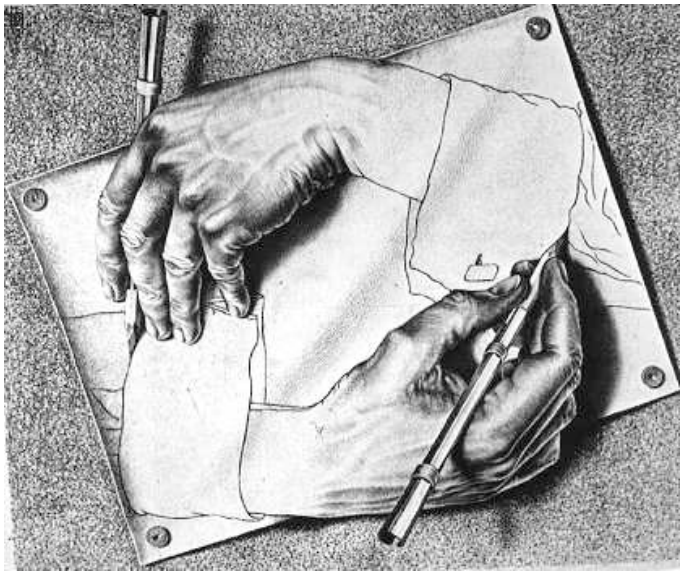
The Current State of the Consumer 3D Experience



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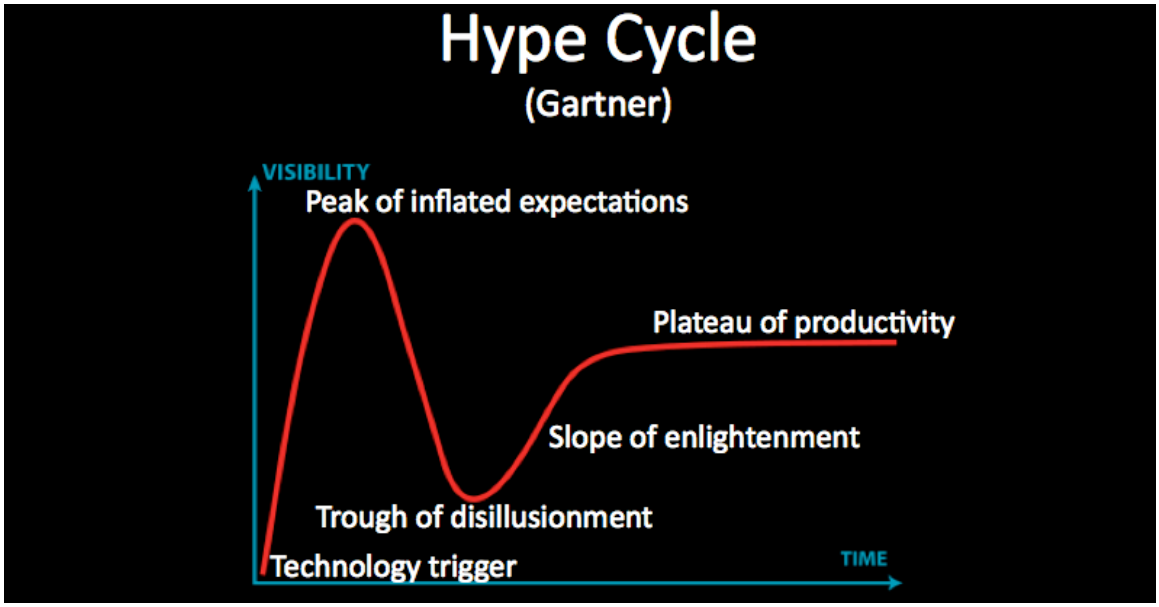
Introduction

The introduction of non-anaglyph, digital S3D as a consumer experience started with Disney's Chicken Little in 2005. But the 2009 theatrical release of Avatar, with James Cameron's strong marketing of the 3D aspect of the feature, was the benchmark event that defined consumer expectations for a 3D experience. Mr. Cameron and company also laid the groundwork for the rapid decent into the trough of disillusionment by telegraphing what consumers should expect before those expectations could be adequately met. At that moment the production, theatrical exhibition, distribution, and consumer electronics technologies infrastructures were still being developed, and content creation was just ramping up.



The ETC's Consumer 3D Experience Lab and Program has ridden the heart of the Hype Cycle; from a few years after digital stereoscopic 3D's (S3D's) launch in cinemas through the peak of inflated expectations, down to the trough of disillusionment, and now upward along the slope of enlightenment. We are approaching, but not yet at, the plateau of productivity for 3D.

During this period, the ETC Consumer 3D Experience Lab gave over 170 tours and presentations to groups visiting the Lab (see Appendix 1), participated in over 21 conferences worldwide (see Appendix 2), gave a great many print, TV, radio, and podcast interviews. Since the 3D Lab transitioned last year from a focus on demonstrations and presentations to one of news gathering, it has distributed over 2,700 news stories related to 3D to the ETC membership.

Theatrical 3D

As the data originally published in NATO's Box Office Pro Magazine[1] shows (below), consumers are not abandoning the theatrical 3D experience, but they are being more selective about it. This matrix shows the average per screen earnings of a number of recent releases broken down by 3D screens and 2D screens. At one end of the data spectrum, Shrek Forever earned 283% more per screen on the 3D screens. At the other end, Kung Fu Panda 2 earned only 72% as much per screen on 3D screens than on 2D screens. The publicly available NATO data was not accompanied by market research explaining the differences, which could be due to consumer attitudes toward each feature, consumer attitudes about 3D in general, the availability of a nearby 3D theatre, or many other factors.

Movie	3D Screens	3D Sales (M)	Average	2D Screens	2D Sales (M)	Average
Harry Potter 7.2	4250	$ 72.70	$ 17,098.00	6750	$ 96.10	$ 14,233.00
Transformers 3	4146	$ 57.60	$ 13,892.00	5154	$ 40.10	$ 7,788.00
Shrek Forever	3394	$ 43.30	$ 12,757.00	6106	$ 27.50	$ 4,507.00
How to Dragon	2363	$ 29.70	$ 12,568.00	4442	$ 14.00	$ 3,151.00
Pirates 4	3964	$ 42.60	$ 10,746.00	4136	$ 48.60	$ 11,758.00
Thor	3909	$ 39.60	$ 10,130.00	3741	$ 26.40	$ 7,057.00
Cars 2	3140	$ 27.10	$ 8,630.00	4550	$ 41.00	$ 8,980.00
Kung Fu Panda 2	3979	$ 30.60	$ 7,690.00	3521	$ 37.40	$ 10,623.00
Green Lantern	3200	$ 23.70	$ 7,406.00	4000	$ 29.00	$ 7,246.00

No mainstream metric has emerged to help consumers decide whether to see a feature in 3D or in 2D when both options are available in nearby theatres. Reviews often include a sentence or two addressing whether 3D adds to or distracts from the storytelling experience. Reviewers have moved beyond the snap-judgement comments that conversions are bad and native 3D is good – especially since the release of Titanic 3D.

