3rd Dimension

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Chainsaws and glasses…

by Mark Fihn

A couple of weeks ago, I was working in the back yard taking out some dead trees with my chainsaw. Usually, my eyeglasses serve to protect my eyes adequately, but this time, a small chunk of wood got lodged in my eye, resulting in two weeks of discomfort.

More on glasses in a moment, but first a commentary on chainsaws… For me, chainsaws are purely utilitarian devices made for the purposes of cutting trees. For others, chainsaws are chisels, used to sculpt works of art from wood. Mr. Randall D. Boni, shown below is a wildlife sculpture artist, capable of crafting beautiful three-dimensional pieces using his chainsaw. Sculpture is a difficult art form – forcing the artist to perform in three dimensions – a skill that many people cannot master, even if they are accomplished painters or artists in other 2D formats.

Back to glasses… I have been wearing eye-glasses since I was 9 years old. When told be people that wearing glasses to view 3D images would be a non-starter for many people, my reaction until recently was that the content would quickly outweigh the inconvenience of wearing glasses. Just as I wear glasses to improve my vision to 20/20, my logic has been that wearing 3D glasses would not be an impediment for 3D adoption, as viewers would simply want to enjoy the immersive experience.

Well, I need to amend my position about 3D glasses a bit. For cinema and gaming applications, wearing glasses is really not a problem. These are environments where the viewer is captive and the glasses will quickly be forgotten. The problem with glasses is related to 3DTV. While glasses will work on some occasions, frequently the living room is a social environment – where viewers interact with others and the environment. The phone rings, you want to check the time, you are paging through a magazine, or you are talking to family members. 3D glasses don't work in this situation – viewers will not want to constantly be donning glasses and taking them off. Moreover, if a viewer enters the room, the image will be doubled – creating an uncomfortable solution for anyone not wearing 3D glasses.

For 3DTV solutions, glasses will not work, in my opinion. In other words, for 3DTV to work, unless social habits in the living room change significantly, I think there are two viable solutions:

1. Autostereoscopic displays are an obvious solution. Unfortunately the technology is not quite to the point that autostereoscopic solutions are good enough for home viewing. A few years, maybe, but until then, 3DTV will struggle if glasses are required.
2. A more subtle solution that I think will suffice is for the image to serve a dual purpose. If the viewer wears glasses, a 3D image will show; but without glasses, the viewer gets an uncompromised 2D image. I don't know if this is technologically possible, but for 3D to get into the living room, something like this will be mandatory.

After a lifetime of perfect vision, my wife is now quite frustrated by her recent need for reading glasses. Part of the frustration is related to her inability to see things nearby clearly, but equally frustrating is her frequent tendency to lose her glasses. In fact, to help avoid the problem, she has several pairs of glasses lying around, in the hope that she can always find a pair. For me, my glasses are the first things on in the morning, and the last things off in the evening. No problem. But I can imagine that in the living room, if required to wear 3D glasses, I would suffer the same fate as my wife with her reading glasses. Imagine the comedy of TV, first looking for the remote control, then for the 3D glasses, (and what happens if you need reading glasses in order to see the keys on the remote control)?...

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If you haven't seen Disney/Pixar's stunning *"Up"* in digital 3D – do yourself a favor. It's a fun film, with a positive message. The 3D is not noticeable – you become immersed into the film and don't notice the 3D; it's purely an enhancement. And it's done well at the box office.

In its opening weekend *"Up"* was No. 1 at the North American box office with an estimated $68.2 million. The film opened in 3,766 theaters, including a record 1,534 3D theaters. This surpassed the opening weekend domestic gross of DreamWorks Animation's *"Monsters Vs. Aliens"*, which debuted with $59.3 million in March, although with fewer 3D theaters (an estimated 1,300).

- *"Call of the Wild 3D"* opened on June 12.
- Fox's anticipated 3D release of *"Ice Age: Dawn of the Dinosaurs"*, is scheduled for a July 1 opening date.
- The Disney/Jerry Bruckheimer 3D release of *"G-Force"* debuts on July 24.

3D news from around the world

compiled by Mark Fihn and Phillip Hill

LG embeds 3D capability into the display rather than the glasses

LG announced that it had taken the technology that would normally be embedded in a pair of 3D glasses and installed it in a Full HD 23-inch 3D LCD panel. With conventional 3D LCDs, like the Samsung SyncMaster 2233RZ, when wearing the 3D glasses, each eye sees the same image from a different perspective. The 3D glasses shut off one lens and then alternate shutting off lenses consistently, very quickly. With the new LG display, 3D glasses will still be required, but according to the company, the glasses won't be as expensive as the $200 Nvidia 3D Vision Kit, since much of the technology required is in the panel, instead of the glasses. It's expected that this setup will deliver a similar 3D effect. Also, by embedding the technology into the panel itself, LG is able to build a display twice as bright as conventional 3D LCDs. http://www.lg.com

CyberLink unveils high-definition 3D movie playback on PCs

CyberLink showcased for the first time its high definition 3D movie playback technology using PowerDVD. The new 3D movie playback technology will allow consumers to experience stereoscopic 3D effects by using PowerDVD. CyberLink 3D video technology is planned to be built into PowerDVD and other video decoder software such as PowerCinema. The Computex showcase demonstrates how users will soon be able to enjoy life-like 3D movies right from their desktop and notebook PCs in the near future. http://www.cyberlink.com

Acer to build laptop with 3D screen

Acer Inc. plans to release a notebook PC this fall equipped with a 15.6-inch 3D screen, according to a report. The notebook will have built-in software that can correctly display 3D movies but also convert regular 2D movies into 3D, Campbell Kan, vice president of Acer's mobile computing unit, told the Taiwanese magazine, *DigiTimes*. In 2003, Sharp Corp. released its Actius RD3D notebook with nearly identical 3D rendering capabilities. Consumer electronics companies such as Mitsubishi, Samsung Electronics and LG are also building TVs with 3D screens. Users of Acer's first-generation notebook will still need to wear stereoscopic glasses for the 3D to be effective, Kan said, though future models should be able to show the content in 3D without special glasses. The notebook will ship with Windows 7 and be available at the end of October. http://www.acer.com

CEA sets up 3D video working group

The CEA Video Systems Committee announced the launch of a new working group, R4 WG16. The working group will address issues with 3D technology, including investigating and drafting standards for 3D glasses. For more information, or to join the R4 WG16 working group, contact standards@CE.org.

3D at home interests 17% of US consumers according to NPD

A recent survey on US consumer interest in 3D entertainment conducted by the NPD Group found that 17%, which NPD calls "significant", would be interested in watching 3D movies. According to NPD's "Entertainment Trends in America" consumer tracking studies, other movie choices that were popular with home video users were as follows: video-on-demand available on TV the same day it's released on disc (24%); a DVD or Blu-ray disc with a digital file of the movie/TV show that can be viewed on a portable device or computer (14%); a paid digital download that can be burned to a DVD for personal viewing (14%); watching an advertising-supported movie on a social-networking site for free (12%); downloading a movie through a video game console (8%); and downloading or streaming a video to watch on a mobile phone or smart phone (4%). http://www.npdgroup.com

New 3D theater at Bletchley Park shows how Enigma codes were broken

BCS president, Alan Pollard, unveiled a 3D theater, the latest attraction at Bletchley Park (near London). The theatre will show a short film explaining how the Enigma machine worked and how the Turing-Bombe was used during World War II by the German army and air force for communication between commanders and the field. A working party of the BCS Computer Conservation Society (CCS), led by John Harper has spent 13 years rebuilding and conserving the Turing Bombe and Colossus machines at Bletchley Park. Chairman of the CCS, David Hartley, explained: "This new attraction will make use of the 3D photographs taken by Mike Hillyard, a member of the CCS who took part in the rebuild and captured the process for posterity. As well as taking the photos, Mike and his son Paul designed and built the equipment that enables the show to be seen by the public at the press of a button at any time of the day." http://www.bletchleypark.org.uk

American Paper Optics distributes 16 million 3D glasses in April

American Paper Optics manufactured another 16 million 3D glasses for five Time publications on newsstands in April. This order came on the heels of the 130 million piece order American Paper Optics produced for the Super Bowl commercials. These glasses were distributed in *People*, *Time*, *Fortune*, *Entertainment Weekly*, and *Sports Illustrated* to enhance and bring to life both editorial photos as well as full page 3D ads for McDonalds, DreamWorks Animation, Intel, and Hewlett Packard. American Paper Optics, the world's leading manufacturer and marketer of 3D glasses, has now delivered over 200,000,000 units in the 1st quarter of 2009. http://www.3dglassesonline.com

projectiondesign introduces 3D

Norway's projectiondesign recently introduced an active stereoscopic 3D projector, the F10 AS3D, which provides convincing and compelling 3D imagery from a single, portable device. The company will be showing that, as well as F32 and F22 3D stereo projectors using INFITEC technology, and F80 1080 optimized for ColorCode 3D to deliver large screen passive stereo images. The F10 AS3D enables full 3D stereoscopic visualization at full 120 Hz refresh rates commonly used in stereoscopic systems. Fully 1080p compatible, it is a tool not only for the scientific visualization and simulation industries, but also in video and film production and DI and VFX creation. http://www.projectiondesign.com

Fantastic Films International signs multi-picture deal with Imagination Films

Los Angeles-based Fantastic Films International (FFI) announced a multi-picture worldwide distribution deal with stereoscopic 3D animation house Imagination Films (IF), a Mexico City-based company. Imagination Films is currently in production on three feature length animated films that will be delivered in both digital 2K and stereoscopic 3D. "Z-BAW" should be ready for delivery by December 2009. The other two films will be completed in 2010. http://www.fantasticfilmsinternational.com/

History Channel launches new "Expedition" series with glasses-free 3D LCD display technology

Magnetic Media Holdings announced that History Channel will utilize the company's display technology to promote its new series "Expedition". Magnetic's 57-inch auto-stereoscopic Enabl3D displays will be featured in two street level billboard installations designed by Pearl Media. Passer-bys will be able to experience Expedition content in true 3D without the use of any special eyewear. Magnetic produces auto-stereoscopic 3D LCD displays, 3D content creation, 3D digital signage solutions and 3D software. Magnetic's 3D LCD displays enable viewers to see 3D without glasses. Display sizes include a wide range of products including 57, 47, 42, 32 and now 22 inch. http://www.magnetic3d.com

HELIUM3D consortium develops direct-view RGB laser projection technology

The HELIUM3D consortium is creating a 3D display that will extend the state of the art in autostereoscopic (glasses free) displays. The HELIUM3D display technology addresses the efficiency and color limitations of current and next generation displays by developing a new display technology based on direct-view RGB laser projection via a low loss transparent display screen to the eyes of viewers. The HELIUM3D consortium consists of De Montfort University, England (display design, construction, and project coordination); Philips Consumer Lifestyle (commercial applications, interaction and human factors); Barco (stereoscopic systems and professional applications); University College London (optical design and simulation); Fraunhofer Heinrich-Hertz-Institut (far and near field viewer tracking and interaction); Eindhoven University of Technology (human factors and interaction); Koç University (optical design); and Nanjing University (near-field viewer tracking). The fundamental features of the display are: support for multiple viewers; viewer freedom of movement; motion parallax to all viewers; high brightness and color gamut; viewer gesture/interaction tracking; and user-centered design, ensuring that future products are "fit for purpose" in terms of perception and usability. Several viewing modes are possible including: motion parallax (the "look around" capability) to each viewer, privacy of viewing from other viewers, a different camera viewpoint to each viewer and also conventional 2D to all viewers providing backward compatibility when necessary. This gives a display with a very wide range of applications and modes of operation. http://www.cse.dmu.ac.uk/~heliumusr/index.html

XPAND powers 3D cinema in Czech Republic

XPAND has powered four Xtreme Cinema theaters in the Czech Republic to provide 3D movie-going experiences. XPAND's new X101 series 3D glasses and other system components were installed by Xtreme Cinema's technical support and service arm, XCData Ltd., in theaters in Prague, Louny, Sokolov and Dobrany. XPAND has just rolled out the X101 Series 3D active glasses in a sleek, new model providing increased efficiency, durability, customer comfort and exhibitor convenience. The glasses interface with an XPAND infrared emitter box to create stereoscopic 3D with any DCI compliant digital cinema projection system. XPAND's patented "pi-cell" technology works as a rapid stereoscopic shutter to deliver the alternate right- and left-eye images with optimal brightness, steadiness, depth and clarity. http://www.xpandcinema.com

Thales Angenieux and Binocle showcase solution for true 3D stereoscopic imaging

Thales Angenieux and Binocle previewed a ground-breaking imaging technique that will allow full 3D stereoscopic shooting without objectionable side effects. The solution combines perfectly paired optics with full motion control, along with advanced algorithms designed to alleviate viewing stress. Since its inception, full acceptance of 3D stereoscopic imaging has been hindered by the incompatibility of the human eye to process dual images without visual aids. Engineers at Binocle, France's leader in stereoscopic film shooting and post production technology have overcome the challenges by developing a technique that allows camera motion to be accurately controlled with the use of computers and digital image correction. Thales Angenieux has partnered with Binocle on these developments and the company's optics have been instrumental in Binocle's recent developments. Thales Angenieux offers a full complement of high precision lenses for a wide range of broadcast and video production applications. http://www.angenieux.com

LEVEL Vision Electronics showcases its glasses-free 3D screens

LEVEL's Division of 3D Multimedia Advertising/Technology plans to deploy and bring to market a new multimedia solution for advertising markets. This technology of 3D screens with or without integrated CPUs was developed in collaboration with a development partner/engineering firm in Taiwan. Public and private demonstrations of this 3D technology have been made over the last nine months to advertising agencies, digital signage companies, film studios, software developers, public transportation corporations and international chains (hotels, restaurant, night clubs). The screens' measurements and specifications can be found online at http://www.levelelectronics.com.

PassmoreLab begins shooting 3D surfing documentary

San Diego-based multi-media production studio PassmoreLab, in conjunction with on-location entertainment company Lucid Dreams 3D, has begun principal photography on a new educational 3D surfing film called "Physics of Surfing", available to science centers and museums later this year. Shown in high-definition 3D, audiences everywhere will follow two professional female surfers to locations around the world – including Hawaii's breathtaking North Shore and renowned surf spots along the California coast. http://www.passmorelab.com

Quantel and Spatial View announce Stereo3D technology strategic partnership

Quantel and Spatial View announced that the companies have entered into a strategic partnership agreement that will make it easier and more cost-effective for content creators of any size to accelerate 3D development projects. The first partnership project will be a plug-in that enables Stereo3D material produced on Quantel systems to be displayed on a wide variety of Spatial View devices, including 3D displays, computer screens, and the iPhone 3G, without the need for 3D glasses. Quantel's Stereo3D technology, as used in movie productions such as Disney's "Hannah Montana" concert movie, has enabled the industry to handle the post-production of live action, high-resolution Stereo3D media in manageable timescales for the first time. Spatial View is a leading developer of autostereoscopic 3D image processing and display technologies that enable glasses-free presentation of 3D-rich content for key markets, including retail/POS, digital signage, professional design, gaming, entertainment and animation. Spatial View's latest product, the Wazabee 3DeeShell, enables 3D content to be viewed on the iPhone 3G, glasses-free. http://www.quantel.com

TDVision selects Magnum Semiconductor for world's first Full HD stereoscopic 3D real-time encoder

TDVision Systems announced it has selected Magnum Semiconductor for the development of the world's first and only Full HD stereoscopic 3D (1920x1080 per eye) real-time encoder. The system applies TDVision's "Encode Once, Deploy Everywhere" methodology to HD stereoscopic 3D digital video streams, resulting in an H.264 3D-Ready video format that can be deployed on Blu-Ray disc and broadcast platforms, such as cable, satellite and IPTV, and for studio dailies as well as live-event streaming to cinemas. The system uses TDVision's patented 2D Delta TDVCodec technology to compress the video streams at full resolution while maintaining backward compatibility with all existing 2D displays in 2D HD, as well as forward compatibility with all existing and future 3D-ready displays and methods. The system does comparison between left and right source frames, compresses the video information based on redundancies between the two, resulting in stereoscopic compression at less than 200% of a 2D video stream. TDVision's 2D Delta TDVCodec is referenced by ISO, JVT and MPEG as a core patent for future stereoscopic 3D video standards. "Legacy solutions for stereoscopic 3D broadcasts have recently produced resolutions as low as 640x720 per eye on a 2K digital cinema screen. Audiences tune into 3D live event broadcasts for a premium experience and they expect HD resolutions. TDVision is committed to 3D HD on all delivery platforms, including broadcast, streaming and optical disk, as well as for all possible content, including live events and movies at quality levels that match the original's," said Ethan Schur, chief marketing officer at TDVision. To achieve practical bit rates, without compromising quality and resolution, TDVision has selected Magnum Semiconductor to provide real-time compression and decompression for stereoscopic video streams. Magnum's DXTPro family of advanced multi-core media processors supports multiple video standards, such as MPEG-2, H.264 and VC-1, at full frame-rate 1080p60 encoding, decoding and transcoding. The DXTPro provides a single platform for all segments of the broadcast chain, from contribution to production to distribution. http://www.tdvision.com

