glasses, a 3D plasma TV display (with active shutter glasses), and a 3D projection system (please note this projection uses 2 projectors and polarized glasses.)

What makes a bad 3D movie is when the two images are out of synch. Without having to take this calibration into consideration I can see where the use of 3D will become more common place. Eliminating the excess expenses incurred with additional crew and time on set to adjust complex 3D rigs, it is foreseeable that more directors may opt to use 3D in their projects.

3.4 The anticipated Australian output of 3D product in the

3.4.1 short term (2 years)

Thea Dikeos on the June 3rd 2010 7:30 Report Australian Broadcasting Corporation said that "Sony expects in the next 3 years to sell 100 million 3D televisions around the world and by the end of next year (2011) more than half a million 3D sets in Australia."[25]

Foxtel is scheduled to be launching a 3D channel in 2011. Consumer interest at the moment is present but it may still be a bit too early to tell, broadcasters are likely to wait a little longer to see what the uptake will be by the public before they are likely to implement costly upgrades. The debate still rages with consumers as well over the glasses, will they will opt for the cheaper passive version or the more expensive active shutter glasses or wait for glassless technology.

Although Australia's 3D film production activity is still in its infancy, a number of 3D productions are already underway. In addition, Screen Australia has recently provided funding to Great Wight Productions to establish a dedicated 3D production and post-base in Melbourne. The company's objective over the next three years is to produce 3D projects and to build recognition for Australia as a leader in 3D production[26].

In July 2010 Panasonic unveiled the world's first consumer level 3D Camcorder. It is anticipated that this technology will become even more affordable over the next two years and that there will be a significant increase in the country's 3D home movie output.

3.4.2 Long term (10 years)

TV broadcasting
Gaming (Wii 2 is speculated to be 3D)

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[25] Thea Dikeos, *3D television health warnings - The 7:30 Report*, June 03, 2010, www.abc.net.au (accessed August 25, 2010).ABC

[26] http://www.if.com.au/2010/10/26/article/Screen-Australia-injects-funds-into-five-production-companies/SADKVXQQSS.html

With the projection of glassless technology we may see an increase in the 3D deliverables. Most reports for the future of 3D technology looks to 2015 being the year when 3D technology is standard. It will be up to the broadcasters and filmmakers to determine if they will continue to use this technology.

At present 3D television will be delivered as a specialty channel. According to Broadcast Australia's report, "To-date, commercial 3D TV services around the world have been launched on subscription cable and satellite platforms; the next challenge will be laying the foundations for terrestrial 3D broadcasts, the primary delivery platform for free-to-air services."[27]

Broadcast companies are in the experimental phase of 3D television where they are learning what works and what doesn't. Just like with 3D cinema 3D television looks as though it is here to stay.

3.5 2D to 3D conversion technology

There is software within the industry that is used the convert 2D films to 3D images, this technology was used for films such as *Alice in Wonderland* (2010), *The Last Airbender* (2010), and James Cameron is said to be in the process of converting Titanic to a 3D version. There is similar software version available on a consumer which does the same thing. *The Economic Times'* June 9, 2010 report stated that, "TVs are already on sale from Samsung that convert two-dimensional signals into 3D in real time."[28]

It is important to note doing 2D to 3D conversion isn't true 3D more it is 2D+ at best. The quality of the conversions is very poor. Essentially it is a computer algorithm that takes the 2D image (shot from one Camera angle) replicates it and offsets it to give the effect of a different perspective. This only displays negative 3D perspective (image set into the screen) and none of the 3D space displayed forward of the screen.

3.6 A future where glasses are not needed to view 3D

Glassless technology

Toshiba is reported to be releasing a glassless 3D TV in time for Christmas. They are limiting the screen size to 21 inches and is speculated to be very expensive. The technology is based around emitting light rays at different angles, which eliminates the need for glasses. Other TV manufactures say that the technology is still in its infancy; they are developing the technology but will not be releasing a set in the near future.

As it stands glassless technology is still limited to a small screen size, this limits the range of the viewers head which in turn helps to maintain a realistic 3D effect.

Nintendo is rumoured to be releasing a glassless 3D gaming console, 3DS, scheduled to be out by the end of the year. This is possible because the screen is only a few inches big and the user is never more than a few inches from the screen.

The way of 3D technology is a move towards glassless TV sets. While there is initial testing and rumors of glassless sets to be released this year, the fact remains that glassless 3D

[27] Broadcast Australia, *3D or not 3D: The road ahead for TV - White Paper*, July 13, 2010, broadcastaustralia.com.au (accessed August 27, 2010).

