



## EXECUTIVE BRIEFING SERIES

### 3D – THE THREE MEDIA VIEW

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## THREE MEDIA ASSOCIATES LTD

**TMA works with broadcast and media companies to plan and implement major business and technology change**

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## 1 INTRODUCTION

How many times this year have you heard your colleagues debating the merits or otherwise of 3D, and whether it will take off or become another technology that dies a death such as BSB and the squarial ! This document will hopefully help you to make your own decision on 3D technology or give you the impetus to research it further.

There have been many white papers written on this topic already this year. We have chosen to highlight two areas that are critical to the success of 3D in the broadcast market but are less frequently discussed in the current rush of enthusiasm. These are both critical in different ways.

First we consider the health implications of watching stereoscopic 3D moving images. We believe that these have not been properly assessed, and that there are significant areas for concern. The second subject is the impact of audio on the viewing experience. While inevitably there is much discussion about the visual impact of 3D it is easy to overlook sound, which actually can do a great deal to make the visual effect more solid.

This paper also provides an overview of the 3D technology and how it has evolved, and also discusses some of the business and commercial factors that will govern its success.

We conclude with a Three Media assessment as to whether 3D will be a success in the short, medium and long term and for which markets.

The paper throughout refers to a number of articles, which reference others, and overall there are over 242 articles declared in the reference section at the end of the document.

## 2 OVERVIEW OF 3D TECHNOLOGY

It is useful to understand the history and evolution of 3D and the different types in use in the current market.

### 2.1 18TH CENTURY AND BEFORE

The idea of stereoscopy can be traced back 500 years to some binocular drawings made by Giovanni Battista della Porta (1538-1615). During the same period Jacopo Chimenti da Empoli (1554-1640) produced drawings side by side which clearly indicated his understanding of binocular vision. (WIKI)

Despite this, it was the 1800s before equipment was built to prove the theory. Although the first invention is attributed to Brewster, it was Sir Charles Wheatstone in 1838, who described his invention with the words "*I...propose that it be called a Stereoscope, to indicate its property of representing solid figures*".

Eleven years later Sir David Brewster invented a binocular camera and the first stereoscopic pictures were produced. It is estimated that by the mid eighteen-fifties over a million homes owned one.

## 2.2 3D DURING THE 1950S AND BEYOND TO 2009 – ANAGLYPH IMAGES

During the 1950s anaglyph images were used to provide a stereoscopic 3D effect. Images were made up of two colour layers, superimposed but offset with respect to each other to produce a depth effect. Usually the main subject was in the centre, with the foreground and background shifted laterally in opposite directions. The picture contained two differently filtered coloured images, one for each eye. To view the stereoscopic image the viewer had to wear a pair of "anaglyph glasses". The glasses had lenses of chromatically opposite colour, usually red and cyan. The brain then translated this into a perception of a three dimensional scene. (WIKI)

In the year 2000 and onwards, ColorCode3D was introduced which used amber and blue filters and was intended to provide nearly full colour viewing. The left eye (amber filter) receives the cross-spectrum colour information and the right eye (blue filter) sees a monochrome image designed to give the depth effect. The brain ties the two images together. The 2D viewing experience was slightly improved.

Most of us in the United Kingdom will remember that C4 in November 2009 commenced broadcasting a series of programmes in 3D using this technology, and glasses could be picked up from large supermarkets and TV magazines. This was a one off designed to prove 3D could be achieved on television, but has never been broadcast this way since. However, Monsters v Aliens the film was released in 3D in the cinema with this technology in the early months of 2009.

In America, there was a 3D advertisement break during the 2009 Super Bowl featuring commercials for SoBe, Monsters v Aliens and Chuck. It is reported that the Obama family sat in the White House wearing their 3D glasses so that they could experience this new technology!

This technology is not commonly used in today's market.

## 2.3 CURRENT TECHNOLOGY - POLARIZED 3D GLASSES

The most well known product of 3D in this form is Avatar, which was released worldwide in December 2009. Cinema goers donned "cheap" polarized 3D glasses to obtain the full effects of the 3D production.

To present the stereoscopic motion picture, two images are projected superimposed onto the same screen through different polarizing filters (usually using circular polarisation). The eyeglasses also contain a pair of different polarizing filters. As each filter passes only that light which is similarly polarized and blocks the light polarized in the opposite direction, each eye sees a different image. This is used to produce a three-dimensional effect by projecting the same scene into both eyes, but depicted from slightly different perspectives. As the polarisation is circular, viewers do not need to keep their head in the same position to get the full effect as they would with plane polarisation. (WIKI)

This is mainly for use in the cinema, although Samsung have announced they will be launching a new LCD television to be used with RealD (inexpensive) polarized glasses in 2011.