Hubble Space Telescope repair mission filmed in IMAX 3-D

Filming an IMAX 3-D feature about NASA's last manned mission to make repairs to the Hubble Space Telescope created some big challenges. Using only eight minutes of film, astronauts had to capture the essence of five long space walks using a custom-made IMAX camera as big as a robotic submarine during the 90-minute day-night cycles as the space shuttle orbited Earth. Over the course of eight months, other astronauts trained with a similar camera during simulated space walks in NASA's Neutral Buoyancy Lab. The actual camera sat installed in the cargo bay of the space shuttle Atlantis. http://www.nasa.gov

I.E. Effects launches full-service stereoscopic 3D pipeline

I.E. Effects announced that the company is now offering a complete postproduction solution for stereoscopic projects. With a strong background in stereo work, I.E. Effects has assembled the talent base, tools, and the expertise to offer everything from on-set supervision to distribution, all under one roof. Stereoscopic films for theatrical release can take advantage of I.E. Effects' dual-stream 2K pipeline, while they can also accommodate an HD stereoscopic workflow for TV and commercial projects. The company offers a complete range of services, including visual effects, editorial, titles, motion graphics, digital intermediate and stereoscopic 3D post. At I.E. Effects, directors can review their projects on the same floor as the color grading, editorial, and visual effects suites. The company also offers a stereo screening room with a dual-projection system and a 14-foot screen. http://www.ieeffects.com

Nikola Knezevic designs prototype 3D Blu-ray camcorder

Designer Nikola Knezevic has come up with a prototype 3D Blu-ray camcorder. It sends a 3D recording to a Blu-ray disc directly in high definition without having to go through a conversion process on a computer or any touch-ups. http://www.nikoladesign.com

Blu-ray Disc Association forms 3D home standards task force

The Blu-ray Disc Association has formed a 3D task force to formally integrate advanced 3D technology into the Blu-ray format. Studios, consumer electronics manufacturers and information technology companies are all represented in the task force. The group will work toward forging a universal 3D home entertainment specification. A meeting timetable for the task force has not been specified. Due to its large capacity, Blu-ray has long been talked about as a perfect disc source to house advanced 3D theatrical projects. The BDA's task force underscores the industry's commitment to getting high-quality 3D to homes. Today's lack of 3D home standards has meant that current theatrical pictures are downgraded to weak anaglyph 3D imagery when released on Blu-ray or DVD. Enhancing Blu-ray with 3D capabilities should additionally prop up the format with advantages over standard-definition DVD. Walt Disney Studios Home Entertainment is already moving toward making 3D a Blu-ray premium (although currently in anaglyph style). The June 30 release "Jonas Brothers: The 3D Concert Experience" will only be available in 3D on Blu-ray; "Jonas Brothers: The Concert Experience" will roll out on standard DVD. http://www.blu-raydisc.com

Futuresource Consulting forecasts 3D to reach Blu-ray first, HDTV soon after

The first commercially available (non-prototype) Blu-ray Disc releases of movie titles in 3D will not happen until at least 2011, according to Futuresource Consulting. The analyst said in a recent study that one big obstacle to bringing 3D into the home is a lack of technical standards for a wide array of presumed 3D display devices. The next two years will be mainly devoted to 3D projects for motion pictures and movie theaters, not to consumers at home. In fact, several mostly computer-animated feature films this year and in 2010 will be presented in 3D in facilities equipped for the new technology. The movie technologies currently being deployed for theater use do require 3D glasses though. Futuresource predicts that by 2012, up to 10% of US TV households will have 3D-equipped HD sets – a penetration rate that could surge to 70% by 2015. http://www.futuresource-consulting.com

Digital TV Group unveils 3DTV findings

Developments in 3DTV are being hampered by a fragmented industry approach and a lack of standards, according to a landmark consultation. Announcing the findings of the UK's first industry consultation on broadcast 3DTV, the Digital TV Group http://www.dtg.org.uk said members wanted it to assume a leading role in helping to define standards for early 3D broadcasting systems. The consultation, which closed in April, drew responses from across the UK digital TV industry – from broadcasters and platform operators to receiver manufacturers and technology providers. 78% of respondents agreed 3DTV was an evolutionary next step for high definition TV. Several members said 3DTV was either important or very important to the strategy of their organization. Key points from the consultation:

- 3DTV is being driven by Hollywood's embrace of digital cinema (45% of respondents spontaneously cited this as a reason) and the prospect of cost-effective home delivery solutions (28%)
- It is regarded as important or very important to the strategies of 50% of respondents, and an evolutionary next step for HDTV (with 78% agreeing)
- Though prototype technologies exist, most (81%) agree that current systems are too immature for a successful market launch. 3DTV could, however, become a mass entertainment medium in the UK within three to five years (56% stating a timeframe), and the UK could lead the world (70%)
- Most members (85%) have allocated some level of R&D budget, with most of them (64%) describing it as “very limited funding”
- The business case is far from being established (only 14% agreed it had), largely due to the difficulty of forecasting consumer acceptance of an emerging technology and its potential take-up (54%), and uncertainties over the business model
- Most members (73%) agreed HD pay-TV subscribers would pay more for 3DTV; a smaller majority (55%) agreed 3DTV could represent a premium advertising proposition for commercial broadcasters
- Members are discussing developments in industry bodies (50%) and standards bodies (50%); some (22%) have launched prototype products, systems and/ or services
- Use of the BBC license fee to fund R&D in 3DTV is widely supported (73%); several members commented on the historic role played by the BBC in helping to take forward innovations in broadcasting technology

Many uncertainties and knowledge gaps exist:

- Chief among these are issues around standards (spontaneously mentioned by 50%), as well as how to manage its introduction (36%) and produce 3D-optimised content (21%)
- The biggest (69%) area of required additional research is understanding the psycho-physiological effects of stereoscopy (such as eye strain, headaches and possible safety issues)
- While glasses-based (active shutter and passive polarized) systems are regarded as having the best short-term potential for a 1G 3DTV system (80% agreeing), the reluctance of consumers to wear glasses was cited as a probable hurdle to take-up (72%)
- The potential introduction of 3D Blu-ray movies is regarded as a significant step by many members (72%) as it could stimulate consumer interest in broadcast 3DTV and help establish a path to standardization
- While most (69%) members supported some form of consumer labeling (such as '3D-Ready') on equipment, several made clear the need to avoid misunderstanding and confusion caused in the market by early HD-Ready labeling
- Backwards compatibility with 2D HD is regarded as important or very important by many (60%) members; in this camp are players that believe 3DTV should be introduced as an optional enhancement to HD, with simulcast services. An alternative camp regards 3DTV as such a different viewing experience that simulcasting would not be appropriate, or possible, due to bandwidth

- Some members fear de facto, non-open standards, for 1G broadcast 3DTV will result from the technology decisions made by first providers. These are likely to be pay-TV operators, keen to differentiate their platform and consumer proposition. Technology decisions made by these players may not suit the current or future needs of free-to-air broadcasters
- Free-to-air broadcasters will require additional spectrum for 3DTV if it is not to be an exclusive pay-TV offering; this reopens the debate on spectrum allocation for DTT, bringing 3DTV into the public policy arena

Members are looking to the DTG to assume a leadership role:

- Mostly on standards (75%), establishing a 3DTV forum to discuss and monitor developments (50%)
- That role needs to evolve to include: educating members via the DTG website, seminars and conferences (64%); creating a '3D Book' (36%); establishing the world's first 3DTV quality benchmarks (9%)
- Without the DTG's involvement the industry risks further fragmentation (43%); consumer confusion (29%); a standards battle (29%); and possibly no broadcast 3DTV at all (14%)

French Open Men's Final – Live and in 3D

On June 7, 2009, with the backing of the French Tennis Federation, Orange and France Télévisions, the Tournament's official partners, the French Open men's final live and in 3D on cinema screens in France and Spain. Orange and France Télévisions will be capturing the final in 3D thanks to five stereoscopic cameras set up around the Philippe Chatrier court. The 3D images from the final will be broadcast by satellite from Roland-Garros to the various cinemas concerned thanks to GlobeCast, the Orange subsidiary.

ViewSonic extends projector offerings with three new 120Hz / 3D-enabled DLP products

ViewSonic announced the availability of the all new PJD6211, PJD6221 and PJD6381 projectors with enhanced 3D display capabilities. These projectors are ideal for classroom, corporate and gaming audiences as they come equipped with advanced network management capabilities, multiple inputs and 120Hz refresh compatibility for a truly immersive 3D experience. ViewSonic's new DLP projectors are equipped with a 1024x768 XGA resolution, up to 2,700 lumens and a 2,800:1 contrast ratio to display bright, crisp images onto various surfaces. The projectors are compatible with the two leading stereoscopic 3D technologies from Texas Instruments (DLP Link) and NVIDIA (3D-Vision) allowing educators and gamers to interact with amazing 3D content. Gamers in 2D mode can also take advantage of the blazing fast 120Hz refresh rate to eliminate shadowing and distortion of screen images. The PJD6211 and PJD6221 will be available in July 2009 with MSRPs of $849 and $999, respectively. All of ViewSonic's DLP projectors are Energy Star certified and feature ECO Mode configuration options. This can save up to 40% in energy consumption and extend the lamp life of the product up to 6,000 hours, decreasing the total cost of ownership. http://www.viewsonic.com

Lightspeed Design and Real D PRO introduce 3D bundle

Lightspeed Design and Real D PRO announced the release of the new DepthQ/Real D PRO Bundle. It consists of a DepthQ HD 3D projector, four CrystalEyes 3 professional liquid crystal shutter eyewear, and an EXXR long-range wide-angle IR Theatre Emitter for a total price of $7500. In addition, customers purchasing a DepthQ/Real D PRO Bundle from Lightspeed will be able to purchase additional CrystalEyes 3 eyewear under special pricing. DepthQ HD 3D Projectors offer 120Hz stereo 3D at 1280x720 resolution. These bright, professional-level 3D projectors can easily display 9ft (2.7m) wide 3D high-definition images using the latest Texas Instruments DLP and BrilliantColor technologies for stunning colors and a 2000:1 contrast ratio. The EXXR Long Range Theatre Emitter offers a 130 degree infrared spread transmitting up to 70ft (21m) making it the most powerful active eyewear synchronization emitter in the world. http://www.depthq.com/projector.html

Lightspeed Design and Real D PRO introduce 3D bundle

Lightspeed Design, Inc., a developer of 3D stereoscopic projectors, and Real D PRO, announced the release of the DepthQ/Real D PRO Bundle. The DepthQ/Real D PRO Bundle consists of a DepthQ HD 3D projector, four CrystalEyes 3 professional liquid crystal shutter eyewear, and an EXXR long range wide-angle IR Theatre Emitter for a total price of $7500. In addition, customers purchasing a DepthQ/Real D PRO Bundle from Lightspeed will be able to purchase additional CrystalEyes 3 eyewear under special pricing. DepthQ HD 3D Projectors offer, 120Hz stereo 3D at 1280x720 resolution. These bright, professional-level 3D projectors can easily display 9 ft (2.7m) wide 3D high-definition images using the latest Texas Instruments DLP and BrilliantColor technologies at a 2000:1 contrast ratio. CrystalEyes 3 is an industry standard for engineers and scientists who develop, view and manipulate 3D computer graphics models in CAVEs, theaters and immersive environments. CrystalEyes 3 is a leader for 3D visualization in molecular modeling, virtual prototyping, and aerial photography/mapping. The EXXR Long Range Theatre Emitter offers a 130 degree infrared spread transmitting up to 70ft (21m) making it the most powerful active eyewear synchronization emitter in the world. http://www.reald.com

SENSIO technology allows 3D live opera to be seen across France's cinemas

SENSIO Technologies announced that its technology, which allows the live 3D broadcast of content across existing distribution networks, was deployed for the live 3D broadcast of the Don Giovanni opera originating from the opera house in Rennes, France. This lyrical show, a world premiere, was simultaneously broadcast on June 2 in Rennes' city hall lounge and four digital cinemas equipped with the SENSIO decoding technology. http://www.sensio.tv

Leicester Square is Europe's first theater with Dolby 3D for large screens

Dolby Laboratories announced that the Empire Leicester Square in London has become Europe's first auditorium to utilize the new Dolby 3D Digital Cinema large screen solution. The Empire installed the Dolby 3D system in time for the United Kingdom premiere of Walt Disney Pictures' "Jonas Brothers: The 3D Concert Experience". The movie will premiere in front of an invited audience of more than 1,300 guests. The new Dolby 3D large screen solution combined with Barco's digital cinema twin-projector allows exhibitors to project Dolby 3D onto standard, non-silver screens ranging from 12.5 to 21 meters, surpassing the previous size limit of 12 meters. The Empire Leicester Square, one of the UK's oldest and largest cinema venues, regularly hosts movie premieres. With its 20-metre screen, the Empire boasts one of the largest screens in the country. Without requiring a special silver screen, Dolby's color filter technology and lightweight passive Dolby 3D glasses give every member of the audience a memorable 3D experience. The Dolby 3D system provides realistic, full-spectrum color reproduction and extremely sharp images, while the environmentally friendly glasses, designed for repeated use, significantly reduce the cost per viewing for exhibitors, the company says. http://www.dolby.com

BAFTA selects Dolby 3D for London showpiece theatre

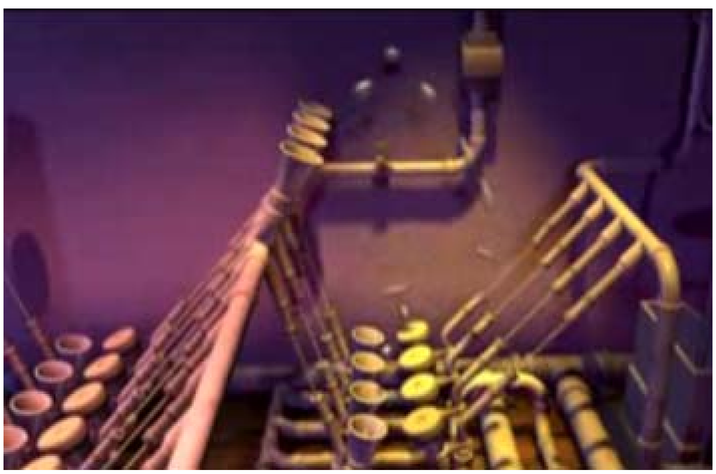
Dolby Laboratories announced that the British Academy of Film and Television Arts (BAFTA) installed Dolby 3D Digital Cinema in its prestigious London headquarters' showpiece theatre at 195 Piccadilly. The Princess Anne Theatre sits at the heart of the BAFTA headquarters building. The state-of-the-art cinema equipped with premium digital projection facilities seats more than 220 people and plays host to many leading industry events. The Princess Anne Theatre projection room at BAFTA already boasts a selection of Dolby digital cinema equipment, including a Dolby Digital Cinema server and Dolby Show Library, Dolby DMA8Plus Digital Media Adapter, and Dolby CP650 Cinema Processor. The addition of Dolby 3D Digital Cinema brings a stunning and realistic extra dimension to the 3D content shown in the theatre. http://www.dolby.com

Panasonic develops 3D camera

Panasonic announced it will start developing a professional 3D Full HD production system. The system, which is expected to be the first of its kind in the industry, consists of a twin-lens P2 professional camera recorder and a 3D-compatible High Definition Plasma display. At present, 3D content producers have to hand-build their own 3D production systems by physically connecting multiple 2D production devices. Each component of Panasonic's innovative 3D Full HD production system has unique features. The twin-lens P2 camera recorder enables the capturing of natural and high-quality live 3D images. Thanks to the non-mechanical solid-state construction of the P2 system, the camera recorder will be compact enough to allow more flexible 3D shooting, thereby maximizing the creativity of the filmmakers by eliminating the stress factor from the use of the equipment. 3D Full HD recording using Panasonic's proprietary P2 system also enables recording of two channels of Full HD images on the P2 card. P2's non-mechanical construction and compactness will also be incorporated into the company's 3D image recording and editing equipment to make production in the field highly flexible and efficient. Panasonic's 3D Drive System enables the display of Full HD moving pictures for the left and the right eyes, so large screen 3D viewing will become possible. The excellent moving picture performance and accurate color reproduction characteristics achieved by Plasma's self-illuminating technology enables the realization of high-quality 3D image evaluation capabilities required in the professional content production field. http://www2.panasonic.com

Animusic Pipe Dream 3D music visualization astounds

Animusic created an amazing 3D visualization of MIDI-based music -- voted as one of the 50 greatest animation projects ever by 3D World magazine. Check out the video here: http://www.flixxy.com/animusic-pipe-dream.htm



Texas Instruments shows first technology to enable affordable single-projector 3D

Texas Instruments showed the breadth of its manufacturers' 3D Ready projectors and the first high-brightness lamp-free data projectors, all designed to address the growing needs of classrooms and conference rooms. DLP innovation of 3D display increases interactive learning through immersive curriculum with an affordably priced single 3D Ready projector. Nine of DLP Products' more than 30 manufacturers will have 3D Ready projectors on the market soon, including BenQ, InFocus, LightSpeed, Mitsubishi, Optoma, Sharp, and ViewSonic, in addition to high-end products from projectiondesign and Christie Digital. Taking the cinematic-like experience to a new level with 3D curriculum, DLP Products has worked closely with content providers such as Discovery Education, Safari Montage, Eon Reality and NeoTech to bring 3D educational material to market. http://www.ti.com.