Specialty sites like CinemaBlend.com and its "To 3D Or Not To 3D: Buy the Right (Movie Name) Ticket" are implementing the frameworks for evaluating the 3D aspects of a feature. Their efforts have not yet caught on with the mainstream movie-going culture.

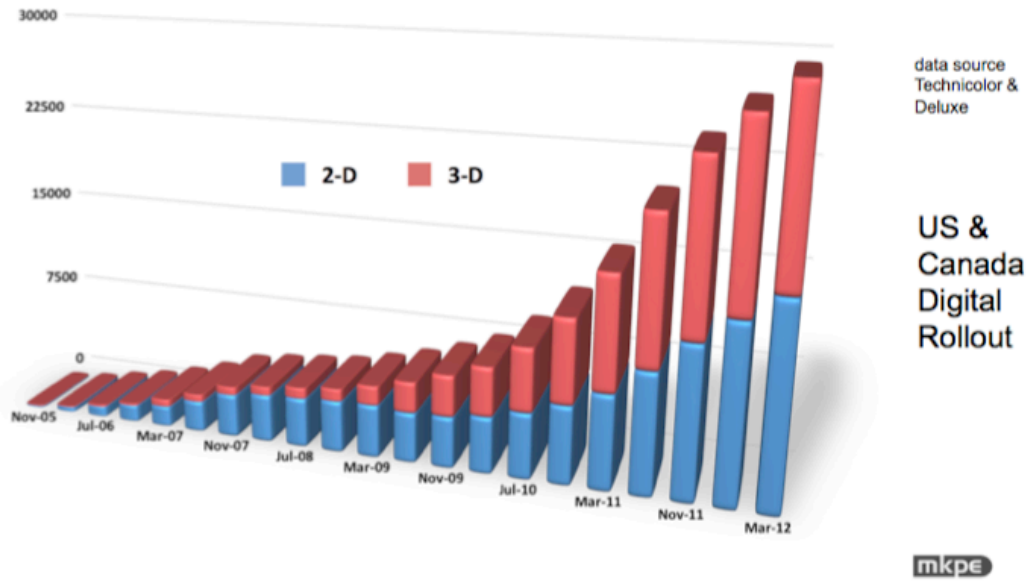
Until there is a consensus viewpoint regarding what a good theatrical 3D experience entails, consumers will rely on anecdotes from social media, random reviews, and other sources when determining whether to see a 3D feature in 3D or 2D.

Even if a metric were in place, the in-theatre experience varies in fundamental ways. There are three different mainstream 3D technologies deployed in theatres: passive polarized (RealD, MasterImage), active shutter (Xpand), and color shift (Dolby). When comfort and cleanliness of the glasses, and differences in how each audience member's visual system responds to each technology are taken into account, then their complete movie-going experience can vary from screen to screen. Most

[1] Republished in the article; 4 Reasons 3D Movies Aren't Just a Fad, Mashable, 12/22/11

consumers are not aware of this. Their opinion of a movie can therefore be colored by the conditions under which they watched it to a much greater degree than is the case with a 2D feature.

The lack of a shakeout of all of these variables has not slowed the rollout of 3D screens. The rollout has accelerated in concert with the rollout of digital systems in general to replace film projectors, and the growth of screen counts in emerging markets. According to IHS Screen Digest[2] there were 63,825 digital cinema screens worldwide at the end of 2011; 51.5% of total global screens were then digital. Of those, 35,979, or 56.4% of them, were 3D-capable screens. That total does not include the nearly 80% of giant screens worldwide that were 3D-capable by the end of 2011. Outside of North America (see plot below), 3D screen count is growing most rapidly in China, France, UK, Germany, Russia, and Mexico.[3]



Source: MKPE Consulting[4]

Since Avatar's release and thru June, 2012 there have been over 120 mainstream Hollywood studio 3D features, plus IMAX-only 3D features, and features with embedded 3D sequences (ex. 20 minutes of the IMAX version of Harry Potter and the Order of the Phoenix).[5] Based on the analysis[6] of data from 2000 through 2010 (below), the ROI of a 3D feature is not out of line with that of 2D features. They cost

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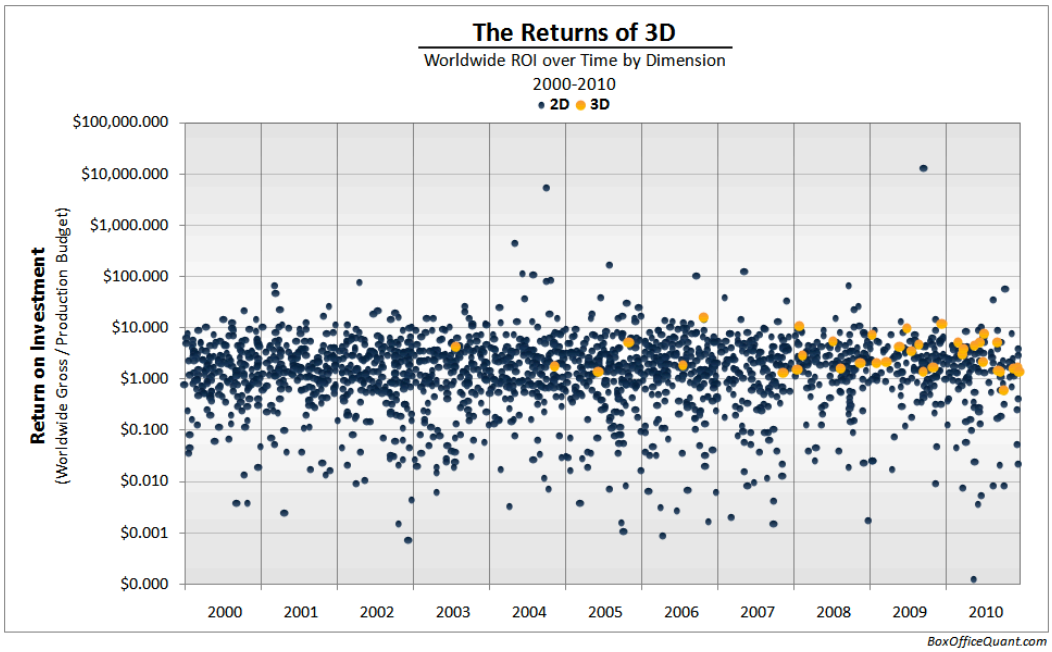
[2] http://www.screendigest.com/reports
[3] 4 Reasons 3D Movies Aren't Just a Fad, Mashable, 12/22/11
[4] Michael Karagosian, President, http://www.mkpe.com/
[5] The Illustrated 3D Movie List http://www.3dmovielist.com/list.html
[6] Source: The Rise of 3D, Jan. 26, 2011, Box Office Quant, http://boxofficequant.com/the-rise-of-3d/ The author, Edmund Helmer, was a statistics masters student at Stanford University in 2011. He has not posted an update to cover 2012.

more to make, but the inherent risk associated with a 3D feature appears to be in line with that of traditional 2D features.