## 2.4 CURRENT TECHNOLOGY – SHUTTER GLASSES

These glasses are used to create the illusion of a three dimensional image when viewing programmes broadcast in 3D on a television or computer screen.

The glass in each eye contains a liquid crystal layer which has the property of becoming dark when voltage is applied, being otherwise transparent. The glasses are controlled by an infrared, radio frequency, DLP-Link or Bluetooth transmitter that sends a timing signal that allows the glasses to alternately darken over one eye, and then the other, in synchronization with the refresh rate of the screen. Meanwhile, the display alternately displays different perspectives for each eye on a frame by frame basis, using a technique called “Alternate-frame sequencing”. This also achieves the desired effect of each eye seeing only the image intended for it.

All currently available 3D-compliant TV receivers use this technology. However, only one or at the most two pairs of glasses are included in the purchase. Because shutter glasses use active components for synchronisation and shuttering they are relatively expensive, and buying enough pairs for all the friends likely to want to watch would be a significant investment. So far the most popular way to watch 3D in the UK is to go to the pub where they are promoting the event and the glasses – usually polarised glasses used in conjunction with a projector – are handed out for free.

## 2.5 CURRENT TECHNOLOGY – AUTOSTEREOSCOPIC 3D

This form of 3D is shot in such a way that the brain is able to process the images without glasses. This has to be the future but only when the standards for 3D technology have been resolved.

Sharp has not yet launched a TV that delivers a 3D display, but they are very close to it. They have however been selling 3D LCD laptops for a number of years. Hitachi has released the first 3D mobile phone for the Japanese market; it is expected this technology will take off for mobile. The new Nintendo 3DS which is in development also supports the technology.

# 3 3D BROADCAST, SUCCESS OR FAILURE ? FACTORS TO CONSIDER

## 3.1 IN SICKNESS AND IN HEALTH

There are over 240 articles to support the physical and psychological issues raised in this section, and these are detailed in the reference section at the back of the document

### 3.1.1 Physical

The health issues which are experienced as a direct result of viewing 3D are related to the way that we see. In particular they are linked to the “accommodation reflex”.

The accommodation reflex is a reflex action of the eye in response to focussing on a near object, then looking at a distant object. It refers to the way the eyes focus and specifically to the way each eye focuses in relation to the depth of field that is “in focus” at each focal plane in the image.

In the real world, the eye and brain judge depth by combining accommodation – the need for the eye to physically change to focus at different distances – and vergence, the degree by which the eyes need to move away from the parallel to make them homogenous, that is for the visual images to mould together properly.

Consequently, when presenting a 3D signal to the eyes and then the brain, the different focus points for the two images of the left and right channels cause that part of the brain to work much harder than it would with the normal images it gets when viewing 2D – this is due to the accommodation/vergence conflict. This creates *fatigue* and is one of the most common side effects of 3D.

It is well known that fatigue drives headaches, and recent research has shown that 10-15% of people will get *headaches*. For the unlucky few this can also trigger migraine.

The brain when processing these images initially might focus for example on an object that is 15 feet away with one eye and then focus on the TV which could be 8 feet away with the other eye. The brain is getting mixed messages as it tries to focus on two distances, and this naturally changes as the pictures change. The eyes' focus is jumping backwards and forwards, left and right. The brain is continually trying to work out where the object is and where it is trying to get the eye to focus, and this can trigger *motion sickness* in up to about 10% of people.

It should be noted that for some people who have defective vision in one eye they will not experience the 3D image, and will only ever see 2D.

### 3.1.2 Psychological

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Also related to motion sickness is *disorientation*. Some people experience serious side effects in that they cannot sit still, whilst others cannot stand up until at least 30 to 40 minutes after viewing a 3D image.

Perhaps most worryingly, there is good anecdotal evidence that this can also trigger a schizophrenic attack if that person already suffers from schizophrenia. Further, there is evidence that mental illnesses can be set off where previously no signs had been exhibited.

Everyone has their own experience of reality, and everyone's experience is slightly different from everyone else. Normally this experience of reality is similar enough between people that we all agree what reality is and it appears 'solid' even 'real' to us. 3D directly interferes with our link between our visual system and sense of reality, and the people that are affected and disturbed the most by this are those who have a weak link in this area.