Ubisoft supports the SENSIO 3D format for stereoscopic video gaming

SENSIO Technologies announced that James Cameron's Avatar: The Game, will be available in SENSIO 3D format for output from both X-Box 360 and PlayStation 3 game consoles. To benefit from this stereoscopic experience, players of Avatar: The Game can connect their existing game consoles directly to 3D-enabled TV's with built-in SENSIO 3D decoding technology. This game is a great addition to the growing library of DVD titles and live 3D events broadcast in digital cinemas that are all currently available in the SENSIO® 3D format. These live 3D events will soon be made available to consumers through Pay-Per-View or Video-On-Demand, increasing the quantity and variety of available content in the market. http://www.ubisoftgroup.com

Mitsubishi announces new 3D-ready HDTVs

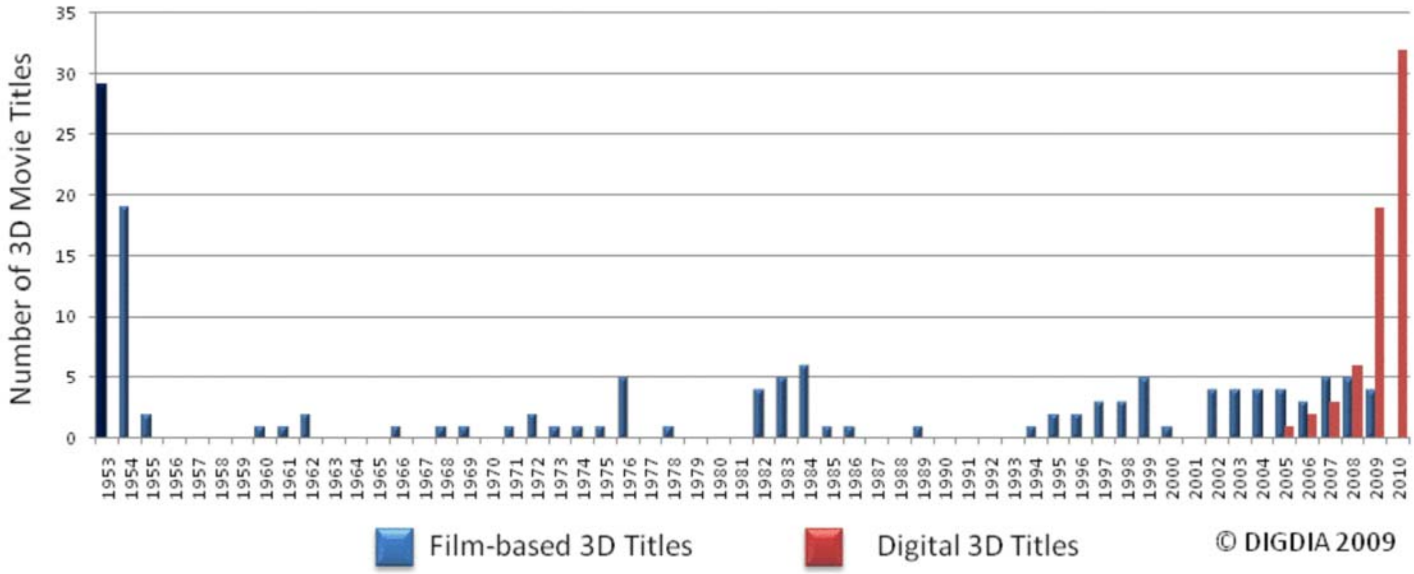
Mitsubishi announced that it would field a total of eight 3D-ready HDTVs – including what it termed the largest mass-produced 3D television, the 82-inch DLP Model WD-82737. Mitsubishi is at full bore in helping dealers promote its products, according to David Naranjo, director of product development. A 53-foot Mitsubishi Mobile Showroom making the rounds across the country carries 3D TVs and a 3D logo wrapping, and a 3D retail fixture merchandising kit is being deployed to several hundred retail locations, he added. The retail fixture, said Frank DeMartin, vice president of marketing, will include a PC server, four pairs of 3D glasses and a retail stand, with a button that consumers hit to view a 3D demo. http://www.mitsubishi-presentations.com

Mitsubishi 3D-ready 1024x768 projector

Mitsubishi expanded its projector product line-up with a series of new portable projectors that weigh less than eight pounds at over 4,000 lumens. The XD600U is the first in Mitsubishi's new family of high-brightness projectors. This XGA-resolution projector has a long-life lamp, estimated to last up to 5000 hours under normal operating conditions in low mode. The Mitsubishi XD600U is the first projector in Mitsubishi's line designed with the latest DDP2230 and DLP Link chipset, making it 3D-ready for three-dimensional display content. The projector supports a 3D experience when users input and display their 3D content and watch the display with optional DLP Link-compatible 3D glasses. Mitsubishi's new XD600U projector is designed for both education users as well as business professionals, offering a 10-watt speaker and audio mix capability, closed captioning decoder, a visual public addressing (PA) feature, user-friendly menus, and low cost-of-ownership. The new XD600U projector includes dual 15-pin computer inputs as well as S-video and RCA video inputs. It also comes with HDMI™ inputs for digital sources so users can switch between a computer presentation and video with just the press of a button. http://www.mitsubishi-presentations.com

DIGDIA reports that 3D screens now number over 5,000 worldwide

In every industry from movie production to consumer electronics, the subject of 3D has been a main topic of discussion. Topics like Digital Cinema, Digital Cable, and HDTV have begun to settle down and forward thinkers are now wondering what 3D means to their businesses. One piece of evidence – there are now over 5,000 digital 3D screens worldwide. And, the companies that are installing 3D equipment in theaters – Real D, XPAND, Dolby and Master Image – all report hundreds of orders in their pipeline.



Another piece of evidence – there are over 30 digital 3D movie titles in the works for 2010. There haven't been this many 3D titles since the so-called "golden age of 3D" in the early 1950s. Now the rest of the digital entertainment value chain is taking notice. There are at least 16 standards, coordinating organizations and national research labs working on bringing 3D to the home. Many consumers may not know it, but many new digital televisions are already "3D ready". A new market analysis report from DIGDIA takes a look at digital 3D entertainment in detail. The report called "Digital 3D Entertainment – From Theater to Home, Why, How and Opportunities" covers the market, technologies, products, issues and opportunities. http://www.digdia.com

Sky shoots Swan Lake in 3D

Broadcaster Sky has continued its research into the potential of 3D TV by filming snippets of the famous ballet Swan Lake in 3D. At a recent event in London, 32 of the English National Ballet's dancers were filmed gliding around by several dual-lens HD cameras which capture images for the left and right eyes. But instead of simply shooting from a fixed point – as was the case when Sky previously captured band Keane in 3D – the cameras moved among the ballerinas. The results were shown at the recent Hay-on-Wye literature and arts festival, but Sky doesn't have any plans to broadcast it to a wider audience. Sky remains tight-lipped about its plans for a commercial 3D TV service. It has said that 3D content availability is the main hurdle.

Sky's 3D dual-lens cameras glided around the dancers

NEC unveils new ultra bright NC2500S-A projector ahead of Disney Pixar's 3D release of "Up"

NEC Corporation of America unveiled the new NEC NC2500S-A digital cinema projector. As Hollywood studios begin requiring a higher level of brightness for 3D movie releases, NEC says it is the only provider to offer all pre-existing customers this new feature in their current models with a simple upgrade. The world-renowned Ziegfeld Theatre will be among the first of NEC's customers to embrace these new projectors. The NEC NC2500S-A's new technical enhancement allows 3D content to utilize the full 2K resolution of the 1.2-inch DMD from Texas Instruments using triple flash technology for smooth motion. With an increase in resolution and brightness of up to 33%, compared to previous generations, the boost in performance means a greater viewing experience for theatergoers. The exhibitors can now display content on larger screens to bigger audiences than before. Current NEC DLP cinema projector customers will be able to make this upgrade easily and in the field. NEC is offering this service to customers through both NEC factory engineers or through factory training provided to the exhibitor and independent service engineers, allowing for a flexible transition to the new NEC NC2500S-A projector. All digital cinema 3D technologies will benefit from this upgrade. http://www.necam.com/dc/

NEC's new projector will be used for Disney's projection of "Up"

Alioscopy autostereoscopic 3D displays join Autodesk Gallery in San Francisco

Alioscopy announced that its 42-inch LCD autostereoscopic 3D display is now a part of the design collection in the prestigious Autodesk Gallery at One Market in San Francisco, California. Built to celebrate the design process of its customers, the Autodesk Gallery at One Market features more than 20 different exhibits that highlight the vast range of inspiring designs, from cathedrals to giant Lego dinosaurs. The Alioscopy autostereoscopic 3D display supports Autodesk 3ds Max software (with planned future support for Autodesk Maya and Autodesk Softimage software) and Autodesk Toxik software – allowing artists and technical directors to create and composite autostereoscopic 3D content. Visitors will be able to view real-world examples of immersive autostereoscopic 3D animations and images on the Alioscopy LCD display without wearing any type of 3D glasses. A special lenticular lens, attached to the LCD display, completes the autostereoscopic effect. The Alioscopy technology opens new frontiers for digital signage, advertising, medical and design visualization, gaming, concerts, trade shows and events – and even a way for cinemas to promote upcoming stereoscopic 3D films in the lobby, without having to issue 3D glasses. http://www.alioscopyusa.com

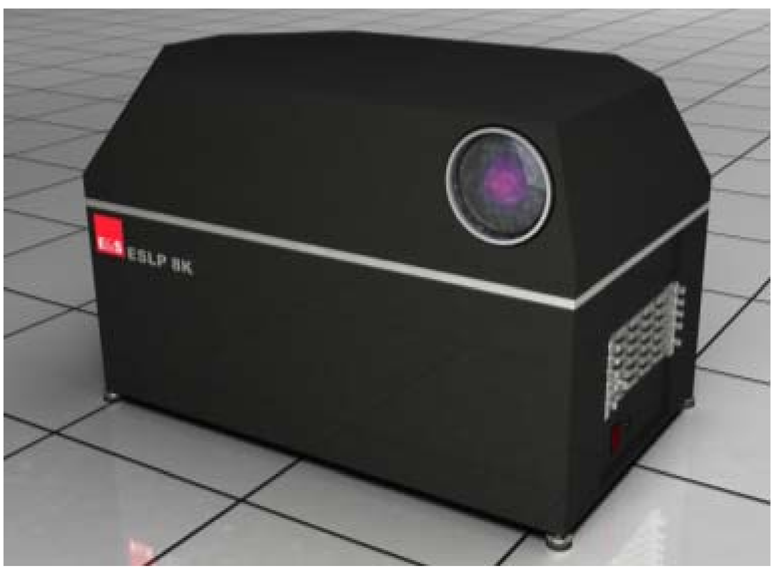
Alioscopy's 3D autostereoscopic display is now part of Autodesk's gallery in San Francisco

Radi Designers feature pepper ghost mannequins

Created for the Musée de la mode et du textile, Paris 1998, Radi Designers created a beautiful exhibition design that integrates 98's technologies such as projections of portraits. The exhibition consisted in a retrospective on graduates work from FIAMH (Festival International des Arts et de la Mode, Hyères) where moving heads animate mannequins and produce ghost like pictures. http://www.radidesigners.com/

Evans & Sutherland premiers 4K x 4K 3D Projector

Evans & Sutherland demonstrated for the first time its revolutionary new 3D capable laser projection system at the InfoComm 2009 tradeshow. This newest E&S Laser Projector (the ESLP 8K) is the world's highest resolution production video projector, and it provides superior 3D images at a 4K x 4K resolution. It will offer museums, universities, research labs, control rooms, creative studios and indoor venues worldwide with a 3D experience that brings viewers into worlds both real and imaginary in a way that they have never experienced before. The ESLP 8K offers unique advantages when it comes to displaying 3D stereographic video. Because of its zero-persistence characteristic, the projector can effortlessly switch between left-eye and right-eye views at 120 Hz or more, without any 'bleed' between the left and right views. This results in a noticeably cleaner separation and 3D effect, when compared to using active stereo glasses with an LCoS or LCD projector. For customers that have a need to switch between 2D and 3D images based on the video content being displayed, the ESLP 8K comes with flexible control software that allows users to change the display format from 3D to 8K x 4K quickly and easily. http://www.es.com



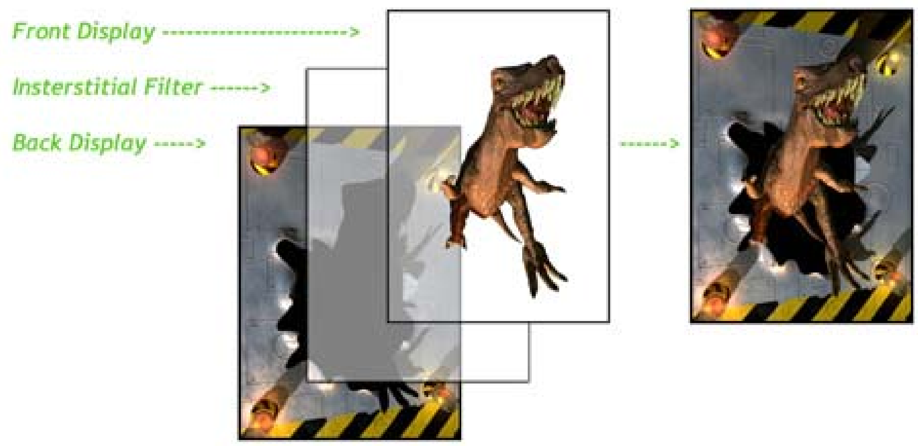
The ESLP takes advantage of the nanopixel light modulator, which is a MEMS (micro electro-mechanical system) device fabricated on a silicon microchip. On this chip are thousands of electrostatic reflective elements arranged in a line array.

Japanese and German companies, TMDisplay and Newsight, showcase glasses-free displays

At a recent show, Toshiba Matsushita Display Technology (TMD) showcased its Integral Imaging 3D display that does not require the wearing of special glasses to view 3D images. In the 2D mode, the 12.1-inch display panel has a resolution of 1400x1050. Newsight showcased its parallax barrier 3D display, which also requires no special glasses in viewing the image. In the 2D mode, the 42-inch display panel has a 1920x1080 resolution. http://www.newsight.com http://www.tmdisplay.com

PureDepth MLD technology drives Japanese "Onihama" game

PureDepth, the creator of Multi-Layer Display (MLD) technology, announced that a pachislot game featuring its patented technology has been rated by players as the second most popular pachislot machine in Japan. The "Onihama" pachislot game, which was introduced in November 2008 and is sold by Abilit Corporation, uses MLD technology to offer images with real depth and excellent color and contrast that enhance the player experience. In response to its popularity, Abilit Corporation has recently launched a number of variants of the game. PureDepth's MLD technology is currently available in Japan through a licensing agreement with Sanyo Electric Co., Ltd., which incorporates the technology into its hardware platforms for the widely popular pachinko and pachislot markets. The Onihama game uses an MLD technology manufactured and developed for pachislot by Sanyo Electric System Solutions. PureDepth's MLD technology effect is created by placing layers of display panels placed in front of one another in a single monitor, with patented technology used to remove interference. Viewers using an MLD-powered device will see data or images on the front display screen while simultaneously viewing images displayed on the panel(s) behind. PureDepth says its technology doesn't give people headaches, dizziness, fatigue and loss of orientation like other 3D display technologies that simulate depth rather than creating real depth. http://www.puredepth.com



Real D introduces world's first mobile, single-projector 3D

Real D introduced the Real D LP (Linear Polarizing Z Screen) to bring the power of 3D to the small screen. The world's first mobile, single-projector, passive 3D solution, the Real D LP brings high-quality 3D to smaller venues such as conference rooms, R&D centers, museum exhibits, mobile education centers, virtual rides and other entertainment attractions. Designed to be set up for individual 3D presentations in minutes, or permanently mounted for long-term use, the Real D LP allows the flexibility of switching between 2D and 3D on the fly while alleviating maintenance and other issues of dual-projector 3D systems. The Real D LP is an externally mounted peripheral for a single 3D-enabled DLP projector, with electronic controls conveniently integrated inside the device. When 3D content is fed to the projector in full-resolution, frame-sequential format, the Real D LP allows content to be seen in 3D by polarizing right- and left-eye images. Viewers wear comfortable, affordable and reusable Real D eyewear custom built for the LP. Suitable for screens up to 17 feet wide, the Real D LP works with 3D-enabled projectors such as NEC NC800, Christie Mirage HD, and Lightspeed Design HD DepthQ, along with a silver screen from Harkness, MDI or Stewart. http://www.RealD.com

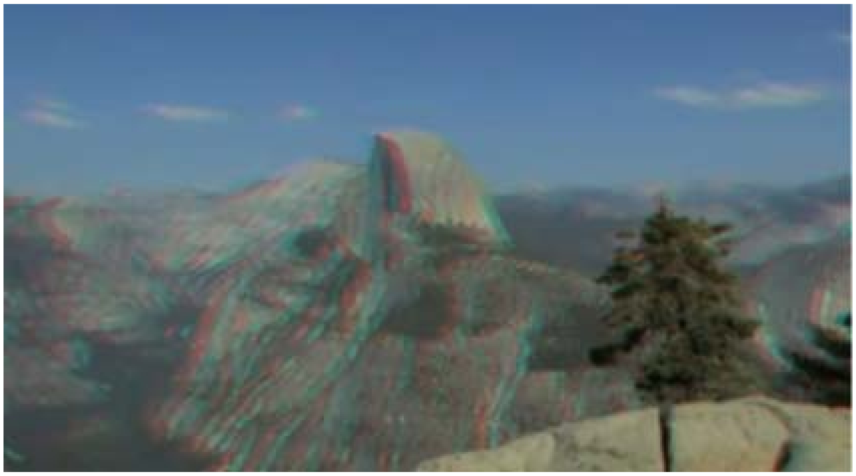
3D Film Factory introduces production-ready 3D camera rigs