Hollywood's push into 3D has catalyzed a similar growth of 3D releases outside of the mainstream Hollywood studio system.

Bollywood (Ra.One, Don 2, Haunted-3D), China (Flying Swords of Dragon Gate, CZ12 - Chinese Zodiac), and other national film production industries are embracing 3D for content intended for their local markets and, they hope, global markets.[7]

Independent filmmakers are embracing 3D where they see a value-add. Recent high-profile indie examples are Francis Ford Copolla's Twixt, Wim Wenders' Pena and Werner Herzog's Cave of Forgotten Dreams.

There has also been an explosion in the number of 3D discussion tracks and competitions at film festivals worldwide, including those run by the International 3D Society,[8] LG,[9] and the Los Angeles-based 3D Film Festival.[10]

The box office returns from IMAX 3D versions of highly anticipated tentpole movies, as well as the longevity of Pena in limited 3D arthouse release, indicate that consumers will seek out an enhanced experience - including 3D, a bigger screen, better sound, and stadium seating - when they feel it will add value to something that already interests them. The days when consumers will come out to see a 3D movie simply because it is released in 3D appear to be over.

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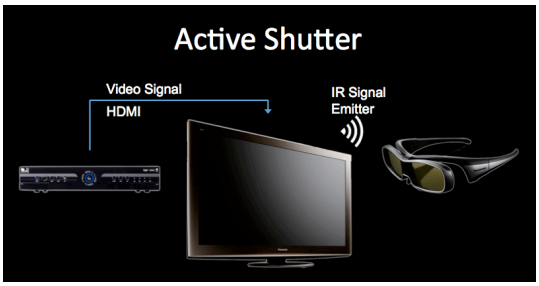
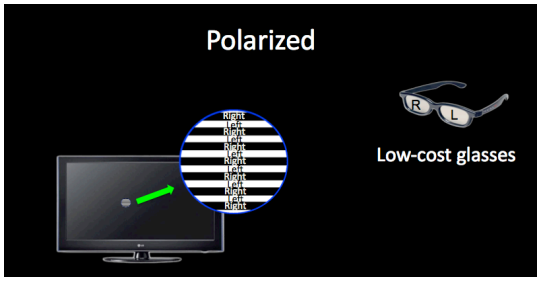
[7] List of 3D Films, http://en.wikipedia.org/wiki/List_of_3D_films
[8] 3D Independent Film Competition 2012, http://www.international3dsociety.com/International_3D_Society/3DINDYFILM_2.html
[9] 3D Short track at the 2011 Tribecca Film Festival (http://lgindiablog.com/?p=550)
[10] http://www.3dff.org/3D_FILM_FESTIVAL.html

We are witnessing the emergence of the language of 3D storytelling. The audience is learning the conventions of the language and adjusting their expectations accordingly, from out-of-screen experiences used for shock value (ex. Piranha 3DD) to subtle atmospherics (ex. Hugo).

Two years ago, at the 2010 Variety 3D Entertainment Summit, M. Night Shyamalan said that the act of putting on the 3D glasses changed the audience's expectations of the theatre-going experience, and limited what he could do as a filmmaker. That is still the case, but the barriers are starting to fade. An economic glasses-free mass market in-theatre experience is years away. The glasses will be needed for the foreseeable future, but the impact of wearing the glasses will fade, just as the novelty of digital projection instead of film projection has already faded.

Theatre owners are already being offered the next 'next new thing' that, their evangelists hope, will generate more theatre traffic. On the content side, those offerings include live events (ex. sports) and specialty presentations (ex. pre-recorded operas and ballets). On the technology side, they include 3D audio (see Appendix 3), brighter projection lamphouses (ex. laser-based technology), and in-theatre interactivity (ex. smart phone apps for relevant games and rewards).





3D TVs

There are now two competing 3D TV display formats on the market, active shutter and passive polarized. Active shutter 3D TVs and glasses, which entered the global mass market in 2009,[11] use the same alternating image / alternating lens technique as theatrical active shutter. Passive polarized 3D TV displays, which entered the global mass market at the beginning of 2011,[12] dedicate the even-numbered lines on the display to the image for one eye, and the odd-numbered lines on the display to the image for the other eye. The passive display technology does not involve the

[11] 3D is coming to a living room near you, CNET, January 15, 2009, http://www.cnet.com/8301-19167_1-10142957-100.html

[12] LG Display thinks it can fix 3DTV with passive glasses & FPR, January 5, 2011, Engadget, http://www.engadget.com/2011/01/05/lg-display-shows-why-it-thinks-3dtv-has-a-shot-with-passive-glas/

shuttering in the glasses that some consumers find uncomfortable, but the image it displays is at less than full resolution – although how much less is the subject of great debate.

In the early days of the marketing of 3D TVs, there was a very limited amount of 3D content available for consumers. 3D Blu-rays of recent movie releases entered the market in 2010. Many were released in exclusive bundling deals with specific 3D TV manufacturers. This limited the number of widely available 3D titles to less than six[13] towards the end of 2010.

On June 16, 2010 the ETC and the CEA co-produced the "Selling 3D at Retail" conference. The conference brought together senior marketing and technical executives from content creation, consumer electronics manufacturing, and retail companies to discuss barriers to consumer adoption. The group identified three problems:

- Consumer & Salesforce education; neither the industries nor the individual companies had settled on a compelling statement articulating why a consumer would want a 3D display in their home. The sales force was not adequately trained in either answering consumer questions or running a compelling demo – if one were available;
- Compelling demo: The salesforce needed a high quality, low-maintenance demo set-up plus material from three major content categories that consumers would want to view in 3D - movies, sports, and games; and
- Interoperability: Standards and guidelines were needed on core aspects of 3D TV technology, such as the signals that trigger the active shutter glasses

The 3D marketing push following the release of the 3D Blu-ray and 2D DVD of Avatar illustrated the problem. Panasonic had an exclusive multi-year bundling deal for the 3D Blu-ray of Avatar. Beyond playing 3D-originated content, many 3D TVs from competing brands came equipped with 2D-3D conversion chips. In-store demos would often use the widely available 2D version of Avatar, played back in 2D-3D conversion mode, to demonstrate all brands of 3D TVs. This inferior experience was often a consumer's first impression of the 3D TV experience. Best Buy set up four-station demo kiosks and other easily accessible in-store demos to provide a more satisfactory demo. Based on an unscientific survey of Best Buys in the Los Angeles area just after they were deployed, their track record for keeping them in working order was spotty.