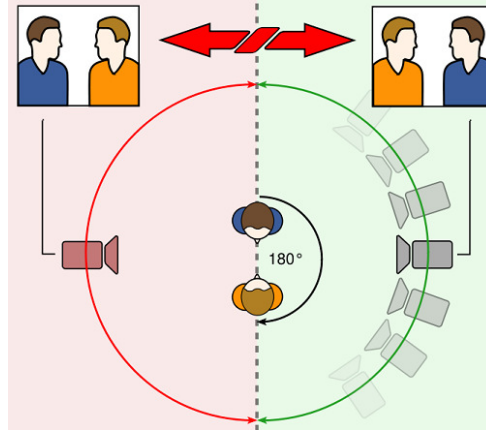
It should be noted that normal 2D television is also capable of triggering this, but to a much lesser degree.

## 3.2 IMPACT ON PRODUCTION CREATIVITY

To date there have been many papers on the impact of 3D on production creativity so we have highlighted only the key points:

- Very fast intercuts should be avoided during the recording and post production process
- Pop style cutting is a definite no and must be steered clear of.

- Producers, directors and editors must adhere to the 180° rule to avoid editing and cutting “crossing the line”. (*The 180° rule is a basic guideline in film making that states that two characters, or other elements, in the same scene should always have the same left/right relationship to each other. If the camera passes over the imaginary axis connecting the two subjects, it is called crossing the line.* [[http://en.wikipedia.org/wiki/180\\_degree\\_rule](http://en.wikipedia.org/wiki/180_degree_rule)])



- Too much foreground movement will exacerbate the health issues raised in the previous section
- Ideally, lots of wide pans that come in slowly to close ups are the ideal

The production industry has already acknowledged they will have to change their techniques to accommodate these facts, but it is possible even then that some programme genres will never lend itself to 3D.

### 3.3 THE AUDIO EXPERIENCE

Audio is often the forgotten component of the production process with little understanding of how sound adds to the viewing experience. The latest SMPTE research carried out experiments for 3D and virtual reality, and found that between 44 and 48% of the viewing experience was enhanced by the audio.

This has not been acknowledged by 3D programme makers to date, despite the statistics to prove that budgets and resources need to be adjusted to ensure audio production and delivery is as important as the video.

A series of academic studies also recently carried out reinforces this phenomenon. The studies used 3D content with surround sound or 5.1 audio, or better, with very good correlation between the 3D locations of audio and video. 20 to 30% of people involved in the studies agreed that when the audio and visual 3D location matched, the experience was greatly enhanced. This research was carried out in Germany, USA and Japan to ensure that the different hearing profiles worldwide were accounted for.

The education of the viewer is also a missing link in the production to consumption chain. At the moment most HD sets are delivered with quality audio systems, but it is left up to the viewer to link this to surround sound systems in the home. Most people do not attempt or even consider this. When these sets are purchased, sales staff do not discuss with the purchaser how to maximize the viewing experience in the home by setting up surround sound.

Education needs to go as far back as the supplier, and they should provide guidelines as to how audio should be set up for their own sets. Even then where there is mass turnover (big supermarkets like Walmart, Tesco, Aldi) it is never likely to be a feature of the sale. This change will not take place overnight, which is one of the reasons why we believe there will not be a mass take up of 3D in the short to medium term.

### 3.4 3D STANDARDS – WHAT STANDARDS ?

SMPTE has agreed a standard for H264 AVC, and HDMI has agreed 3D formats to connect the set top box to the television, but within these standards there are many variations and competing standards. There are at least a dozen different bodies who are attempting to standardize 3D television, a dangerous situation which speaks for itself!

LG, Panasonic, Sony, Phillips and Samsung have implemented the HDMI V1.4 specification and all support 3D with viewers using the shutter glasses. Despite that they need to be provided with a signal that is compliant with the HDMI specification - such as the frame-compatible system used by BSkyB – to provide 3D for a viewer. Within the display itself the formats are pretty much standardized.

3D processing starts off with two video channels (left eye and right eye), and then the left and right video frames are filtered and interleaved to create one 3D data frame, which is broadcast (transmitted). In the receiver the opposite occurs to get back to the two video, left and right channels. The difference between the standards is the way the frames are filtered and interleaved

Given 3D is now effective as live and in the market place, market forces will drive the standards bodies to a pragmatic solution. The big manufacturers have pre-empted the standardization process, as often happens, and what they have adopted will more than likely become the standard on a territory by territory basis.

The global standards will be all encompassing and will contain the local references within it. The SMPTE and EBU standards will fall under a common ISO standard.

### 3.5 COMMERCIAL & BUSINESS CONSIDERATIONS FOR 3D

#### 3.5.1 Resilience of the viewer

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The biggest piece of research still to be conducted within the industry is the length of time a viewer can manage to view 3D content in one viewing. Avatar is the longest film so far, but at around three and a quarter hours it has not come close to the duration of an evening's viewing for most families. What is not known is what the percentage increase would be for each of the health issues raised earlier, the longer 3D is watched. These results could have a dramatic effect on the success of broadcast 3D.