3D Film Factory has developed the first-ever line of production-ready, cost-effective, 3D camera systems designed to shoot superior 3D. Developed over the course of several years, with the guidance of veteran stereographers and award-winning filmmakers, these durable, dual camera rigs provide an alternative to the custom, high-priced 3D systems costing ten times as much. The company has released for sale three systems: the 3D-SB (split-beam); 3D-SS Indie (side-by-side); and the 3D-SS Pro (side-by-side) models. Each system is designed for a specific production purpose and to accommodate various prosumer and professional grade SD and HD cameras. The 3D-SB (split-beam) system is constructed using black anodized aluminum that's virtually indestructible and light-absorbing, removable plastic. With a total weight of only 22 lbs., the rig is easy-to-use, allowing for quick set-ups and precise 3D alignment. It's being introduced for a complete price of $1,995.The company's two side-by-side 3D rigs are less complex, but equally necessary in most 3D production situations. Side-by-side systems are specifically designed for filming master to panoramic shots in 3D. In this case, the simple side-by-side camera posture allows for fast, accurate 3D alignment and unobstructed shooting. Both 3D-SS systems weigh less than 4 lbs., are priced at about $300, and boast inter-axial (camera to camera) distances from about 6 to 24 inches. http://www.3dfilmfactory.com

The 3D split-beam system

3D Film Factory begins production on Yosemite documentary

3D Film Factory (3DFF) recently began production of an original documentary showcasing one of America's greatest natural treasures in 3D – Yosemite National Park. This film will chronicle the history, seasonal cycles and visual grandeur of the park all in high-definition 3D. It will showcase the park's best known activities and natural phenomenon: Yosemite Falls, rafting on the Merced river, climbing Half Dome and El Capitan, tracking bears, the giant sequoia trees and the back country. With the larger landscapes much of the shooting was accomplished using a side-by-side, 3D camera system (3D-SS Pro Rig) and dual HD cameras. For the close-up and personal nature shots, a split-beam camera rig (3D-SB) was employed. The production is expected to be completed by late fall. A preview trailer for the film can be seen in anaglyph (red/blue) format on YouTube at http://www.youtube.com/3deefilm



3dtv.at releases latest version of its stereoscopic player software

3dtv.at released in May the latest version of Stereoscopic Player version 1.4.6. Stereoscopic Player is a full-featured 3D movie player that plays stereoscopic movie files and 3D-DVDs. Users can also watch stereoscopic webcasts as well as live images from a camera or TV card. It supports a wide range of 3D hardware, including anaglyph glasses, shutter glasses, autostereoscopic displays and projection systems, and supports all major 3D video formats. http://www.3dtv.at

SID Display Week Symposium 2009

June 2-5, 2009, San Antonio, Texas

Phillip Hill covers papers from Nokia Research Center, National Chiao Tung University/Chung Yuan Christian University/Chunghwa Picture Tubes, Samsung Advanced Institute Technology (SAIT), National Taiwan University, and 3M/Toshiba Matsushita Display Technology Co.

Subtitles in Short 3D Movies
Lachlan Pockett, *Monika Pölönen*, and *Marja Salmimaa*, **Nokia Research Center**, Tampere, Finland

Since movie production is international, subtitles are essential in some cases to allow wider distribution of the movies. With 3D movies and the way the subtitles are shown, an understanding of the consequences of the depth levels used either in the content or the subtitles is crucial. This paper describes the results of subjective tests investigating subtitles in stereoscopic 3D still images for small size displays. More precisely the effect of different depth levels of the subtitles and their interaction with different scene contents with varying depth was investigated.

Seventeen participants evaluated four different image contents with three different subtitle 3D locations. The results showed that participants preferred zero disparity subtitles for improved readability, naturalness and general impression. Slightly better 3D impression was perceived with a negative disparity on the text, utilizing the full 3D space and removing depth conflicts. The purpose of this pilot study was to get a better idea of the components influencing human perception. The effect of disparity on the perception of text in still images may differ in moving scenarios. Hence a future larger scale study would be desirable in order to create a deeper understanding of the various influencing factors regarding moving content with a wide range of disparities in different scenes.

An Auto-Stereoscopic 3D Display Using Tunable Liquid Crystal Lens Array that Mimics Effects of GRIN Lenticular Lens Array
Yung-Yuan Kao, *Yan-Pean Huang*, and *Paul C.-P. Chao*, **National Chiao Tung University**, Hsinchu, Taiwan
Kai-Xian Yang, **Chung Yuan Christian University**, Chung Li, Taiwan
Chi-Chung Tsai, and *Chi-Neng Mo*, **Chunghwa Picture Tubes**, Taoyuan, Taiwan

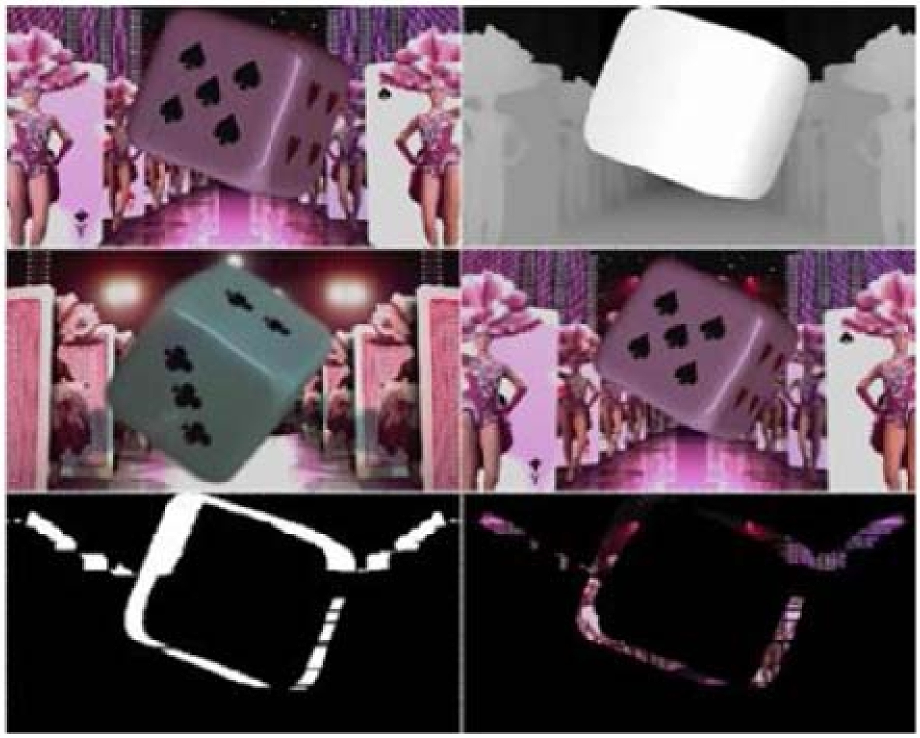
A tunable liquid crystal lenticular lens array is proposed to make an auto-stereoscopic 3D display. The focusing can be achieved based on non-uniform phase retardation across the width of the LC lenticular lens, mimicking the effects of a gradient index (GRIN) lens. The viewing distance and zones of this display can be adjusted in an on-line fashion to track the viewer position relative to the display. The proposed scheme can present the lenticular lens and the LC GRIN lens simultaneously, so that the simulation results can express the low value of crosstalk of 9% by the lenticular lens array and the LC GRIN lens array.

The 3D image can be achieved in either this new designed lenticular or GRIN lens array systems. Different parameters are derived for both cases in accordance to their essential features and characteristics for optimal auto-stereoscopic performance in certain confined conditions as the module size, the pupillary width, and the viewing distance. It is proven that the proposed tunable LC GRIN lenticular lens array is capable of displaying 3D images with adjustable viewing distance and zones, despite slightly higher cross talk as compared to a conventional lenticular lens array.

Depth-Image-Based Rendering (DIBR) Using Disocclusion Area Restoration

Young Ju Jeong, Youngshin Kwak, Youngran Han, Yong Ju Jung, and *Du-sik Park*
Samsung Advanced Institute Technology (SAIT), Gyeonggi-do, Korea

3D displays have been evolving from stereoscopic 3D system into multi-view 3D system, which provides images corresponding to different visual points. Currently because of input source formats such as two-dimensional images, multi-view display systems need technology to generate virtual view images of multi visual points. Due to the changes in the visual points, the occlusion region of the original image becomes a dis-occluded area, resulting in a problem to restore the output image information which is exclusive of the input image. This paper proposes the method for generation of multi-view images through two steps which are depth map refinement and dis-occlusion area estimation and restoration. The first step, "depth map refinement", removes depth map noise and compensates mismatches between RGB and depth, preserving boundaries and object shape. The second step, "the dis-occlusion area estimation and restoration", predicts dis-occlusion area using disparity and restores information of the area using neighbor frame's information, which is the most similar to the occlusion area.



Disocclusion area map and restored image. The first row left image is the input RGB image and the right image is the input depth map. Second row images are -1 frame image and +1 frame image. The bottom row left image is the predicted dis-occlusion area map. The bottom row right image is the restored information of the dis-occlusion area.

The researchers have developed a virtual view generation algorithm for 3D multi-stereo displays. This algorithm was developed by dis-occlusion area estimation according to visual point changes and dis-occlusion information restoration using temporal information such as neighboring frame information. Firstly, for the prevention of multi-view image distortion caused by depth map noise and mismatch with RGB image and depth, depth filtering is applied, preserving discontinuity and also expanding the discontinuity boundary. Then, dis-occlusion area is restored using the background information of neighboring frames which have a big correlation with the dis-occlusion area. The resulting stereo images generated by the algorithm are natural and vivid 3D, having restored dis-occlusion area by neighboring frame information. The algorithm could be used as the key technique to provide better 3D image quality.

A Quality-Scalable Depth-Aware Video Processing System

Chao-Chung Cheng, *Chung-Te Li*, *Yi-Min Tsai*, and *Liang-Gee Chen*
National Taiwan University, Taipei, Taiwan

To produce high quality three-dimensional content, depth map generation is the major issue in content creation. In this paper, the researchers propose a quality-scalable depth-aware video processing system, which retrieves depth maps using hybrid depth cues from single view video content. The system uses a hardware-oriented algorithm and generates spectacular and comfortable results. With the help of the depth map, 2D videos can be converted to 3D format and can be displayed in 3D/stereoscopic displays by a depth image based rendering technique. Moreover, for conventional 2D displays, they also propose a 2D video depth perception enhancement application. With a depth-dependent parameter adjustment, the stereo effect of the 2D content is also enhanced.

Compared with the previous work, the proposed method has three major advantages. Firstly, the depth from multiple cues can provide extra depth information to generate more realistic effects. The depth from relative position generates stepping depth gradient over the object segment, and the depth from motion parallax (DMP) enhances the depth when a video has camera motion, and the depth from geometrical perspective enhances the stereo effect of the scene structure. Secondly, the process of proposed methods using block-based DMP and line-based depth from relative position (DRP) cooperate with bilateral filters and is more suitable for hardware implementation. Finally, the proposed method is quality-scalable. Depending on the applications, different block sizes can be selected or cooperated with multi-scale sub-samples. For example, a large block size is suitable for 2D enhancement because 2D enhancement applications do not require high-resolution depth maps. Larger block sizes will result in lower depth detail. Moreover, the system proposed can be used both in depth perception enhancement of conventional 2D display and depth-based processing for modern 2D+Z and N*2D displays. It is suitable to be integrated into 3D display and broadcasting systems.

Original sequences and corresponding depth maps. By fusion of the depth map from motion and scene, both static objects and moving objects generate depth.

Full Resolution Autostereoscopic 3D Display for Mobile Applications

John C. Schultza, Robert Brott, Michael Sykora, and *William Bryan*, **3M**, St. Paul, Minnesota
Tetsuo Fukami, Kenji Nakao, and *Akio Takimoto*, **Toshiba Matsushita Display Technology Co.**, Ishikawa, Japan

This paper describes the implementation of a 3D film method for achieving full resolution autostereoscopic 3D displays in handheld and portable devices. The three components of this technology – a directional backlight, 3D film and a 120Hz LCD panel – are described. Modeling and experimental device performance using OCB LCD panels are reviewed along with 3D visualization performance. The performance of this autostereoscopic solution was evaluated using demonstration units in a 3-inch diagonal 400x240 size and a 9-inch diagonal 800x480 size using Toshiba Matsushita Display (TMD) OCB LCDs.

There is rapidly increasing public interest in 3D with the increase in 3D movies, gaming and other content. Mobile devices, for which stereoscopic 3D is not generally practical, will be a major implementation area for 3D viewing in the near future as content is ported to the smaller displays. The autostereoscopic 3D solution described in this paper was demonstrated with a simple backlight construction consisting of 3D film, a directional backlight and a TMD OCB 120Hz LCD panel. This simple construction was found to provide excellent autostereoscopic viewing in both cell phone and larger sizes up to 9-inch diagonal.

Cell phone-like 3-inch 3D display, and a netbook-like 9-inch 3D display

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Dimension 3 International 3D Stereo Forum

June 2-4, 2009, Seine-Saint-Denis, France

Jon Peddie and *Kathleen Maher* from Jon Peddie Research provide their insight and commentary about the Dimension 3 event in Paris.

If you want to learn anything about and/or know everything about S3D, Dimension 3 is one of the must-see conferences. It's three days and nights of jam-packed high-level and high-concept presentations from the making of movies, to figuring out the TV, building displays, and driving the content from mobile phones to PCs to simulcasts and movies.

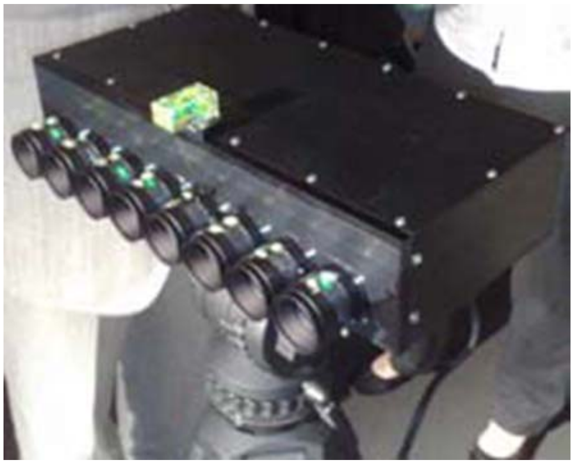
S3D is far from finished and, although you may have been to the movies and seen DreamWorks and Pixar/Disney animations, in S3D those are at best very well done prototypes and not viewable in still outside the U.S.

Capturing the content: The issues begin with the camera – parallel cameras, or two cameras with a beam splitter a mirror that enable them to capture side-by-side images while mounted in a variety of ways, or one camera with prisms. The quality of the camera from cheap handicams to serious studio cameras from Red or JVC is the next choice, or is it? Some budgets and studios and shooting scenes require a certain camera; e.g., wild outdoors or underwater, dark drama, or sports events, etc. One of the things that came out at the conference is that there are almost as many rigs for stereographic 3D capture as there are stereographers. It's a small club but everyone has their preferences and the quality is variable, as was evident during the screenings and events at the conference. An experienced and talented stereographer can write his or her own ticket these days.

A beam splitter arrangement with the second camera above.

Displaying the content: And then there's the display. Will it be with or without glasses? The approach that doesn't use glasses, known as autostereoscopic, uses displays with parallax barriers, most commonly lenticular lenses (small vertical prisms designed to drive the view to the left or right eye). The autostereoscopic screens come with flat or dead spots as the viewer's head moves from the left to right or vice versa. Typically there are four or five dead spots depending on who made the screen. To overcome that, clever people like Alioscopy offer a screen that reconstructs an autostereoscopic image from eight cameras. That results in eight to 12 dead spots but they're much smaller. As the number goes up, the so does the viewing comfort, and with more cameras you actually get a more realistic depth view that actually changes as you move from the left. For example, a person standing at the left side of the screen looking at a model will see a different part of her face than a person standing at the right side of the monitor, just as one would in real life. The multi-camera autostereoscopic screens can have as few cameras as four and as many as the budget can tolerate. For the ultimate in realism there is the Light Box which immerses the scene/actor(s) in a huge open sphere that is ringed with lights and cameras collecting all the light, reflections, shadows, and depth information possible.

For viewing with glasses there are several choices as well, shutter glasses from European-based (and maybe centric) XPAND for the cinema, to Nvidia's 3D Vision for PC games and TV viewing (using Peter Winner's 3D TV content). The passive polarized glasses you get at North American theaters come from Real D and sometimes they are Dolby color shift glasses (not found in Europe to speak of). For PCs IZ3d polarized glasses seem to be the dominant supplier. And, everybody's all time favorite, and most affordable, the red-green anaglyphic which are being rejuvenated as a cheap way to introduce (or re-introduce) people to the concept of S3D. The anaglyphic glasses can be embedded in magazines and thrown away, whereas the shutter and polarized glasses cost anywhere from as little as $5 to make to as much as $20 for Dolby models.