In a February 24, 2012 story titled "Mad rush to market hurt 3D TV sales…"[14] Brian Markwalter, SVP Research and Standards, CEA, articulated the following points on why 3D TV sales still had not taken off a year and a half later:

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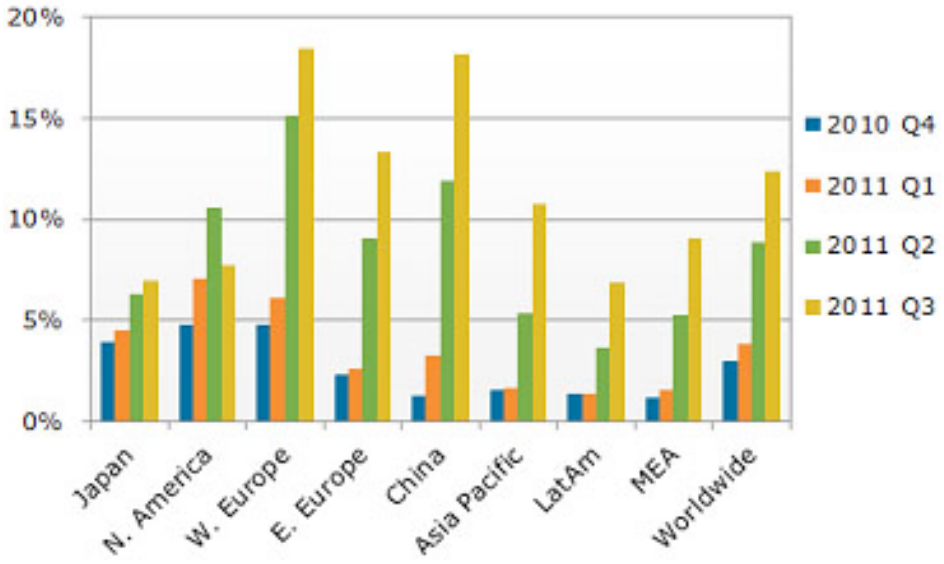
[13] Blu-Ray 3D Exclusivity May Kill Format, to state the obvious, I4U News, http://www.i4u.com/39228/blu-ray-3d-exclusivity-may-kill-format

[14] Mad rush to market hurt 3D TV sales, prices are stabilizing, claims CES VP, www.current.com.au, February 24, 2012

- The hype surrounding 3D outweighed the ability of the suppliers to deliver hardware
- The paucity of native 3D content
- A lack of standardization across the category
- There is a whole supply chain, and "we probably got things a little out of order"

There is evidence, however, that outside of the US/Canada market where 3D TV was most heavily hyped early on, 3D TV sales are trending upward. NPD DisplaySearch[15] (chart below) found strong 2010/2011 quarterly growth trends in China, the Middle East, Asia Pacific (non-Japan), and Latin America. East Europe, West Europe, and even Japan showed growth. Only North America reported a decline in the percentage of 3D TVs shipped.

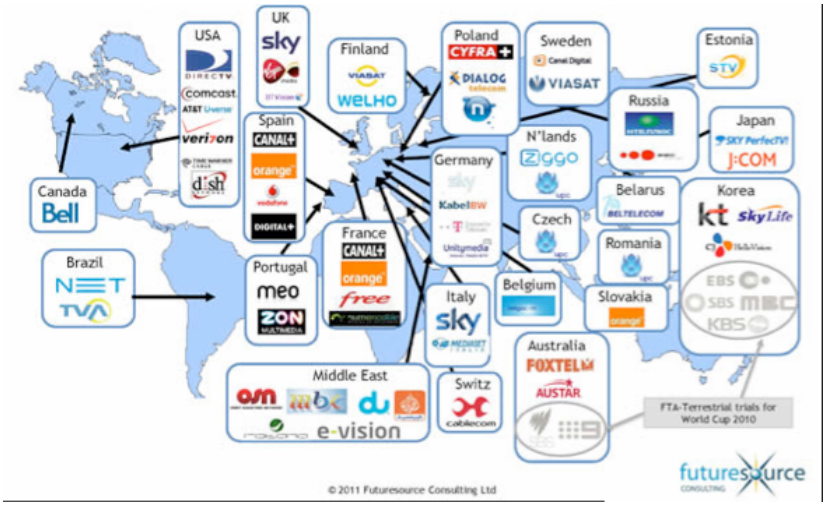
Figure 1: 3D Penetration as a Percentage of TVs Shipped



Source: NPD DisplaySearch Quarterly TV Design and Features Report

This may reflect the build-out of a global 3D content creation, distribution, and display ecosystem. 2011 saw a rise in the number of available 3D channels around the world from 50 to 90, with an additional 15 to 20 expected in 2012.

[15] NPD DisplaySearch Quarterly Advanced Global TV Shipment and Forecast Report, May 10, 2012.



China's CCTV 3D started 3D broadcasts in Jan 2012. YOU On Demand, China's VOD service, and 3NET announced a 3D content distribution agreement in May, 2012. The London Olympics, which will have extensive 3D coverage, is expected to drive another bump to 3D TV sales.

The prices of 3D TVs, especially displays over 40", have fallen to where the premium for 3D capabilities has almost disappeared. The arrival of passive polarized 3D displays to compete with active shutter displays, while adding yet another buying decision for an already overwhelmed and under-informed consumer, has proven to be popular. Samsung, the main manufacturer of active shutter displays, saw its US 3D LCD market share fall from 48% in 1Q11 to 46% in 4Q11.[16] LG, the main manufacturer of passive polarized displays, saw its US 3D LCD market share increase from 8% 1Q11 to 27% 4Q11.[17] To put that in the broader context of the highly competitive marketplace, Samsung and LG's combined 3D LCD market share increased from 56% in 1Q11 to 73% in 4Q11, greatly overshadowing Panasonic, Sharp, Sony, Toshiba, and others.[18]

NPD DisplaySearch[19] expects 46M 3D displays to be sold worldwide in 2012, a 90% increase over 2010. Most of those sales will occur outside of the US. They also anticipate that 3D will be a standard feature on displays larger than 40" by 2014.

Of course, 3D technology continues to advance.

Z-Screen technology, from RealD, utilizes a layer of active LCDs on the display to shutter the screen between clockwise and counterclockwise polarizations. It can display 3D content from existing Blu-ray and digital distribution sources at the same resolution as active shutter, and uses the low-cost, non-electronic polarized glasses.

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[16] NPD market research, January 30, 2012
[17] ibid
[18] ibid
[19] NPD DisplaySearch Quarterly Advanced Global TV Shipment and Forecast Report, May 10, 2012

RealD was going to launch Z-Screen in partnership with Samsung last fall, but the deal fell through in November, 2011, and no subsequent deal has been announced.

Dolby, in partnership with Philips, showed a very viable large autostereoscopic display at NAB in April, 2012. Although a cellphone and tablet size version of the technology may be available soon, a large consumer-market autostereo display using this technology is a few years away.

NHK recently showed an "Integral 3D" autostereo display[20] that provides a limited view around objects, as well as an 8K ultra-high resolution display. Neither will be entering the consumer market anytime soon. NHK said that they expect the Integral 3D system to be ready around the year 2030.