The other factor to be considered is the social impact of wearing 3D glasses night after night, on family and friends who watch TV together. Currently, this has not been considered as 3D has been single event driven, but investigations could prove that this could be detrimental to 3D success.



### 3.5.2 What is the payback?

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If we look at Sky in the UK and ESPN in North America, they both need to be a leading edge differentiator and for them it is vital that they are seen to be the first. This is part of their USP as a premium service provider. However, has it provided any payback to date? No, but it is very early days.

It has yet to be proven that 3D actually works for main sports events. Football, American football, basketball, soccer, baseball have all been broadcast to test audiences but there is no evidence it added any value to the viewing experience. If it can be proven to add real benefit then it is recognized they will keep a loyal audience once competitors start to do the same.

Judging by the comments on forums from the early adopters, the majority has expressed some disappointment with the 3D coverage of sports, and most are looking forward to viewing 3D on DVD's. It is acknowledged that Sky's quality of 3D is not as good as Blu-ray due to the amount of compression applied over the transmission link. The 3D illusion is quite sensitive to compression artefacts, and it is vital premium bit rates are secured for the transmission path. Even then this will not match the quality of a DVD.

### 3.5.3 Inclusion of surround sound in TV sets

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As mentioned earlier, audio is key to helping to provide a true 3D experience, and surround systems are not included with existing sets as the norm. This will need to change but could drive prices of television sets higher and out of the reach of the man on the street.

### 3.5.4 Supporting infrastructure budgets

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We have previously discussed the increased production costs, but there are also increased technical infrastructure costs to be considered. Naturally there are additional processes to manage the filtering and interleaving of the video signals, but there will also be additional costs for the viewing and monitoring of the 3D content across all technical areas.

### 3.5.5 Programme sell-on costs

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Broadcasters are introducing new revenue streams by selling content on the non linear and new digital platforms. It is inevitable 3D content will also be sold. Any sell-on costs need to take account of the additional costs to down convert 3D to HD (or SD) and then onto the format required for the different platforms.

## 4 CONCLUSION

Three Media believes that a true 3D broadcast channel is a number of years away. For the short to medium term it is unlikely 3D production and transmission will move out of the niche areas of sport and film.

There is not enough competition around to drive broadcasters to expand or commence 3D production, and there is not enough profit for those broadcasters that have made the jump to 3D already to extend their offering to other channel genres.

In fact, even then, it is probable makers will not commence commercial production in 3D until there is a certain percentage of the viewers who have the equipment to watch these 3D programmes – and consistently choose to do so.

For the longer term we believe its success is dependent upon a number of factors:

- Production companies need to understand and account for the health issues that have been highlighted.
- Production techniques will need to change, and even then it is probable that some genres may never be able to accommodate these different techniques.
- Research to determine a viewer's resilience is essential to prove 3D can be tolerated hour after hour, night after night.
- Proof 3D adds value to the viewing experience
- Adoption and acceptance of surround sound being part of the TV viewing experience;
  - Broadcasters need to adjust budgets to deliver quality audio
  - Viewers need to understand the value of adding a surround sound speaker system to their TV for 3D to be shown to its full effect (research has shown that only 12% of people who bought HD TVs had surround sound. This needs to be 50%+ before it starts to become the norm).
- Standardisation of 3D by the industry bodies to enable the free and rapid exchange of material between broadcasters.
- The commercial success of a 3D channel could be reliant on three different scenarios:
  - Can an existing 3D channel generate enough revenue from advertising and / or additional 3D subscriptions to increase the profit ?
  - Can a non 3D channel afford to increase the cost base to broadcast 3D because the decision not to adopt it would introduce revenue erosion due to lost viewers ?
  - The non 3D platform / broadcasters have to see the value in 3D before sinking money into productions and infrastructure. This may never happen as there may not be enough viewers to support the existing 3D channels. Consequently production levels will remain static and 3D could fizzle out. The economic recession could play a part here as this is seen to be a luxury item and not a priority.
- The film makers have proven they can make extra profit by making films in 3D, by the marked increase of numbers in the cinema. A lot of the early content available on 3D could be films, although this content is licensed to RealD, makers of the polarized glasses. They will delay the transmission of this content on a broadcast channel where viewers would use shutter glasses. RealD are naturally pushing for polarized glasses to be the standard, and their control over the 3D films could delay the broadcast uptake and hence shutter glasses.

In summary it is too early to really forecast the success of 3D long term but in six to 12 months time it should be more predictable.

Three Media is of the opinion that until television sets are autostereoscopic 3D enabled and have adopted by the viewer, a broadcast channel will never be fully 3D, but that 3D commissions will be event or genre driven. To get to this point could take many years.

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