Multiview 3D displays require cameras with multiple lenses to capture the scene. This camera from 3D TV offers 8 lenses to complement displays like those made by Alioscopy.

Platform issues: There are five platforms that are targets for S3D: Cinema, TV, PC, mobile phones, and signage, and each has different demands on brightness, content, capture and display technique.

- **Cinema** has decided on glasses, and the content providers say they don't care which type of demodulator is – used-active or passive polarized or color-shift – that's the exhibitor's problem. That sounds nice but is total BS, and the content is dramatically affected by the demodulation scheme. As mentioned, in the U.S. polarized Real D is the winner, in Europe XPAND's shutters seem to be taking the lead, and no clear winner has emerged in Asia as far as we can tell.
- **TV** is a hodgepodge of conflicting approaches with each provider trying to get one or another standards committee to select their technology. The common wisdom is that viewers won't wear glasses no matter how lightweight or unobtrusive they are and therefore the autostereoscopic screens have to prevail. Naturally all the display manufacturers who have been investing in 120Hz screens don't like the sound of that, and point out that the filtered autostereoscopic screens cost more, and have reduced brightness and resolution. The autostereoscopic suppliers deal with that by merely waving their hands in a dismissive way and saying "pshaw." In the mean time no standards are adopted, nor is there even a leaning toward one. Some think SMPTE should do it, others think government agencies like FCC should decide, and still others say it will be content delivery systems like Sky, DirectTV, and the cable companies who will make the decision. The bottom line is don't expect to have S3DTV in your home with OTA or down the cable content delivery for many, many years. Pre-recorded HDTV on Blu-ray discs will be possible with 120Hz screens and DLP projectors that will require wearing shutter lenses, and you can find some early examples of that now – albeit with limited and usually crappy content choices.
- The **PC** is the leader of the pack with 120 Hz screens and glasses, provided you want to play games or watch a little TV (i.e., we mentioned Peter Winner's content earlier:http://tinyurl.com/2cqrm5)
- **Mobile phones** will go for autostereoscopic lenses. It makes sense due to the small screen size and personal nature of watching – one doesn't tend to bob their head around much unless they're watching a music video. Here a battle rages between NEC and Sharp about how to go about it, but for the most part the content providers don't care, although NEC says they do because all the other solutions dim the image too much. The content will be snacks, re-rendered YouTube things, a few specialty made commercials and mostly novelty stuff.

- **MID opportunity?** Autostereoscopic screens on MIDs are another possibility. With a larger screen and battery, and different usage model than a mobile phone, it's entirely possibly the media-player model will be the home for more elaborate content like movies, pre-recorded TV, and certainly games.
- **Digital signage** will use large (>40-inches) autostereoscopic screens in portrait and landscape mode to show off products – not the least of which will be coming attractions in movie theaters. A few high-end department stores are already experimenting with the model and some auto dealers (the surviving ones) are also looking into it. You can expect to see lots of S3D in the malls this holiday season. Alioscopy is rolling out their technology in the U.S. as a digital signage option. The company's principals will tell you candidly that they don't expect to be selling multi-view screens in the home any time soon but they've already got deals going for digital signage. The company's strategy is to offer its customers templates which will allow them to easily create content.

The content: Quite a bit of it is pretty crappy and lots of people are afraid that if it doesn't get better real fast we're going to repeat the disappointments of the 50s and 60s. The problems involve a multitude of issues, not the least of which (mentioned earlier) are the display device, and the capture technique. But even more important than the electro-mechanical technical issues is the directors – art, photography, and story. If these three puppet masters don't know what they are trying to accomplish, and what the impact of the artifacts of the electro-mechanical technical elements will do their art/story/photography we the consumers will walk away in disgust.

We had the opportunity to watch a simulcast of *Don Giovanni* in Paris's amazing Geode, an IMAX chrome dome located in the center of the city's Technological History Museum. A visit to this wonder is in itself an amazing experience and S3D devotees' as we are had our sense of excitement cranked to the danger zone.

If you've even been in an IMAX theater you know the feeling, dome-like inside with rows of seats that spiral upward several stories so that you think you're going to get a nose bleed if you go to the top, or worse yet come tumbling down bouncing row over row till you land on the stage. Naturally we went for the highest seats and had to arm wrestle some minor French official for the seat he thought he was entitled to (at some loss of personal diplomacy I'm afraid).

Well we should have let the bureaucrat have seat and gone to the *Nightmare Before Christmas*, which was playing in S3D in another theater. *Don Giovanni* was a total failure and may have set back S3D it looked so bad. Dark, sometimes the actors' feet disappeared, sometimes they had a green outline, almost never did they have a realistic 3D look. One of the concerns some of the experts at the conference told us about was the effect of camera placement relative to the actors and how some of the actors (depending on where they stood) would suffer from dwarfism. That artifact was very prominent in the show. What all the technical failures revealed was that the director didn't have a clue about S3D, how to light it, how to project it, or how to present it. Clearly there were no dress rehearsals with the equipment turned on or anyone looking at it. It was a sad sorry affair and the halls of the conference echoed that for the next two days. Some people were seen approaching each other and just shaking their heads sadly.

Bwana Devil Stereo 3D movie circa 1952.

We also got to look at several movies, and here again you could see the lack of understanding of the medium. Effects for effects sake – the 50s revisited. Jarring frame changes and too sudden scene cuts that made your eyes go into shock until your brain could adjust to the new scene – amateur stuff that if properly shot and edited could have been avoided. 3Ality honcho Steve Schklair was on hand at the conference and he spoke about bad 3D as "stuff that rips the audience's eyes out of their heads." It always seemed like an exaggeration when he's said that before but some of the examples we saw at the conference illustrated exactly what he meant.

Granted, we may be the most critical audience in the world, we are, after all, the experts and technicians of this stuff. But we couldn't help but cringe when the artifacts overwhelmed the story. We want S3D to succeed. It does bring more to the tool set of a director, and it can enhance the effects and story of a movie. But it's still the early days, and the big question is will the audience come back to a S3D movie if the first two or three times are annoying.

PC games aren't any better. There is actually more opportunity to do it right with a game because of its inherent 3D construction. And there's really no major dislike to wearing glasses (although the jury's still out if hard-core tournament players will go for them.) A few games, FEAR2 for example, handle it pretty well. But all the games available today – some 300 of them, are driver tweaks – not originally constructed or designed for S3D. And due to the various map overlays (shadows, water, fire, gun sights, etc.) special coding has to be added by the graphics board driver writer, with variable amounts of success. The net result is that some games (most) require the depth to be dialed so far down, and special shading features turned off that its questionable if any value at all is being gained playing in S3D.

So far only one game is coming out, Resident Evil 5, that was designed to exploit S3D and although Nvidia has showed snippets it's too limited to be able to determine if it's any good for S3D – we have our fingers crossed.

What do we think? Benefits of the recession: Dimension 3 has been a great if not novel conference and such a pleasant departure from the mundane yadda yadda ones we so often have to go to. SXSW, IBC, and SIGGRAPH are others – you can count them on one hand.

The biggest hope is that the industry, or the fragments of what will one day be an industry, can get their collective acts together and make S3D work the way we know it can and should before the consumer comes back to life and starts buying stuff. If this had been early 2008 and the consumer was out there buying S3D stuff he or she would have either taken it back, or pushed it aside and written it off. Hopefully the big muckymucks that make the big decisions about these things will realize that it starts with the directors, not the equipment. If the directors – game and movie (you TV guys can just stand back and watch for a while) can understand, i.e., invest some time learning and studying how S3D can help and not take short cuts or cheap effects cuts, we may be able to have a new medium that people will be drawn to, rather than have to be pushed only to come running away screaming.

You'll know when… You'll know when S3D is a success – when you don't talk about it. When was the last time you went to a movie and came out saying, WOW – did you see the color in that movie? Or Gee, did you hear that stereophonic sound – holy cow!

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This article was first published in Jon Peddie's Tech Watch newsletter on June 8, 2009. http://www.jonpeddie.com

JPR Jon Peddie Research — Jon Peddie's TECH WATCH

You have to find the cracks before you can fill them

Gaming commentary from the Dimension 3 Forum

by Neil Schneider

Neil Schneider is the president & CEO of Meant to be Seen. He runs the first and only stereoscopic 3D certification and advocacy group. MTBS is non-proprietary and they test and certify video games for S-3D compatibility. They also continually take innovative steps to move the S-3D industry forward through education, community development, and member driven advocacy. In addition to game certifications, they have recently added a game review service that measures the enjoyment and quality of games from a stereoscopic 3D perspective using modern hardware solutions. The following article was originally posted on June 7 on the MTBS website. http://www.mtbs3D.com

We are on the last leg of our trip to France, and are just digesting the experiences we had at this year's Dimension-3 Expo. For this editorial, I'd like to place a focus on S-3D gaming, and an interesting conversation that took place after our presentation.

MTBS has been positioned as an advocacy group. Our whole reason for being is to make S-3D successful in the home through the power and enthusiasm of customers and end users. However, just because we are an advocacy group, and just because we want to see industry-wide success, it does not mean we have to be 100% positive about every S-3D experience and every S-3D hardware/software solution.

Let me explain why I am saying this. I jointly presented with Dr. Jon Peddie at Dimension-3 Expo. His presentation gave a great summary of the S-3D gaming industry, and using screen captures of games and some sample anomalies provided by one of our valued members, Yuriy Nichsych (AKA YuriyTheBest), he explained the leading problems faced by games that are poorly optimized for stereoscopic 3D gaming. I then followed this presentation with an explanation of how MTBS is working to get game developers onboard to take more care in their programming, and how we are working to benefit game developers for doing this.

As a sucker punch, the last audience question was not a question, but a put-down. A remark about how "depressing" our presentation was, and how showing the poor anomalies in gaming is going to hold back S-3D in the home.

Having read my share of S-3D industry blogs and seen more than my share of industry panels and discussions, I can see why he reacted the way he did. In all the conference's I've been to, most presentations quickly get kissy, kissy and lovey-dovey. For Jon and me to go on stage and spend oodles of time talking about the challenges must have gone against the grain.

There are challenges with modern gaming. As an advocacy group, it's our responsibility to discuss and try to find ways to solve them. I see nothing to be upset with here.

We spoke further outside, and he explained that S-3D cinema is insistent on a perfect 3D experience because ultimately, a negative experience turns customers away. I agree with this, and gaming should be no different. The issue we were trying to address in our presentation is how can we get game developers to work with the driver developers so the best customer experience will occur 100% of the time? What is going to get this quality control ecosystem to form?

Cinema is easy because we have a demonstrated business case where customers are willing to pay a premium for the S-3D experience. Gaming, at least at this stage, is a bit more challenging because game developers can't charge a premium for the S-3D benefit just yet. So what's in it for them?

For MTBS, the answer to the paradox is customers. Customer set expectations, customer driven quality control, customer influence, and the ultimate benefit of reliably reaching and selling to customers. Premium or not, when thousands of customers speak, people listen. Game developers are no different.

I would see cause for depression if the gaming industry didn't have a plan of action; if we just cried on each others' shoulders begging for standards or some demigod to take care of our problems for us. This isn't the case here.

We have modern S-3D gaming systems being sold today, we have leading game developers implementing native S-3D support today, we have members and customers advocating the technology today, and there is clearly a momentum building in the consumer markets around gaming. While we are eons ahead of S-3D cinema in the home, we must also recognize that we are still just getting started.

MTBS exists to do work and solve problems, and as uncomfortable as it may seem, you have to be prepared to find the cracks before you can fill them.

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Stereoscopic Displays & Applications Conference

January 19-21, 2009, San Jose, California

Phillip Hill covers papers published by SPIE from Walt Disney Animation Studios, Dynamic Digital Depth Research, Durham University (x2), Studio 3D/3D Illustrated, Eindhoven University of Technology/Philips Research Laboratories, Fraunhofer Institute for Information and Data Processing (IITB), University of Southampton/Durham University, Curtin University of Technology, Bilkent University, Pavonine Korea, and University of California at Berkeley/Durham University

Stereoscopic Displays and Applications XX

"Bolt 3D": A Case Study

Robert Neuman, **Walt Disney Animation Studios**, Burbank, California

This paper presented an overview of the creative process and the technical challenges involved in the creation of the digital 3D presentation of the film "Bolt" by Walt Disney Animation Studios, which the studio says represents another milestone for the studio in its integration of stereoscopic 3D into their creative process and production pipeline.

Disney led the charge into digital 3D exhibition in 2005 with its release of "Chicken Little" in Disney Digital 3D. "Chicken Little" was done as a post conversion of the monoscopic film through an outside vendor. Disney supplied the CG scene geometry and monoscopic cameras as well as the rendered image levels that were used to create the final composited images. The vendor then created the alternate eye cameras with which they shot the reprojected image data, performing any required "in-painting" to fill gaps in the image data that were exposed by the parallax. Little attempt was made to make creative use of the stereoscopic depth. The primary goal in this process was to provide a comfortable viewing experience for the audience, and toward this end, the dynamic range of the parallax was clamped at very conservative limits.

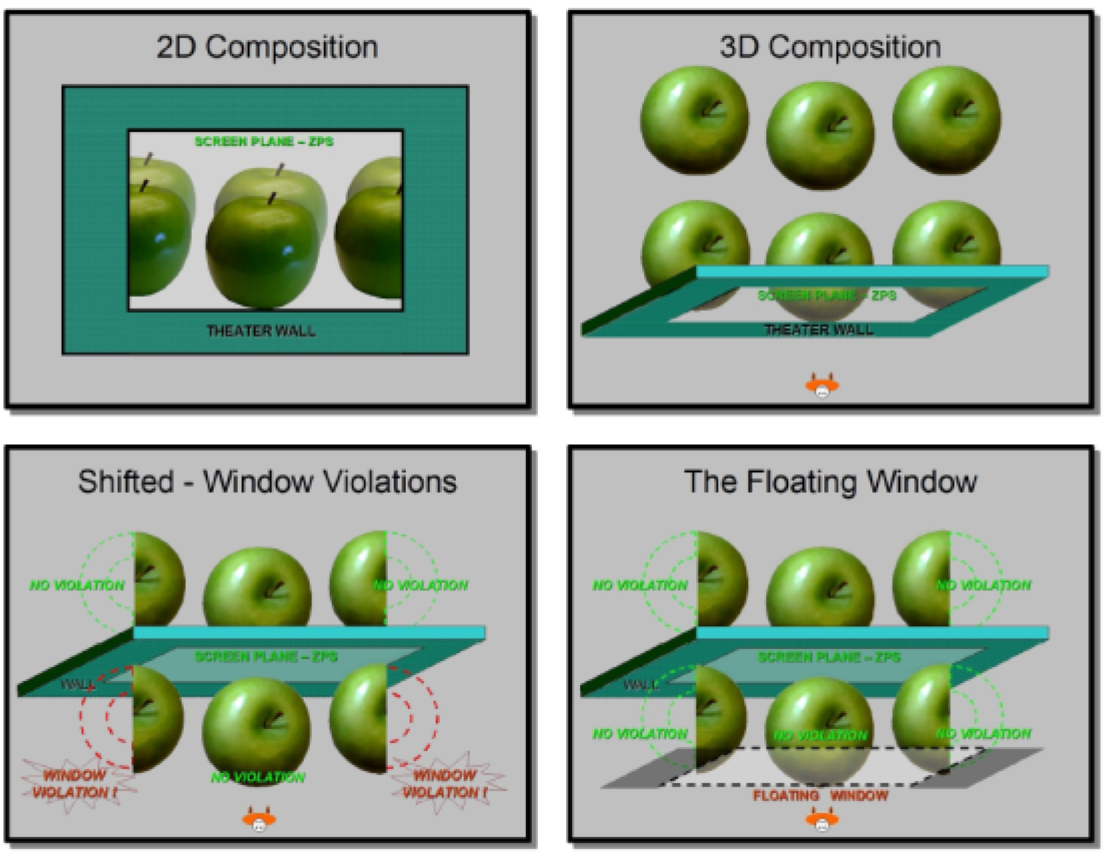
Disney's next animated feature, "Meet the Robinsons", released in March 2007, pushed the integration of stereoscopic 3D deeper into the studio's creative process. Although Robinsons also originated as a 2D film, and was converted to 3D by an outside vendor, the studio kept the creation of the alternate eye cameras, the stereoscopic layout process, in-house in order to maintain creative control of the 3D depth. Rather than use fixed interaxial settings, or default parallax limits, the depth was varied dynamically to mirror the emotional content of the film from shot to shot.

Bolt, released November 21, 2008, was from its inception, produced for both 2D and 3D theatrical exhibition. The philosophy on Bolt was to optimize the 3D experience for both its immersive effect and the comfort of the viewer, while using depth as a storytelling tool. Although the stereoscopic cinema is not new, its history has been characterized by a series of false starts, arguably because it had failed to fully clear the technological hurdles that would make it a viable medium. Embarking on Bolt, Disney decided to take the leap of faith that the advent of digital 3D had signaled the beginning of the second phase of stereoscopic film technology.

The method used borrows depth from the negative parallax region, where comfortable depth is more plentiful, by shifting the entire scene forward stereoscopically. There are two undesired consequences of "borrowing" negative parallax. But in shifting the scene forward they created an unwanted stereoscopic artifact, the "window violation".