3D TV's success will depend on whether the full ecosystem of content creation, distribution, and display builds out to a degree that meets consumer expectations, coupled with the time fortuitous and timely occurrence of one or more 3D events that capture the public imagination and give consumers a reason to put on the glasses.

[20] http://www.theverge.com/2012/5/29/3042847/super-hi-vision-tv-8k-nhk-future

3D Cameras, Laptops, Phones, Tablets

There are many dedicated 3D still-frame and video cameras on the market, ranging from FujiFilm's over 3 year old family of Fujipix cameras[21] to the $70 DXG 3D camera[22] for children. The mass market has not embraced 3D photography, although there are vibrant niche DIY communities[23] as well as novelty videos[24] that can draw large audiences for one-off experiences.

The Lytro, the new consumer-market light field camera, is 3D capable,[25] but they are not emphasizing that in their marketing.

Laptops have been an area of rapid innovation and experimentation. High price points and the lack of a compelling message regarding the value of a 3D experience have left them as niche devices (ex. dedicated gamers).

One of the more interesting models is the Toshiba Qosmio, whose screen can contain a movable, adjustably sized autostereo 3D window within a 2D display.

Eye-tracking technology that moves the autostereo 'sweet spot' so the single viewer gets the best 3D experience is an increasingly common feature.

Smartphones with 3D cameras and autostereo displays have also not been widely adopted by consumers, even though many of these phones can switch between 2D and 3D mode and come with dual high-resolution cameras (ex. dual 8 megapixel cameras in the Sharp Aquos SH-12C, dual 5 megapixel cameras in both the LG Optimus and HTC Evo).

The market for 3D smartphones is very much unsettled and sending mixed signals to consumers. Sprint announced on April 22, 2012 that they would stop selling the HTC EVO 3D. LG announced on April 23, 2012 that they would soon launch a new 3D phone, Optimus Max, in Europe.

Apple, and to a lesser extent Microsoft, have recently filed many patents regarding 3D capabilities in tablets and other small devices. Features that their filings cover include changing the image on the screen based on eye tracking to give the illusion of dimensionality, near-surface gesture recognition and image control, a 3D image capture approach that combines radar, laser, light-detection and ranging, and a multi-tiered haptics system that allows the display to deform to create three-dimension buttons, shapes, and textures on its surface.

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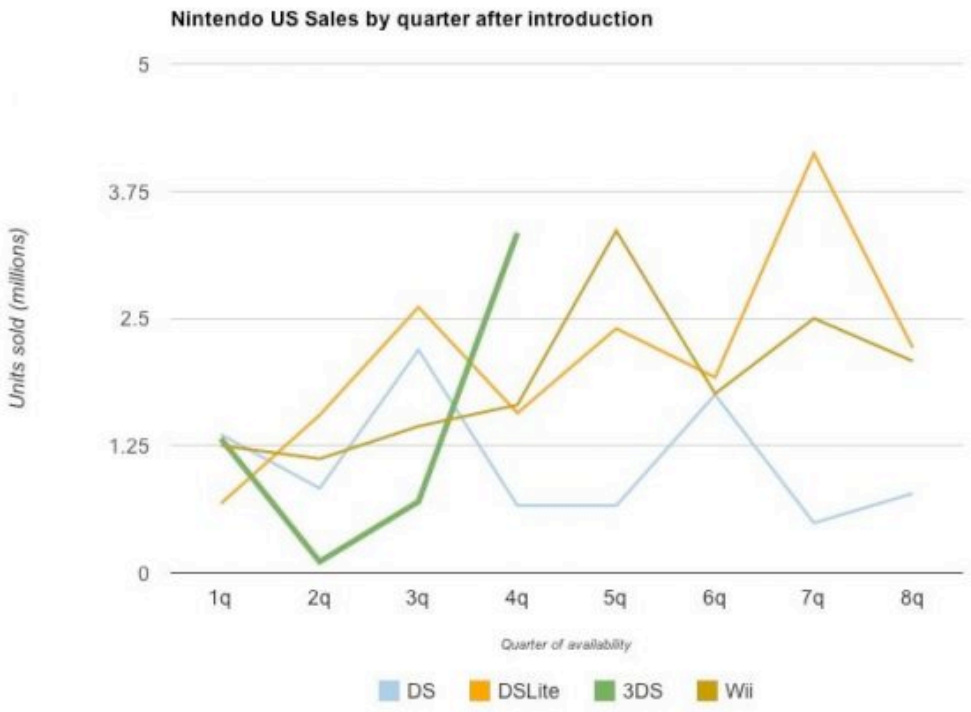
[21] http://www.fujifilm.com/products/3d/camera/finepix_real3dw1/
[22] http://www.engadget.com/2011/06/14/dxg-3d-camera-costs-70-bucks-or-just-three-easy-payments-of-23/
[23] Stereo Club of Southern California, LA 3-D Club, http://la3dclub.com/
[24] Kids Send 3D GoPro Cameras Into Space; Astonishing Footage Recorded, http://www.ubergizmo.com/2012/04/kids-3d-gopro-cameras-space/
[25] It gets better! Lytro 3D Demo, July 6, 2011, http://blog.lytro.com/news/it-gets-better-lytro-3d-demo/

3D Gaming

The Nintendo 3DS remains the dominant handheld 3D gaming device on the market today. There are over 75 S3D games available. Much has been written about slow consumer acceptance, and the multiple price reductions that Nintendo implemented to spur sales. However, one research firm plotted US sales figures[26] to show that the Nintendo 3DS has sold more units than other Nintendo devices over a similar period (plot below). Relative to other Nintendo products, the 3DS had a highly successful US launch.



On the larger gaming screen front, some 3D gaming monitors are using 3D capabilities for dual-user gaming mode (ex. Samsung,[27] Sony,[28] and Philips[29]). This

[26] DigitalTrends.com, March 7, 2012, How the Nintendo 3DS went from a flop to a sleeper hit