[28] Reuters Ist, *3D could be mainstream in homes in two years*, July 9, 2010, economictimes.indianatimes.com (accessed September 3, 2010).

technology is still rudimentary. The technology that exists at the time of the writing of this report is prefatory at best for large screen viewing. The challenges with large screen glassless technology are the viewer has to sit at a specific angle and distance to get the optimum 3D effect. At present glassless technology is only effective in smaller hand held devices like the 3DS.

Glassless technology isn't that far in the future though, it has been featured at trade shows and is projected to be on the market in the next 5 or so years.

4. SOCIAL IMPACT

4.1 How audiences are reacting to 3D cinema and television

People seem to be receptive to the technology; the main complaint is the need to wear the glasses. At present the price of 3D compatible TV is fairly high, it would be my speculation that once the prices comes down people will invest in it. Also once glassless technology hits the market people will be more willing to shell out for the latest and greatest in technology. There is no slowing down in pushing this technology forward. The industry is working not only to develop glassless television sets but also 3D holographic and 3D touch holographic technology.

There seems to be a genuine interest in the 3D films and television. In speaking with a representative from Myers, he projected that once the pricing goes down people will be more willing to make the switch. Presently the average 3D TV runs close to $5000.00 (AU), with very limited 3D viewing options. We are waiting for the technology to take off but 3D appears is here to stay. Considering that 3D televisions have been on the market for a relatively short time, and have already dropped in price, we can expect to see the same trend as more 3D media is produced.

4.2 The perceived health risks

There hasn't been a lot written about the health risks or issues associated with 3D viewing to date. The most common complaint regarding watching 3D cinema is the tendency to feel motion sickness. This occurs when the convergence point of the cameras doesn't match up, and is more common with earlier forms of stereoscopic filming. With the newer digital format directors have more control over the image and can manage these effects.

There are conflicting reports as to the health risks involved in viewing 3D TV. Samsung has issued warnings stating; "viewing 3D television may also cause motion sickness, perceptual after effects, disorientation, eye strain and decreased postural stability,"[29] They go on to further warn that "viewing 3D TV may cause disorientation in some viewers,"[30] and recommend people who are pregnant, sleep deprived, drunk or at risk of stroke or seizures not watch 3D Television. In contrast, Mark Pesce, one of the pioneers in Virtual Reality, warns of the dangers of 'binocular dysphoria'. This condition is caused by over exposing the

[29] CNN, *Samsung issues warnings about 3D TV*, April 15, 2010, www.CNN.com (accessed August 27, 2010).

[30] Ibid.

brain to the parallax based depth cues provided by screen based 3D technology, and may permanently affect a person's depth perception[31]

The major concern is the effect viewing 3D television will have on children.

As with anything too much of a good thing is never good. 3D TV is no exception. Sitting too close to the television and prolonged viewing times can strain the viewers' eyes, or cause head aches. Another concern is the ability to sense depth perception correctly after prolonged use.

Carl Rose from the June 3, 2010 7:30 Report by Australian Broadcast Corporation stated that; "…studies have shown in the US that the health effects are very minimal. Again appropriate usage, you know, is probably the right expression to use. So you know if you watch it for a few hours you're not going to have any… significant health effects. [32]

Quality control of 3D content will be of the utmost importance. If 3D is recorded poorly, e.g. not matching convergence point's etc. people will feel those effects. With some standards put into place the problems should remain minimal.

The majority of the health concerns are related to the virtual reality goggles where small screens are put in front of the eyes and a different picture is projected to each eye. It is this closeness to the displayed picture that is cause for concern. Viewing images from a farther distance 2-3 meters relieves the strain on the eyes and should be less cause for health concerns, as they eyes will be pointing in parallel. Distance from the 3D device and duration of viewing are the points being made with these considerations there should be little cause for health concerns.

Poor 2D-3D conversions done last minute may be the cause of health concerns. "In an article at the Hollywood Reporter, a poor 2D- 3D conversion can actually make things worse for viewers, says Dave Walton, an assistant VP for marketing and communication at JVC Professional, a camera company. Walton cautions that a poor conversion can cause 'bad headaches and nausea within a few short minutes.'"[33]

Sony has also issued a disclaimer warning of the possible health risks of their 3D console. They warn of potential "…discomfort (such as eye strain, eye fatigue, or nausea) while watching 3D video images or playing 3D televisions, If you experience such discomfort you should immediately discontinue use of your television until the discomfort subsides."[34]

It should also be noted that the technology is relatively new, especially for home viewing where extended periods of viewing is now possible and as a result we will have to wait and see what the long term effect may be.