A window violation, also known as the "paradoxical stereo window effect", refers to the conflict of depth cues that occurs when an element that in terms of stereopsis lies in front of the screen, nevertheless is being occluded by the vertical surround of the frameline, which lies behind it at screen depth. Window violations tend to detract from the 3D viewing experience, creating a perceived instability in the image due to the retinal rivalry caused by unequal portions of the object that caused the violation being visible in each eye. An overall flattening in the perception of the image also results, as the viewer mentally pins the cause of the violation back in an attempt to reconcile the conflicting cues. In utilizing more negative parallax, these violations will be encountered more frequently. Fortunately, Disney has a simple technique at its disposal that can solve both of these problems at once, the "floating window".

This technique solves the paradox by creating a black masking at the framelines of both left and right eye images with a disparity that give the masking a stereopsis that places the frameline in front of the element being occluded, thus resolving the conflict in depth cues. Rather than limiting the floating window to an orientation that is parallel to the screen, its depth is being controlled independently at all four corners. The floating window is no longer confined to being in front of the screen. By applying positive parallax to the masking, this technique is being used to push the perceived location of the screen backwards. The floating window also provides a method for us to regain control of the relationship of subject to frameline, independent of how the shot has been mapped to the positive/negative parallax continuum. The fact that they are manipulating the perception of the screen location tends to remain largely invisible to the audience, possibly because one of the ground truths that their minds build upon in reconstructing a scene from the binocular data being presented is the physical screen location, and other depths are gauged relative to this position. This allows them to borrow that extra depth in front of the screen and successfully shift it behind the screen where it is in short supply.



Top left: a 2D composition. Top right: the same composition viewed in 3D. Bottom left: the composition shifted forward in depth, resulting in window violations. Bottom right: the window violations repaired with a floating window.

Optimizing 3D Image Quality and Performance for Stereoscopic Gaming

Julien Flack, Hugh Sanderson, Steven Pegg, Simon Kwok, and *Daniel Paterson*
Dynamic Digital Depth Research, Bentley, Australia

The successful introduction of stereoscopic TV systems, such as Samsung's 3D Ready Plasma, requires high quality 3D content to be commercially available to the consumer. Console and PC games provide the most readily accessible source of high quality 3D content. This paper describes innovative developments in a generic, PC-based game driver architecture that addresses the two key issues affecting 3D gaming: quality and speed. At the heart of the quality issue are the same considerations that studios face producing stereoscopic renders from CG movies: how best to perform the mapping from a geometric CG environment into the stereoscopic display volume. The major difference being that for game drivers this mapping cannot be choreographed by hand but must be automatically calculated in real-time without significant impact on performance. Performance is a critical issue when dealing with gaming. Stereoscopic gaming has traditionally meant rendering the scene twice with the associated performance overhead. An alternative approach is to render the scene from one virtual camera position and use information from the z-buffer to generate a stereo pair using Depth-Image-Based Rendering (DIBR). The paper analyzes this trade-off in detail and provides some results relating to both 3D image quality and render performance.

The illustrations show a comparison taken from Google Earth between a depth-based render (a) and a standard stereo render (b). This is an extreme example selected to highlight a worst case scenario. In this instance we are viewing a section of the Swiss Alps with a highly elevated section (the Matterhorn) in the bottom right hand corner of the image occluding the detailed texture of the valley below in the upper left hand side of the image. The sharp depth discontinuity gives rise to a large occluded region in the depth based render. In (a) the occluded area was interpolated leading to a noticeable loss in texture detail. The stereo render faithfully represents the texture in the same region at the cost of additional overhead required to re-render the scene from a second virtual camera position. In the stereoscopic driver architecture it is possible to switch between a traditional stereo render and a depth based render at run time. Essentially, the user is presented with a quality-performance trade-off which can be optimized depending on the users' system and the characteristics of a specific game. Frame rate is the most important characteristic for gaming and it is likely that most gamers would prioritize high frame rates over 3D image quality, particularly in fast moving games where subtle differences in occluded areas are barely perceivable at high frame rates.

a) b)

Comparison of depth based render (a) and stereo render (b). In both cases highlighted regions show differences in occluded areas.

DDD has incorporated these technologies into a next generation stereoscopic game driver, TriDef Ignition, which features a number of unique and innovative features:

- Auto focus technology to improve the mapping of data into the disparity range.
- Dual stereo and depth render engines providing flexible performance optimization.

- Support for ATI and NVIDIA GPUs on Windows XP and Vista (32-bit) OS, without dependence on specific display driver versions.
- Generic DirectX9 driver: any DX9 game can be enabled with game specific profiles used to configure the renderer.
- Focus on ease of use to enable 3D to reach the mainstream PC gaming market.

Evaluating Methods for Controlling Depth Perception in Stereoscopic Cinematography
Geng Sun, and *Nick Holliman*, **Durham University**, Durham, England

Existing stereoscopic imaging algorithms can create static stereoscopic images with perceived depth control function to ensure a compelling 3D viewing experience without visual discomfort. However, current algorithms do not normally support standard Cinematic Storytelling techniques. These techniques, such as object movement, camera motion, and zooming, can result in dynamic scene depth change within and between a series of frames (shots) in stereoscopic cinematography. In this study, the researchers empirically evaluate the following three types of stereoscopic imaging approaches that aim to address this problem:

(1) Real-eye configuration: set camera separation equal to the nominal human eye inter-pupillary distance. The perceived depth on the display is identical to the scene depth without any distortion.
(2) Mapping algorithm: map the scene depth to a predefined range on the display to avoid excessive perceived depth. A new method that dynamically adjusts the depth mapping from scene space to display space is presented in addition to an existing fixed depth mapping method.
(3) Depth of field simulation: apply depth of field (DOF) blur effect to stereoscopic images. Only objects that are inside the DOF are viewed in full sharpness. Objects that are far away from the focus plane are blurred.

They performed a human-based trial using the ITU-R BT.500-11 Recommendation to compare the depth quality of stereoscopic video sequences generated by the above-mentioned imaging methods. The results indicate that viewers' practical 3D viewing volumes are different for individual stereoscopic displays and viewers can cope with much larger perceived depth range in viewing stereoscopic cinematography in comparison to static stereoscopic images. The new dynamic depth mapping method does have an advantage over the fixed depth mapping method in controlling stereo depth perception. The DOF blur effect does not provide the expected improvement for perceived depth quality control in 3D cinematography. They anticipate the results will be of particular interest to 3D filmmaking and real time computer games.

Publishing Stereoscopic Images
Ron Labbe, **Studio 3D**, Maynard, Massachusetts; *David E. Klutho*, **3D Illustrated**, St. Louis, Missouri

Stereoscopic imagery, by the fact that each eye requires a different image, defies mass marketing. Many have tried various methods over the last 150 years, with varying degrees of success. The paper discusses the history of processes, and covers pros and cons of various methods. Stereoscopic imagery has been mass-distributed in photographic form as both contact print stereocards (1880s-1920s) and as View-Master positive transparency film reels (1940s-present), among others. These systems require separate viewing hardware. Similarly, almost all stereo image publications have required viewing devices to be included (except lenticular, holography and free-viewing). The paper covers the history of photographic stereo-cards, View-Master film reels, 2-color anaglyph prints, lenticular and holography prints, lensed books, mirror stereo books, free-view stereo, and full-color anaglyph.

1950's View-Master ad

Measuring Visual Discomfort Associated with 3D Displays
M. Lambooij, M. Fortuin, and *W. A. IJsselsteijn,*
Eindhoven University of Technology, Eindhoven, The Netherlands
I. Heynderickx , **Philips Research Laboratories**, Eindhoven, The Netherlands

Some people report visual discomfort when watching 3D displays. For both the objective measurement of visual fatigue and the subjective measurement of visual discomfort, we would like to arrive at general indicators that are easy to apply in perception experiments. Previous research yielded contradictory results concerning such indicators. The researchers hypothesize two potential causes for this: 1) not all clinical tests are equally appropriate to evaluate the effect of stereoscopic viewing on visual fatigue, and 2) there is a natural variation in susceptibility to visual fatigue amongst people with normal vision. To verify these hypotheses, they designed an experiment, consisting of two parts. Firstly, an optometric screening was used to differentiate participants in susceptibility to visual fatigue. Secondly, in a 2x2 within-subjects design (2D vs. 3D and two-view vs. nine-view display), a questionnaire and eight optometric tests (i.e. binocular acuity, fixation disparity with and without fusion lock, heterophoria, convergent and divergent fusion, vergence facility, and accommodation response) were administered before and immediately after a reading task. Results revealed that participants found to be more susceptible to visual fatigue during screening showed a clinically meaningful increase in fusion amplitude after having viewed 3D stimuli. Two questionnaire items (i.e., pain and irritation) were significantly affected by the participants' susceptibility, while two other items (i.e., double vision and sharpness) were scored differently between 2D and 3D for all participants. The results suggest that a combination of fusion range measurements and self-report is appropriate for evaluating visual fatigue related to 3D displays.

Evaluation of Stereoscopic 3D Displays for Image Analysis Tasks
E. Peinsipp-Byma, N. Rehfeld, and *R. Eck*
Fraunhofer Institute for Information and Data Processing (IITB), Karlsruhe, Germany

In many application domains the analysis of aerial or satellite images plays an important role. The use of stereoscopic display technologies can enhance the image analyst's ability to detect or to identify certain objects of interest, which results in a higher performance. Changing image acquisition from analog to digital techniques entailed the change of stereoscopic visualization techniques. Recently different kinds of digital stereoscopic display techniques with affordable prices have appeared on the market. At Fraunhofer IITB usability tests were carried out to find out (1) with which kind of these commercially available stereoscopic display techniques image analysts achieve the best performance, and (2) which of these techniques achieve a high acceptance. First, image analysts were interviewed to define typical image analysis tasks which were expected to be solved with a higher performance using stereoscopic display techniques. Next, observer experiments were carried out whereby image analysts had to solve defined tasks with different visualization techniques. Based on the experimental results (performance parameters and qualitative subjective evaluations of the used display techniques) two of the examined stereoscopic display technologies were found to be very good and appropriate. The stereoscopic techniques considered were anaglyph, polarization, shutter glasses and autostereo, plus a monoscopic reference display system. They recommend using polarization or shuttering technique if stereo image analysis has to be done for a longer time periods.

The multi-sensor lab of IITB with the experimental systems of polarization stereo, anaglyph stereo, and autostereo

Binocular Coordination in Response to Stereoscopic Stimuli

Simon P. Liversedge, and *Hazel I. Blythe*, **University of Southampton**, Southampton, England
Nicolas S. Holliman, **Durham University**, Durham, England

Humans actively explore their visual environment by moving their eyes. Precise coordination of the eyes during visual scanning underlies the experience of a unified perceptual representation and is important for the perception of depth. The paper reports data from three psychological experiments investigating human binocular coordination during visual processing of stereoscopic stimuli. In the first experiment participants were required to read sentences that contained a stereoscopically presented target word. Half of the word was presented exclusively to one eye and half exclusively to the other eye. Eye movements were recorded and showed that saccadic targeting was uninfluenced by the stereoscopic presentation, strongly suggesting that complementary retinal stimuli are perceived as a single, unified input prior to saccade initiation. In a second eye movement experiment they presented words stereoscopically to measure Panum's Fusional Area for linguistic stimuli. In the final experiment they compared binocular coordination during saccades between simple dot stimuli under 2D, stereoscopic 3D and real 3D viewing conditions.

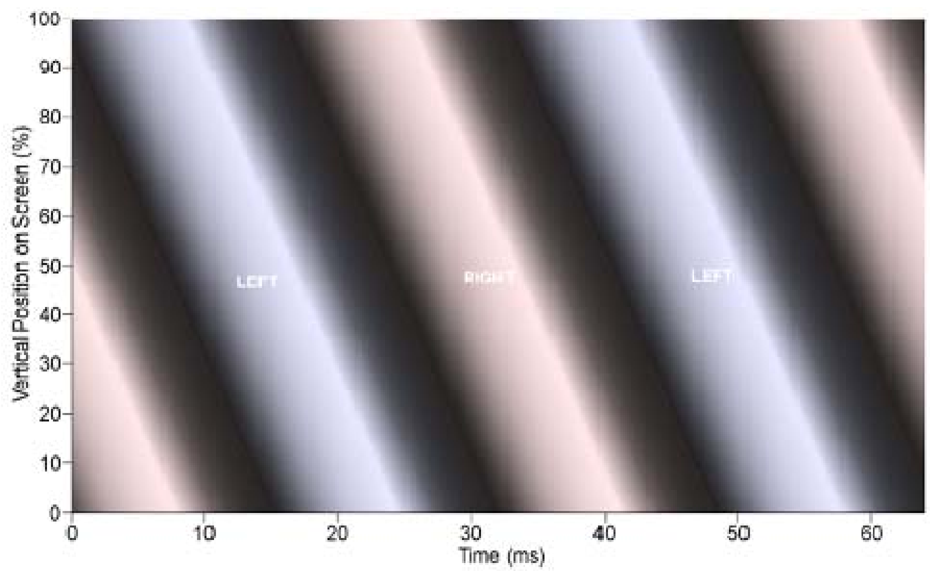
Results showed that depth appropriate vergence movements were made during saccades and fixations to real 3D stimuli, but only during fixations on stereoscopic 3D stimuli. 2D stimuli did not induce depth vergence movements. Together, these experiments indicate that stereoscopic visual stimuli are fused when they fall within Panum's Fusional Area, and that saccade metrics are computed on the basis of a unified percept. Also, there is sensitivity to non-foveal retinal disparity in real 3D stimuli, but not in stereoscopic 3D stimuli, and the system responsible for binocular coordination responds to this during saccades as well as fixations.

The Compatibility of LCD TVs with Time-sequential Stereoscopic 3D Visualization

Andrew J. Woods, and *Adin Sehic*, **Curtin University of Technology**, Perth, Australia

Previous research has shown that conventional LCD computer monitors are not well suited to time-sequential stereoscopic visualization due to the scanning image update method, the hold-type operation of LCDs, and in some cases slow pixel response rate. Recently some new technologies are being used in LCD TVs to improve 2D motion reproduction – such as black frame insertion and 100/120Hz capability.

This paper reports on the testing of a selection of recent LCD TVs to investigate their compatibility with the time-sequential stereoscopic display method – particularly investigating new display technologies. Aspects considered in this investigation include image update method, pixel response rate, maximum input frame rate, backlight operation, frame rate up-conversion technique, synchronization, etc. A more advanced Matlab program was also developed as part of this study to simulate and characterize 3D compatibility and calculate the crosstalk present on each display. The results of the project show that black frame insertion does improve 3D compatibility of LCDs but not to a sufficient level to produce good 3D



The spatial- and time-domain response of the example BFI LCD operating at 60Hz. The vertical axis shows the vertical position on the screen and the horizontal axis time. The LEFT and RIGHT labels and tinting represent a sequence of left and right perspective images shown sequentially.

results. Unfortunately 100/120Hz operation of the tested LCDs did not improve 3D compatibility compared to the LCD monitors tested previously.

Due to the scan-like image update method of LCDs a more useful way of representing the spatio-temporal output of the LCD is shown in the figure. With this particular figure it is easy to see the combination of the sequence of left and right perspective images, the introduction of the inserted black frames (BFI), and the scan-like image update method. It can be seen that the black BFI bands do a good job of separating sequential frames, however the presence of the scan-like image update method complicates matters for time-sequential 3D.

Unfortunately these investigations indicate that unless a commercially released LCD TV specifically designates 3D compatibility, it is highly unlikely to be capable of producing flicker-free low-ghost stereoscopic images using the time-sequential 3D method. Furthermore regular 120Hz LCD TVs (without a “Stereoscopic 3D Compatible” designation) are unlikely to provide improved time-sequential 3D compatibility compared to regular LCD monitors – despite the enticing similarity to the “120Hz 3D” title. The results of the project show that black frame insertion does provide some improvement of 3D compatibility of LCDs but not to a sufficient level to produce flicker-free ghost-free 3D results.

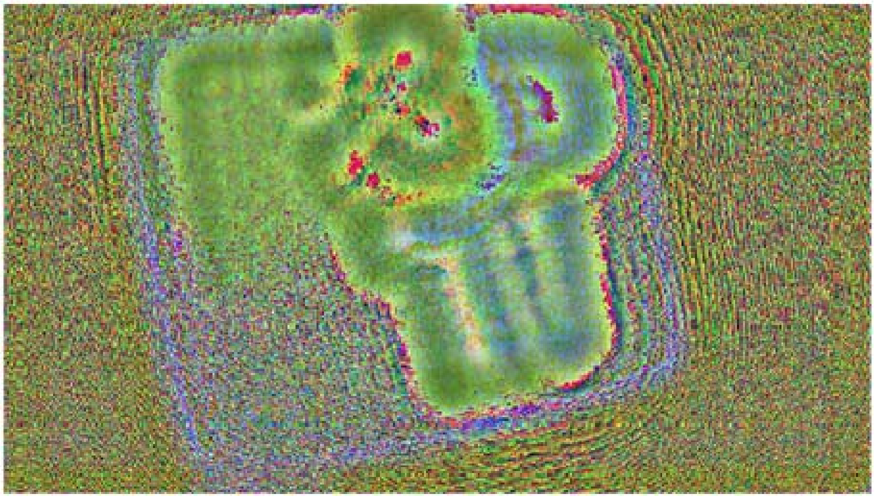
While this manuscript was being finalized, but after the research work was completed, Viewsonic and Samsung each released 22-inch LCD monitors, which are capable of being used for time-sequential 3D viewing in concert with the Nvidia GeForce 3D Vision LCS glasses. It is hoped that more LCDs will be released with stereoscopic 3D compatibility – which will be achieved by addressing the limitations discussed in this paper.