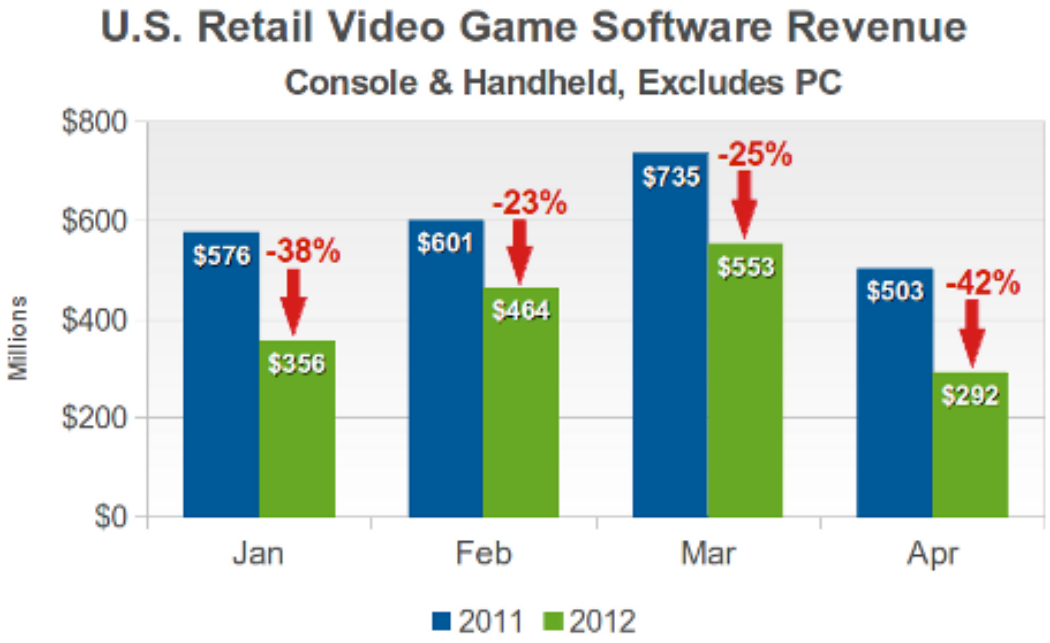
[27] Better Than 3D? One Screen, Dual Viewing, http://www.apartmenttherapy.com/dual-display-gaming-ends-screen-cheatingces-2012-164470

[28] Sony shows 3D displays with Dual-View capability, http://the-gadgeteer.com/2011/06/21/sony-shows-3d-displays-with-dual-view-capability/

[29] Philips adds dual-view gaming feature to 2012 TV lineup, http://www.digitaltrends.com/gaming/phillips-adds-dual-view-gaming-feature-to-2012-tv-lineup/

technique has been available since before 2008 for car dashboard screens[30] that allow the driver and passenger to view different content – driving info for the driver and entertainment for the passenger. With the launch of the Nintendo Wii U[31] handheld video screen controller at E3, it is hard to imagine the dual-view 3D display application reaching beyond specialty markets.

Overall, the handheld and console gaming market is in decline (graphic below).[32] The NPD Group reports that 44 million console and handheld game software units were sold in Jan-April, 2012, versus the high point of 73 million units sold in Jan-April, 2008, a 39% decline in 4 years. The move to casual games does not mean that consoles are being abandoned. For example, Xbox is used more for streaming movies and online services than game play. But it does mean that the major game development houses are not dedicating resources to develop stereoscopic 3D games unless there is a clear path to return on investment. For now, at least, growth in the 3D ecosystem – and the consumer market - will hinge on movies and TV programming much more than gaming.



[30] New 'dual-view' displays coming to production cars, http://www.motorauthority.com/news/1025310_new-dual-view-displays-coming-to-production-cars

[31] Nintendo Wii U and games hands-on (video), June 5, 2012, http://www.engadget.com/2012/06/05/nintendo-wii-u-and-games-hands-on-video/

[32] As the middle market falls out, game retail collapses, Gamasutra, May 16, 2012, http://gamasutra.com/view/news/170406/As_the_middle_market_falls_out_game_retail_collapses.php

Head Mounted Displays

HMDs are about to get a boost from Google's Project Glass. Google's single-eye display system (see image below) is designed primarily for augmented reality uses – projections of images and data onto the real world. If they are able to deliver a seamless and complete user experience, as Apple did with the iTunes store, then they could create a market for all forms of HMDs, including 3D augmented reality and content viewing visors. Vuzix, an established 3D HMD company, has been contracted by Nokia to develop an augmented reality HMD for military and civilian applications. The US Military is already using 3D HMDs in test augmented reality situations. More will be said about that in the Other Markets for 3D section in this paper.

Theme Parks

Bringing it all together, "Live Park"[33] in Korea is the world's first 4D avatar theme park. It has 65 attractions over 7 thematic areas. The attractions' developers utilize 3D video, holograms, and augmented reality technology, RFIDs, Kinect motion capture devices, and other tools to create a seamless experience. The $13M facility can handle 3,000 visitors at a time. It has been highly successful, and they are reportedly planning to open additional parks in China, Singapore, and the US.[34]

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[33] South Korea's Live Park uses Kinect sensors and RFID to create an interactive 3D fantasy world, Jan 16, 2012, http://www.theverge.com/2012/1/26/2736462/south-korea-live-park-kinect-rfid-interactive-attractions

[34] A South Korean Augmented-Reality Theme Park Puts Disneyland To Shame, FastCompany, April 16, 2012, http://www.fastcompany.com/magazine/165/disneyland-live-park

Other Markets for 3D

The collage below showcases some of the industries that are exploring, and in many cases adopting, stereoscopic 3D cameras, tools, and displays.

1) Oil and mineral exploration: For over a decade the oil, gas and minerals industries have used 3D tools to visualize and make sense of massive quantities of three dimensional data in order to identify prospects.

2) Military simulations: In the photo'd example, Russia's MiG Aircraft Company demonstrates a 3D flight simulator for the MiG-29 jet fighter. The system produces stereo imagery of the aerial environment beyond the cockpit. They found that even inexperienced pilots could easily assess distances to and dimensions of other aircraft and objects in the 3D simulation.

3) Professional Training: 3D technologies bring professionals closer to a hands-on training experience. It enables professionals to study activities that may require equipment that is not practical to bring into the training room.

4) 3D Digital Signage: 3D digital signage, which uses glasses-free (i.e. autostereoscopic) 3D technology, is being used in store windows, in-store displays, stadium and movie theatre concession areas, shopping malls, and other public spaces to capture attention and drive awareness and sales. A recent study[35] conducted for Red Bull by the University of Tilburg and Dimenco Displays found that 3D ads achieved 45% more viewer attention and an 8.5% increase in sales.

5) Augmented Reality for more efficient workers: Companies working with the US military are developing ARMAR, or Augmented Reality for Maintenance and Repair.

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[35] 3D Focus, Feb. 2, 2012, http://www.3dfocus.co.uk/3d-news-2/3d-advertising-boosts-red-bull-sales-by-8-5/7179

They have found that ARMAR cuts maintenance times in half by guiding users to the damaged area and displaying 3D animations that demonstrate the appropriate tools and techniques to affect the repair.

6) 3D in the Classroom: There is a rapidly growing body of data documenting how lessons taught in 3D result in higher retention rates, improved spatial understanding, and reduced discipline problems than lessons covering the same material that are taught using 2D aids.

As an unintended, beneficial consequence of deploying 3D in the marketplace and the classroom, American Optometric Association and individual optometrists in the US and UK have spoken in favor of 3D in the classroom as a tool for early diagnosis of binocular vision problems in children.

7) 3D in Medicine: Universities in the US, UK, and Australia are developing 3D medical education resources and facilities. 3D cameras and displays are now being used during laparoscopic surgery, gastric bypass surgery, neurosurgery, and prostate surgery.