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[31] http://www.abc.net.au/unleashed/32814.html

[32] Thea Dikeos, *3D television health warnings - The 7:30 Report*, June 03, 2010, www.abc.net.au (accessed August 25, 2010).

[33] Daniel Long, *Science's health concerns over 3D films*, April 20, 2010, www;crn.com.au (accessed August 27, 2010).

[34] Ryan Fleming, *Sony Warns of Possible 3D Health Risks*, July 13, 2010, www.digitaltrends.com (accessed August 27, 2010).

Most manufacturers' post all potential health risks related to their product to prevent any future litigation, but is all just seems too early to tell what the effects will be.

5. Archival Community

5.1 How other audiovisual archives internationally are handling 3D in terms of Policy, infrastructure and storage.

National Film Board of Canada:

According to an email received by Richard Cournoyer a representative for the National Film Board of Canada on September 11, 2010, the NFB deals mainly with films and not television per se. Conservation of their 3D films follows the same protocols as conventional film, where they differ are the display methods. According to Mr. Cournoyer they are still focusing on digitizing their 3D film collection, and haven't gotten into the preservation of digital 3D footage. Mr. Cournoyer said, "[their] plan [is] to have a global conservation policy by the end of the year."[35]

5.2 Key lessons learned to date

Based on this email received from the National Film Board of Canada it is my impression that they have not fully addressed the issue of preserving digital 3D technology.

Supplemental Information

This report focuses on digital s3D cinema and television technology but there are other formats of 3D media that may impact the NFSA's collection in the future. These additional formats may include:

- Auto-stereoscopic – 3D technology that does not require headgear or glasses, it makes use of head tracking technology but is limited in resolution and size.
- Virtual 3D reality – Computer simulated reality, displayed on a computer screen or through special glasses.
- Pseudo 3D holographic – This displays a 3D image from all angles, the viewer can move around the projected image.
- Touchable 3D Images – Another future advancement of 3D technology. It has potential applications in; medical school (surgical education), computer gaming, as well as the museum industry to accommodate visually impaired visitors.

While these formats may not be of initial interest in the film and TV industry, they have potential applications with medical professionals, graphic designers or fine art practitioners, etc.

Please note: Playback method should not be confused with the method used to record, store, and transmit 3D images.

Points that still require investigation

[35] Richard Cournoyer, interview by Kelly Lynn Archer,, *NFB Email - 3D Conservation*, Email Contact (September 11, 2010).

- **Storage** – Some consideration for the NFSA is the amount of storage needed to handle the digital 3D files. In my opinion a general rule of thumb would be to double the capacity of conventional film shot using 1.3K, 2K or 4K technology. At present television remains tape based but as it moves into a file based this is something that will need to be re-addressed in the future. The NFSA should also take into consideration the uptake ratio.
- **Version Awareness** – As mentioned in section 2.4 a variety of formats may be created for different delivery methods, this will be an area that NFSA will have to address when it comes to what version to add to the collection. One title may be released in standard definition, high definition, 2D, 3D or files for web both in cinema and television.
- **Media Asset Management (MAM)** – Some consideration will have to be made in regard to the effect of 3D intake on MAM. Technical specifications in particular will be important to capture, this includes properly labeling the file as a digital 3D film or TV, file format (1.3K, 2K, or 4K, and any security information if it is 2K or 4K), how it is encoded (side by side, over/ under, frame sequential or checkerboard) and film speed. Capturing this information will be particularly important when determining the playback method necessary. This could be considered at the time of acquisition resulting in an amendment to the *Statement of Technical and Production Details* presently in use. [36] Technical Metadata from the digital file should also be revised in the context of the *Digital Technical Metadata* document.[37]
- **Playback** – Equipment considerations for the NFSA must be addressed when managing 3D material for playback purposes. This includes 3D televisions, computer monitors (if necessary), DCI projectors and their associated glasses.

CONCLUSION

The success or failure of a digital 3D cinema and television will depend on the effectiveness of directors and broadcasters to deliver quality 3D productions relieving the strain on viewers. The technology is moving forward. New more advanced 3D technology is already in the works. 3D is what HD was to standard definition TV, the way of the future.

[36] NFSA, "Statement of Technical and Production Details for Deliverables", NFSA Document.

[37] NFSA "Technical Metadata", NFSA Document, January 2010.

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