Color Holographic Reconstruction Using Multiple SLMs and LED Illumination

Fahri Yaras, and *Levent Onural*, **Bilkent University**, Ankara, Turkey

A color holographic reconstruction technique by using three light emitting diodes (LEDs) is described. Reflective type phase-only spatial light modulators (SLMs) are used since they are suitable for in-line phase holograms. A Gerchberg-Saxton iterative algorithm is used for computing phase holograms. Three phase holograms are calculated separately for red, green and blue colors, for a color reconstruction, and separately loaded to corresponding SLMs. Three LEDs are used for illuminating those phase holograms and reconstructions are combined and captured. Experimental results are satisfactory, the researchers say.

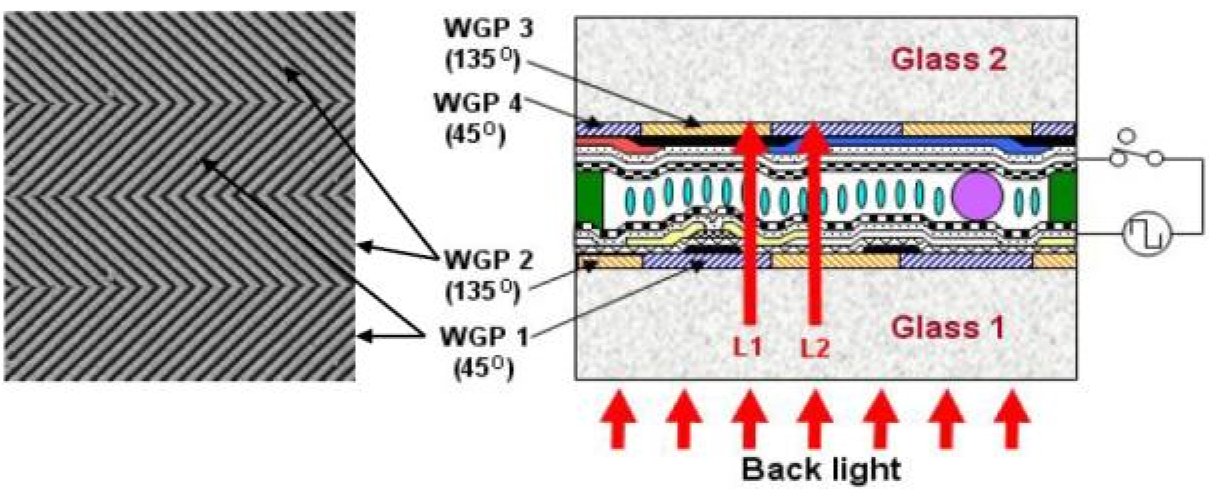
It is observed that the properties of LEDs are sufficient for holographic reconstructions from phase-only SLMs. The quality of color holographic reconstructions, using three phase-only SLMs where each SLM is illuminated by a different color (red, green and blue) LED, is satisfactory. Though computationally demanding, iterative algorithms like the Gerchberg-Saxton algorithm can be used to compute phase-only computer generated holograms. Optical alignment is crucial for color holographic reconstruction. In order to simplify this process, test objects like squares or several dots can be used. The presented system can be used as a color holographic video display.



Color phase hologram, containing red, green and blue channel information

Review of Wire Grid Polarizer and Retarder for Stereoscopic Display
Sung Jung Lee, Min Jung Kim, Kyo Hyeon Lee, and *Kwang Hoon Park*, **Pavonine Korea**, Incheon, South Korea

Pavonine developed two types of a new structured 2D/3D switchable stereoscopic LCD display by making some changes to the structure of the conventional TFT-LCD. This new display can show both 2D image and 3D image, and has no limitations on either viewing distance or viewing angle. Thus, it is possible for multiple persons to view a 3D image on this display simultaneously, and it is expected to be used as a 2D/3D switchable LCD panel in the next-generation flat panel LCD TVs. The principle of the proposed structure for the WGP containing rows of alternating polarization angles can be seen in the figure. When a voltage is applied, an incidence light (L1) entering the wire gird polarizer (WGP 1) with a polarization orientation of 45 degrees, transmits it through the liquid crystal layer before being blocked by the wire gird polarizer 3 (WGP 3), which has a polarization orientation of 135 degrees, whereas the incidence light (L2) transmits the wire gird polarizer two (WGP 2) and LC layer. After this, it is absorbed by the wire gird polarizer four (WGP 4), which has a polarization orientation of 45 degrees. Of course, when an electric field is turned off for the LC layer, the incidence beam L1 and L2 transmits WGP 3 and WGP 4, respectively. In the case of the proposed structure, WGP 1 and WGP 2 having rows of alternating polarization angle, are affixed to the inner surfaces of TFT panel substrate and color filter panel substrate. Therefore, the polarizers are disposed adjacent to the LC layer and the polarizers remove parallax problems remarkably, the researchers say.



A schematic view of the stereoscopic display using wire grid zigzag polarizer

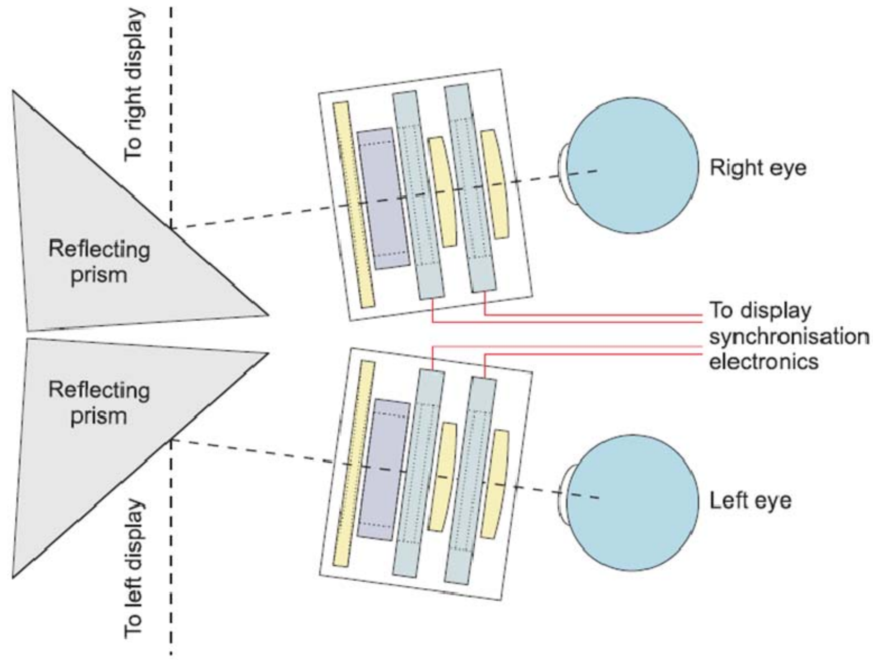
The proposed stereoscopic display will help to improve productivity and reduce the cost of stereoscopic display manufacturing. The advantages of this wire grid 3D display are:

1. One LCD panel serves both 2D and 3D display.
2. No limitations on 3D viewing angle and viewing distance.
3. Manufacturing possible without changing conventional LCD panel manufacturing processes.
4. Viewing 3D image in optimal resolution possible (in preparation for multi-view).
5. One LCD panel has both horizontal 3D screen and vertical 3D screen.
6. Expected to be highlighted as 2D/3D switchable LCD panel in the next-generation LCD TVs.

Stereo Display with Time-multiplexed Focal Adjustment
David M. Hoffman, and *Martin S. Banks*, **University of California at Berkeley**, Berkeley, California
Philip J.W. Hands, Andrew K. Kirby, and *Gordon D. Love*, **Durham University**, Durham, England

In stereo displays, binocular disparity creates a striking impression of depth. However, such displays present focus cues – blur and accommodation – that specify a different depth than disparity, thereby causing a conflict. This conflict causes several problems including misperception of the 3D layout, difficulty fusing binocular images, and visual fatigue. To address these problems, the team developed a display that preserves the advantages of conventional stereo displays, while presenting correct or nearly correct focus cues. In the new stereo display each eye views a display through a lens that switches between four focal distances at very high rate. The switches are synchronized to the display, so focal distance and the distance being simulated on the display are consistent or nearly consistent with one another. Focus cues for points in between the four focal planes are simulated by using a depth-weighted blending technique. They describe the design of the new display, discuss the retinal images it forms under various conditions, and describe an experiment that illustrates the effectiveness of the display in maximizing visual performance while minimizing visual fatigue.

The figure illustrates a system of two lenses and FLCs for each eye. FLC1 is modulated at twice the frequency of FLC2, which enables the sequential addressing of all four combinations of polarization to the two lenses. The result is a four-state switchable lens. In the display, there is one four-state lens for each eye, thereby producing a stereo display with correct or nearly correct focus cues.



Schematic of the switchable lens assembly. Between each eye and its respective display, there is a lens system consisting of (from left to right in the box) a static glass lens to adjust overall focal power, a linear polarizer, ferroelectric liquid crystal 1 to modulate the polarization angle of the light approaching the first birefringent lens, and ferroelectric liquid crystal 2 to modulate the polarization angle of the light approaching the second birefringent lens.

Using Mental Rotation to Evaluate the Benefits of Stereoscopic Displays
Y. Aitsiselmi, and *N.S. Holliman*, **Durham University**, Durham, England

The idea behind stereoscopic displays is to create the illusion of depth and this concept could have many practical applications. A common spatial ability test involves mental rotation. Therefore a mental rotation task should be easier if being undertaken on a stereoscopic screen. The aim of this project is to evaluate stereoscopic displays (3D screen) and to assess whether they are better for performing a certain task than over a 2D display. A secondary aim was to perform a similar study but replicating the conditions of using a stereoscopic mobile phone screen.

The researchers devised a spatial ability test involving a mental rotation task that participants were asked to complete on either a 3D or 2D screen. They also designed a similar task to simulate the experience on a stereoscopic cell phone. The participants' error rate and response times were recorded. Using statistical analysis, they then compared the error rate and response times of the groups to see if there were any significant differences.

They found that the participants got better scores if they were doing the task on a stereoscopic screen as opposed to a 2D screen. However there was no statistically significant difference in the time it took them to complete the task. They also found similar results for 3D cell phone display condition. The results show that the extra depth information given by a stereoscopic display makes it easier to mentally rotate a shape as depth cues are readily available. These results could have many useful implications to certain industries.

Call for Papers

Stereoscopic Displays and Applications XXI (EI101)

Part of the IS&T/SPIE International Symposium on Electronic Imaging
17-21 January 2010 • San Jose Convention Center • San Jose, California United States

Conference Chairs: **Andrew J. Woods**, Curtin Univ. of Technology (Australia); **Nicolas S. Holliman**, Durham Univ. (United Kingdom); **Neil A. Dodgson**, Univ. of Cambridge (United Kingdom)

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This conference focuses on recent advances in stereoscopic systems, including 3D display hardware, computer software, algorithms, image acquisition, and applications illustrating the use of stereoscopic 3D displays. We also consider human factors and other issues that guide the development and use of 3D displays. In both real-world and computer-generated imaging applications, stereoscopic 3D display technologies can improve task performance, enhance the user's ability to perceive objects in their correct spatial locations, and to identify objects efficiently and accurately. The conference brings together practitioners and researchers from industry and academia to facilitate an exchange of current information on stereoscopic imaging topics. Hardware demonstrations of 3D technologies and applications are strongly encouraged at the conference demonstration session. Large-screen stereoscopic projection (both still and video) will be available, and presenters are encouraged to make full use of these facilities during their presentations. A peer-review process is available for academic authors. Papers are solicited for, but not limited to, the following topics:

Applications of stereoscopic displays
- especially novel applications and user trials of existing applications. Application areas include scientific visualization, medical imaging, games, television, entertainment, communications, training, CAD/CAM, molecular modeling, teleoperation, telepresence, industrial inspection, and advertising.

Advances in true 3D display technologies
- including autostereoscopic displays, super and high-density multi-view displays, volumetric displays, mobile 3D displays, stereoscopic projection, & electro-holography.

Stereoscopic Systems design
- for teleoperation, telerobotics, telesurgery, virtual reality, augmented reality, mobile devices, game systems, consumer and professional broadcast, content delivery and interaction technologies.

Stereoscopic 3D digital cinema
- including production, presentation, and case studies.

Stereoscopic imaging
- stereoscopic and multi-view computer graphics, including gaming
- image processing and compression of stereoscopic imagery
- stereoscopic image synthesis: 2D to 3D conversion, depth map generation, multi-viewpoint generation
- software and hardware issues for computer display of stereoscopic images
- methods for recording, playback, transmission, and processing of stereoscopic video.

3D image acquisition and generation techniques
- single- and multi-lens camera systems
- motion parallax, volume projection, graphical construction, stereoscopic computer graphics, computational photography, and other stereoscopic image generation techniques
- guidelines for stereoscopic content development.

Human factors & user-interface issues
- task performance comparisons between stereoscopic and non-stereoscopic displays
- evaluation methodologies (e.g., depth-acuity measurement) and task-performance testing
- benefits for processing and compression of stereoscopic images
- perceptual and cognitive guidelines
- 3D remote manipulation and control of viewpoint
- ortho-stereo, hyper-stereo, and the geometry of 3D perceptual space.

Standards for stereoscopic imaging
- including hardware interfaces, software and transmission formats, and content production parameters.

Visit the SD&A conference website for more information:
http://www.stereoscopic.org

Abstract Due Date: 22 June 2009
Manuscript Due Date: 21 December 2009

SID 3D Technology Update for Display Professionals

January 16, 2009, Costa Mesa, California

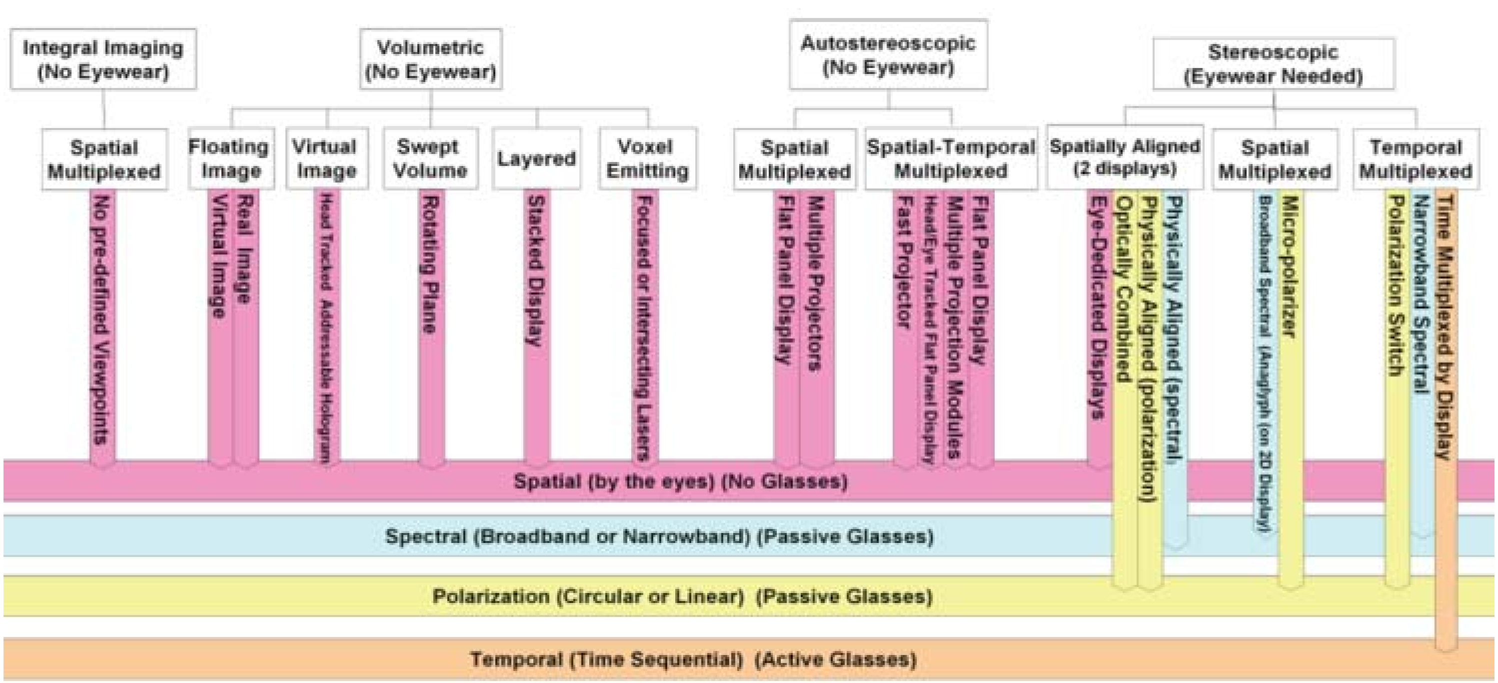
Phillip Hill covers presentations at the SID LA Chapter one-day symposium from Insight Media, UC Berkeley, TDVision Systems, and Agostinelli Inc./RCS

3D Information Display Review

Chris Chinnock, **Insight Media**, Norwalk, Connecticut

In a presentation subtitled "3D Display Primer Covering 3D Display Technology, Delivery Formats, Industry Trends and Forecasts", Chris Chinnock gave a comprehensive overview of 3D technologies; a brief review of near-term home-oriented 3D options; prospects for 3DTV technologies; an introduction to 3D formats; high level trends; and a 3DTV forecast.