Conclusion: Looking Backward, Looking Forward

The underlying technologies and techniques of 3D are much older than most people think. William Friese-Green created the first 3-D anaglyphic motion pictures in 1889.[36] The first 3D feature film, *The Power of Love*, opened in Los Angeles on September 27, 1922.[37] A few months later, the first interactive 3D movie, *Movies of the Future*, opened in New York. Each patron could decide if they wanted to watch the happy ending through the green lens or the tragic ending through the red lens.[38] The first active shutter 3D system, a mechanical projector and viewing shutter system called Teleview, was used in a New York theatre to screen a 3D space travel film, *M.A.R.S.*,[39] beginning on December 27, 1922.

The first color presentation of polarized 3D projection, a film called *Zum Greifen Nah - You Can Nearly Touch It*, was given in June, 1936 at the Haus der Technik in Berlin.[40]

1952's *Bwana Devil* started the 1950's 3D renaissance that ended around 1955 with such titles at *Son of Sinbad* and *Revenge of the Creature*.[41] Since then 3D has been used sporadically, usually as an extended special effects vehicle, in such films as *The Stewardesses* (1969), *Andy Warhol's Frankenstein* (1974), *Jaws 3D* (1983), and *Freddy's Dead – The Final Nightmare* (1991) as well as in content shown in theme parks and other specialty venues.

Camera and projector alignment problems, the difficulty and expense of processing the paired images on film, the added cost of production, and the negative health impact on the audience (i.e. headaches and nausea) brought on by synch, alignment, and image imbalance issues all contributed to the cyclical, novelty nature of 3D moviemaking.

The current renaissance of 3D is an unintended consequence of the conversion of the entire content creation, distribution, and presentation value chain from analog film-based processes to digital file-based processes. Many of the left/right image alignment, synch, and balance issues that plagued film-based 3D work have been, or are currently being, solved by digital tools and techniques. Research on depth perception and the human visual system is helping define the safe zone for a comfortable, mass audience 3D visual experience.

The creative communities - including directors, animators, stereographers, game designers, and equipment, hardware, and software developers - are experimenting with ways to use 3D and extend the well-established language of storytelling to include 3D elements for both linear storytelling (ex. movies, TV, sports) and non-linear storytelling (ex. videogames, augmented and virtual reality).

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[36] Stereoscopy.com FAQs, Anaglyphs, http://www.stereoscopy.com/faq/anaglyphs.html

[37] Internet Movie DataBase, The Power of Love, http://www.imdb.com/title/tt0013506/trivia

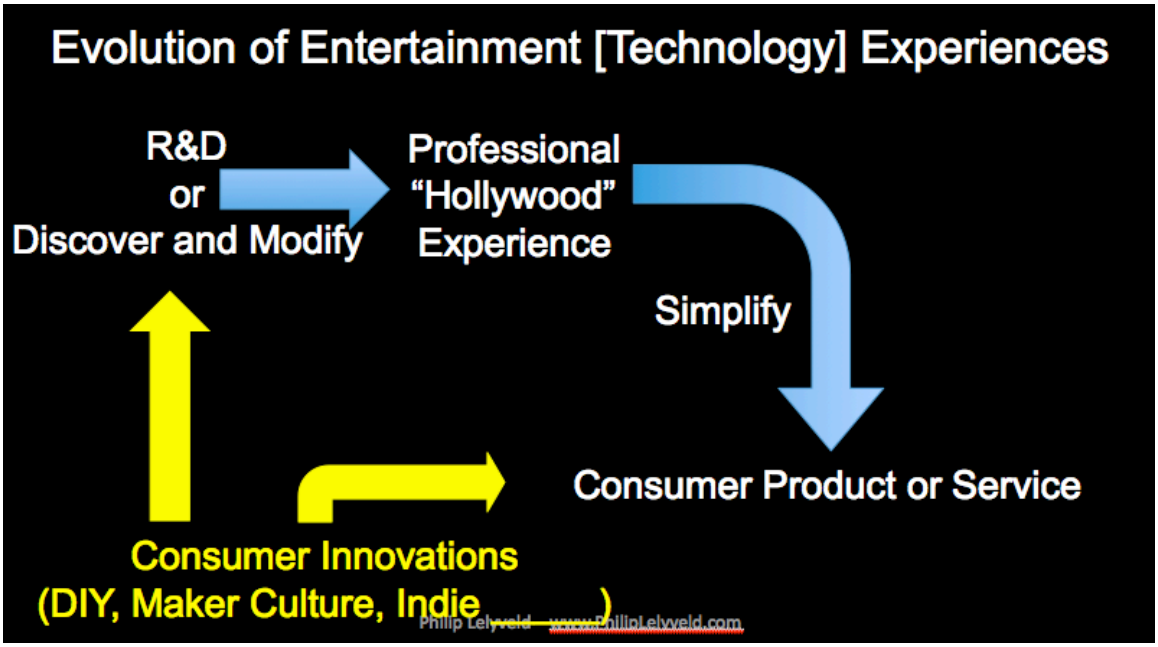
[38] Stereoscopy.com FAQs, Anaglyphs, http://www.stereoscopy.com/faq/anaglyphs.html

[39] Internet Movie Database, M.A.R.S., http://www.imdb.com/title/tt0014391/reviews

[40] Widescreen Movies Magazine, http://widescreenmovies.org/WSM11/3D.htm

[41] Internet Movie Database, M.A.R.S., http://www.imdb.com/title/tt0014391/reviews

After a shaky and over-hyped start, 3D is settling down and making the transition from a premium 'special effect' to a visual enhancement that can add value to the entertainment experience. As it moves up the Hype Cycle's slope of enlightenment and onto the plateau of productivity, 3D will become another tool for the storyteller – including the 'citizen storyteller' – in an ever-growing entertainment ecosystem that now includes social media, second screen / multi-screen activities, augmented reality, transmedia experiences, and other information and entertainment options yet to be imaged.



Appendix 1 – 3D Lab Presentation/Tour Log

(Numbers in parentheses indicate the number of tour dates that year.)

2009

CJ Entertainment
Comcast
DDD
Dreamworks Animation
Game Stop
Intel
Motorola
NIH
NIICT
Orbit Digital Post
Paramount
Sony Group
Stereoscope
TCL Lab
US Navy
Warner Bros

2010

3D Spectacle
AEG Worldwide
All Digital (2)
American Film Inst.
American Optometric Association (2)
AndrewShylkind.com
CCT (2)
Cisco (3)
Comcast (2)
CubicVue Filter
DECE, LLC (2)
Digimarc (2)
Digital Media Mental Images
DirecTV
Disney / ABC (6)
DTS (2)
Durham University
Dutch Media Hub (2)
Einsenhower Fellowships
Eksploriat Edutainment
ESPN
Filter Foundry
FMX 2011 (2)
Fox NewsCorp (9)
HCL America (2)
Huawei Technologies (2)
Igugu (2)
International 3D Society (2)
IRIDAS Americas
KCC (2)
Kerner-Emili C. Univ.
Korpa
L.E.K. Consulting (2)
LG Display
LG Electronics
Master Image 3D
Media and Ent. Tech.
Metro Goldwyn Mayer (2)
Microsoft (4)
NBC Universal
NFL (2)
NHK Cosmo Media
Occidental Petroleum (2)
OMD
Panasonic (6)
Paramount (2)
Playtone
Pusan Int. Film Fest.
Rabbitholes Media (2)
Radiant Grid Technologies, LLC (2)
SMPTE
Sony Electronics (2)
Sony Pictures (4)
Sony Worldwide
Synapse
TCS (2)
Teranex
Testronic Lab
The Daily Beast (2)
Time Warner (2)
Tom's Hardware
TTI Vanguard
Universal Music (2)
USC-SCA (2)
Warner Bros (7)

2011

Avid Technologies
BMW
Disney
Dutch Media Hub (2)
Elevate Studios
Fox NewsCorp
HP Enterprise
IBM Global
Idea Lab Creative
ITRI
LG Electronics
Manchester Investor Development
Microsoft
MPAA
NewInCom AB
Reliance Media Works
Shamrock Capital
Sharp Laboratories
Sidebar
Sony Corp.
Sony Pictures (3)
Sorenson Media
TCS
Telus (2)
Time Inc. (2)
Turner Broadcasting
Venera Tech.
Warner Bros

Appendix 2 – 3D Lab Event Speaker / Moderator Log

An ETC representative presented, spoke, or moderated a panel at the following events (numbers in parentheses are the number of events we appeared at);

3D Film Festival
3D@Home Conference (2)
Digital Hollywood (3)
Display Search 2010 TV Ecosystem Conference
International 3D Society's 3D University (3)
Media Park Annual Conference, Dutch Media Hub, The Netherlands
NAB
Pacific Univ 3D Vision Performance Institute Conference
Seoul Digital Forum
UCLA Anderson's Managing Enterprises in Media, Entertainment, and Sports (2)
Variety 3D Summit (2)
Woodbury University's The Business of Entertainment Lectures (3)

Appendix 3 - 3D Audio

As stereoscopic 3D finds its place within the entertainment ecosystem, 3D audio is poised as the next big thing in the entertainment technology landscape.

There are two types of 3D audio implementations developing in parallel in the marketplace: 3D audio that more accurately positions sound in three dimensions in an open room, and 3D audio that can place audio at specific points in three dimensional space.

Current manifestations of the open room 3D audio approach enable more accurate placement of audio in the full 'audio sphere' surrounding the listeners. This is done by adding a vertical component, as well as a more accurate surround component, to the sound reproduction system.

The DTS system[42] adds speakers over the screen to add vertical dimensionality to the sound. Coupled with their SRS MDA (multi-dimensional audio) technology, the DTS solution can produce an immersive 3D audio experience from a wide range of speaker configurations because it can be tuned to the number and position of the available speakers. It is not hardwired to 2.1, 5.1, 7.1, or other standard speaker configurations. The DTS system is being marketed for home, car, and other consumer market environments.

The Dolby Atmos in-theatre solution[43] is designed for multiple speaker configurations, with speakers placed over the screen and on the ceiling over the audience in addition to the normal placement of speakers in front of, around, and behind the audience. Dolby Atmos supports up to 128 audio tracks that can be directed to up to 64 individual speaker outputs at one time.

Other open room 3D audio vendor products include the Galaxy Studios' and Barco's Aura 11.1 system, imm sound's imm sound technology, and Iosono's Iosono 3D.

3D audio can place sounds in specific locations in three dimensional space (e.g. spatial audio) – including directly over, under, and behind the listener's head. The effect is achieved by manipulating the sound waves that reach the listener's left and right ear in very precise ways. Properties of the sound waves that are manipulated include arrival time, phase, reverberation and reflections. The position of the listener's ears in relation to the direction of the speakers must be tightly controlled for the effect to work. If the listener is not in the 'sweet spot,' they hear perfectly fine stereo audio but they perceive none of the rich spatial effect. Spatial audio does work with properly positioned speakers and a properly positioned listener in an open room. However, most people working in 3D audio today engineer the effect to

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[42] DTS purchase of SRS about next generation 3D and cloud-based sound, April 17, 2012, http://ocunwired.ocregister.com/2012/04/17/dts-purchase-of-srs-about-next-generation-3d-and-cloud-based-sound/14325/

[43] Dolby Atmos, Next-Generation Audio for Cinema, a Dolby white paper http://www.dolby.com/uploadedFiles/Assets/US/Doc/Professional/Dolby-Atmos-Next-Generation-Audio-for-Cinema.pdf

work with headphones, since headphones are widely used and their position is always the same relative to the listener's ears. There are many examples of 3D audio on YouTube and at other internet sites.[44]

[44] 3D Audio Demo Showdown, http://listenwithyourownears.com/3d-audio-demo-showdown/

Appendix 4 - 3D Printers

3D printers are computer peripheral devices that can manufacture a physical object by 'printing' one thin slice of the object at a time, from the bottom up, until the entire 3D object has been built. Common 3D printers, such as MakerBot,[45] the Cube,[46] and Solidoodle[47] print using plastics. However 3D printers have been prototyped that print with concrete,[48] chocolate,[49] metal,[50] drug components,[51] and other materials. Both the professional equipment manufacturers of 3D printers and the DIY (do it yourself) community are rapidly advancing the quality of the printers, reducing the cost of the units and the materials used in printing, and improving the software tools and user interfaces that must be mastered in order to print an object.

3D printers may represent the final frontier in the debate over copyright, trademark, patent, and piracy in the digital age. A digital file can now be a memo, a song, a movie, or the blueprint for a physical object. As part of their Star Wars Weekends 2012 at Walt Disney World, cast members capture 3D scans of participants and print their likeness sculpted onto Han Solo's body, frozen in carbonite, a la "Star Wars Episode V: The Empire Strikes Back."[52] For £80 and two photos of your face, UK's Firebox will print a 3D miniature of your head and place it on a Batman, Superman, Batgirl, Iron Man, Thor, Captain America, or other action figure. The same issues of controls and compensation that have impacted the music and movie industries are about to hit manufacturing industries – including toys and collectables.

[45] Retail price $1749, http://www.makerbot.com/
[46] Retail price $1299, http://cubify.com/cube/
[47] Retail price $500, http://www.solidoodle.com/
[48] Future of Construction Process: 3D Concrete Printing – YouTube
[49] World's first chocolate printer - YouTube
[50] How Its Made 3D Metal Printer - YouTube
[51] University of Glasgow scientists print drugs in 3D, pave the way for in-home pharmacies, Engadget, April 18, 2012
[52] Inside Disney's new Carbon-Freeze Me experience, immersing guests in a Star Wars world to create a custom collectible, May 19, 2012, www.insidethemagic.net