In his comprehensive overview of 3D technologies, Chinnock covered stereoscopic (spatially aligned, optically aligned, physically aligned, HMDs, spatial multiplexed, micro-retarders, temporal multiplexing, and polarization switching); and autostereoscopic (spatial multiplexing, parallel barrier, and lenticular lens arrays).In the section on 3D displays for home prospects, Chinnock said that on the spatial multiplexed LCD front, the advantages were that it was on the market from a growing number of sources. The disadvantages are that 3D resolution is reduced to half that of the underlying LCD, and the micro-polarizer approach requires two elements per pixel. The prospects are that the current price premium is high but that the potential to cost reduce is good. The micro-retarder approach shows the most favorable price/performance tradeoffs.



Display options by technology

Two major trends are vying to follow onto the HDTV revolution: 3DTV, and higher resolution (4K). 3D will not significantly expand the TV market – it will cannibalize 2D TVs. 2009 will be the watershed year for 3D in cinemas – there are enough 3D screens to justify releasing movies in 3D only, and there is the start of alternative content in theaters (sports, concerts, etc.). 2010 will be the watershed year for 3DTV with more content, more TVs, and a viable 3D delivery mechanism. Many standards related activities are underway, there is a new push for 3D gaming, and 3D imaging and cell phones are coming.

Hollywood needs a path to bring 3D to the home. A breakthrough in formats for entertainment is expected soon, and gaming will be a big driver too. The HDTV revolution is maturing –3D is likely to be the next big trend for TV makers. A significant installed base is appearing, breaking the chicken and egg conundrum. DLP RPTV will create a good installed base, but sales are challenging. PDP will be the big near term winner. LCD is the most important and the most uncertain, but a breakthrough is likely. What is missing is a steady stream of content, and distribution standards or leadership, Chinnock concluded.

Stereo Displays: Visual Perception, Performance, and Fatigue
Martin S. Banks, **University of California**, Berkeley, California

The problems with using stereo displays relate to technical issues (developing content; sufficient resolution over time – temporal aliasing; sufficient separation between two eyes' images – "ghosting"), and user issues (vergence-accommodation conflict – fusion failures, fatigue; and perceptual distortions due to incorrect viewing position).

Banks looked at how humans perceive pictures. We almost never view pictures from the correct position. The retinal image thus specifies a different scene than depicted. Do people compensate, and if so, how? Looking at compensation for incorrect viewing position, Banks said that pictures not useful unless percepts are robust to changes in viewing position. People compensate for oblique viewing position when viewing 2D pictures. There are two theories of compensation: pictorial and surface. Data clearly favor surface compensation. There are two versions of the surface method: global and local. Data clearly favor the local slant.

When looking at 2D pictures vs. stereo pictures, in 2D two eyes are presented the same image. Binocular disparities specify orientation and distance of the picture surface; hence it is useful for compensation. With stereo pictures, two eyes are presented different images. Binocular disparities specify orientation and distance of the picture surface and layout of picture contents, hence is not useful for compensation. For most applications, viewers will not be at correct position. Retinal disparities thus specify a different layout than depicted. Do people compensate? Is correct seating position for a 3D movie more important than for a 2D movie? Banks proposed a solution based on ticketing pricing as to where to sit with stereo cinema (*see photo*).

Banks went on to describe the work at UC Berkeley on minimizing vergence-accommodation conflicts in stereo displays. Two volumetric displays have been constructed: a fixed-viewpoint, volumetric display with mirror system and three focal planes (Akeley, Watt, Girshick, & Banks, 2004); and a fixed-viewpoint, volumetric display with switchable lens and four focal planes (Love, Kirby, Hoffman, & Banks, 2009). When vergence and focal distances are the same, shapes are perceived more accurately. When they differ, shape perception is distorted. When vergence and focal distances are the same, the time required to fuse binocular stimuli is reduced. When they differ, time to fusion can be greatly lengthened. When vergence and focal distances change together, visual fatigue and discomfort are minimized. Fatigue and discomfort are caused in part by vergence-accommodation conflict.

TDVisor-HD and Mobile 3D
Ethan Schur, **TDVision Systems Inc**., Naperville, Illinois

Schur first dealt with the ATSC-M/H Mobile Standard. On December 1, 2008, the Advanced Television Systems Committee elevated its specification for mobile digital television to candidate standard status. During the following six months, the industry tested the standard with their potential customers and started first product developments leading to additional improvements. A ratified A/153 standard will be balloted for by the ATSC members in July 2009.

He then went on to discuss the TDVisor-HD (*see photo*), which has a 1280x720p per eye resolution, a tri-color filter LCoS, 42.8 FOV diagonal, LED lit, and all digital.

The Art and Science of Autostereoscopic Display
Greg Agostinelli, **Agostinelli Inc./RCS**, Hollywood, California

Autostereoscopic systems are the most public friendly display, Agostinelli said. They are glassless involving no preparation, available to the naked eye, with 2D mode as well. Brands include Alioscopy, Apple, Dimension Technologies, Fraunhofer HHI, Holografika, i-Art, NewSight, Philips, SeeFront, SeeReal Technologies, Spatial View, Tridelity, Sharp, Epson, Bolod, StereoGraphics, 3D Experience Ltd, Opticality, Miracube, ACT Kern, Dresden 3D GmbH, LightSpace Technologies, Sense Graphics, 4D-Vision, and Dimensional Media Associates. The technologies involved are refraction and occlusion, reflection, diffraction, volumetric, and electro-holography. He went on to discuss these technologies in detail.

The market place for autostereo includes ad agencies (current users are Saatchi & Saatchi, TBWA/Chiat/Day, Goodby Silverstein, and Carat); retail (Adidas, and GAP); theater lobbies (glassless 3D trailers and concession stand advertising; Vegas-style gaming, and home gaming; sports and live events (3D live is emerging as a viable business); and promotion at trade shows, for example.

Agostinelli concluded by saying that public 3D is undefined and in development, “a third venue where content comes to the viewer ready or not”, and he used this photograph to illustrate what he meant.

3D Biz-Ex Conference

September 30 – October 1, 2008, Los Angeles, California

Phillip Hill covers presentations from HDMI, SMPTE, and 3D@Home Consortium

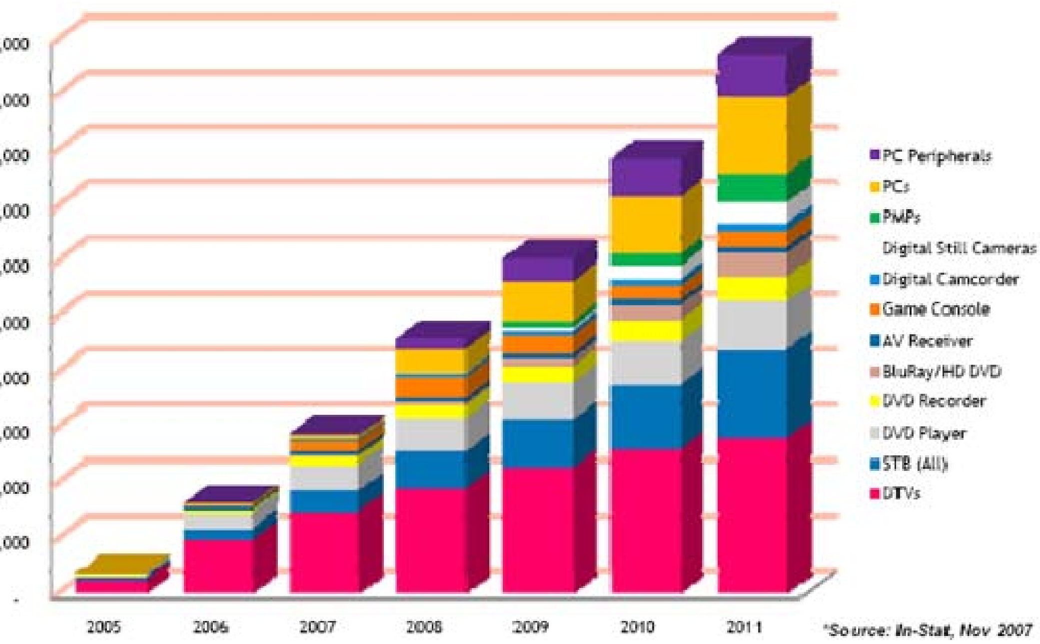
Incorporating 3D in HDMI Capability

Steve Venuti, **HDMI**, Sunnyvale, California

HDMI was founded by leading consumer electronics and PC companies at CES 2003: Sony, Panasonic, Philips, Hitachi, Silicon Image, Thomson, and Toshiba. In five years, HDMI has become the standard for digital connectivity in the home theater. Over 800 manufacturers will ship 300 million in 2009. There will be over one billion devices by 2010, and 100% of DTVs will have at least one HDMI port.

3D in the home today has limited bandwidth. The use of special techniques (i.e. checkerboard, weaving, half-resolution etc.) was required to fit 3D content into existing connectivity solutions (pre-1.3 HDMI and DVI). There is less than full HD resolution experience when viewing 3D content, and there is reduced sharpness and/or frame rate depending on the technique used.

HDMI gives unprecedented bandwidth in the home for high-definition 3D content. HDMI 1.3 Interconnect is a single-link (Type-A) HDMI that supports up to 10.2Gbps – enough for two 1080p/60Hz or 1080p/30fps video per eye. A dual-link (Type-B) HDMI supports up to 20.4Gbps – enough for two 1080p/120Hz or 1080p/60fps video per eye. A 3D IMAX type experience in the home is now possible, Venuti said. Auto lip-sync (audio/video sync) compensates for video processing delays.

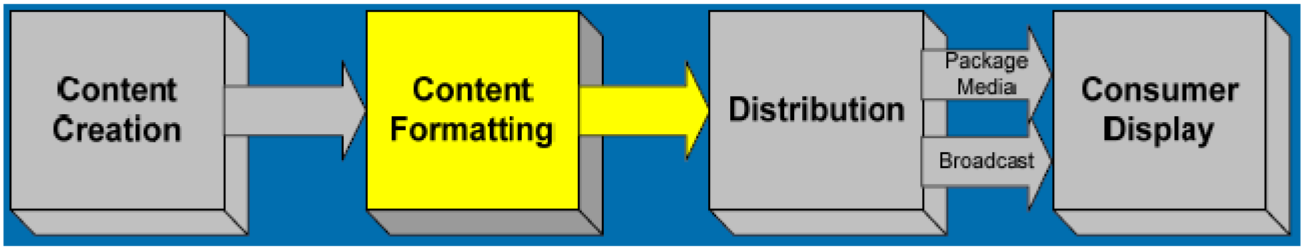


HDMI device growth 2005-2011

SMPTE Task Force on 3D to the Home

Wendy Aylsworth, **SMPTE**, White Plains, New York

SMPTE has set up a 3D Task Force (TF) with its mission to look at what standards are needed for rapid adoption of stereoscopic content, from mastering to consumption in the home on a fixed home display via multiple types of distribution channels (e.g. packaged, broadcast, satellite, cable, Internet). It will liaise with other bodies to ensure needed standards are written, but will not write standards itself. SMPTE scope is on content format standardization, but the 3D TF scope will cover format requirements with consideration of content creation, distribution and display (*see graphic*).



3D end-to-end value chain

The 3D TF will produce a report that: defines the issues and challenges; defines minimum requirements needed to overcome the issues and challenges; defines evaluation criteria based upon the requirements and parameters; and defines the minimum set of standards that would need to be written to provide sufficient interoperability. After the 3DTF, work will be assigned to a SMPTE technology committee to write standards.

An Overview of the 3D@Home Consortium
Mark Hartney, **3D@Home Consortium**, c/o USDC/Flextech, San Jose, California

The consortium's mission statement is to speed the commercialization of 3D into homes worldwide and provide the best possible viewing experience by facilitating the development of standards, roadmaps and education for the entire 3D industry – from content, hardware and software providers to consumers. Hartney emphasized that the 3D@Home Consortium will not be a standards body. Through the steering teams, information and knowledge will be developed that can help build consensus, and possibly recommendations for standards. These will be taken to the relevant standards bodies.

As of September, there are 37 participating companies, five at board level (Intel, Philips, Samsung, Sony, and Sigma); and five at the leadership level (Disney, Mitsubishi, Thomson, Turner Broadcast System, and XPAND). The consortium is run by Insight Media and USDC.

Steering teams (STs) have been set up. ST1 covers 3D content creation/production. High priorities are 3D quality vs. quantity, and mastering 3D content for the home (how is it different from cinema?). Low priorities are 3D creation training and education program development, and 3D workflow training and education program development.

ST2 covers 3D content storage/transmission/distribution. Its high priorities are file formats, compression, transmission (discussions with chip makers, file format and compression companies, broadcasters, Blu-ray/DVD makers, etc.); and monitor and liaison with standards bodies and other consortia, requesting actions as determined, including: DCI, MPEG, SMPTE, IEEE, 3D Consortium (Japan), 3D4YOU (Europe), 3DID (Taiwan) and others.

ST3 covers 3D promotion with a high priority on common naming conventions and vocabulary – industry level; medium priority on developing content for websites and attracting new members from important constituencies. A future priority will be end–user and retailer/reseller education and in-store demos.

ST4 covers 3D displays with a high priority on 3D display quality metrics (ghosting, dimensionalization, brightness, etc.); and medium priority on 3D human factors (eye fatigue, viewing time, etc.).

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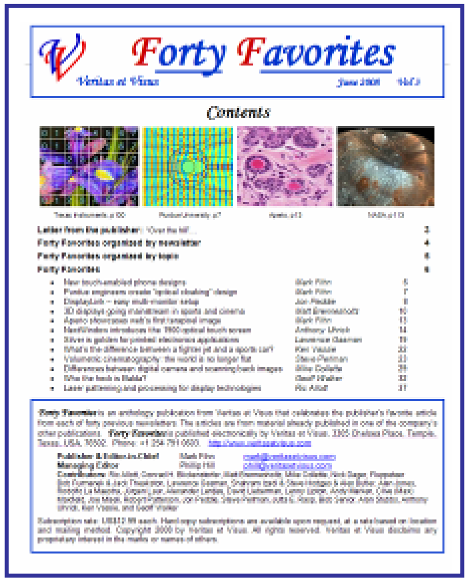
Favorite news stories, commentaries, tutorials and insights from the Veritas et Visus catalog of newsletters. Fascinating insights into the world of display technologies…



Twenty Interviews

Compilations of interviews conducted in various Veritas et Visus newsletters… These documents bring out some of the successes and challenges being faced by the people in technology and marketing as they develop new products and new visual solutions.

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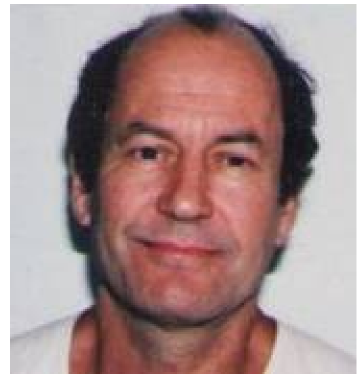
Stereo Camera Geometry

by Michael Starks



After graduate work in cell physiology at UC Berkeley, Michael Starks began studying stereoscopy in 1973, and co-founded StereoGraphics Corp (now Real D) in 1979. He was involved in all aspects of R&D including prototype 3D videogames for the Atari and Amiga and the first versions of what evolved into CrystalEyes LCD shutter glasses, the standard for professional stereo, and is co-patentee on their first 3DTV system. In 1985 he was responsible for starting a project at UME Corp, which eventually resulted in the Mattel PowerGlove, the first consumer VR system. In 1989 he started 3DTV Corp. In 1990 he began work on "Solidizing" – a real-time process for converting 2D video into 3D. In 1992 3DTV he created the first full color stereoscopic CDROM ("3D Magic") including games for the PC with shutter glasses. In 2007 companies to whom 3DTV supplied technology and consulting produced theatrical 3D shutter glasses viewing systems, which are being introduced worldwide in 2008. Starks has been a member of SMPTE, SID, SPIE and IEEE and has published in Proc. SPIE, *Stereoscopy*, *American Cinematographer* and *Archives of Biochemistry and Biophysics*. The SPIE symposia on 3D Imaging seem to have originated due to his suggestion to John Merritt at a San Diego SPIE meeting some 20 years ago. Michael more or less retired in 1998 and lives in China where he raises goldfish and is researching a book on the philosophy of Wittgenstein. http://www.3dtv.jp

Anyone shooting 3D is immediately confronted with the problem of stereo camera geometry – how to align the cameras for best results. This looks like it should be the easiest part of the entire project but in fact it's by far the hardest. Just aligning the cams perfectly in all 3 axes and locking them down is tough and keeping them aligned when changing interaxial, convergence, or zoom is extremely hard. There is very little in the way of comprehensive reviews of this subject in the literature. The best list of patent and tech references I know of are still the ones I published in my SPIE papers 15 years ago and put on my page as part of a Stereoscopic Imaging Technology article. These articles, detailing hundreds of patents and papers on single and dual camera stereo, and many other areas of 3D imaging, as well as hundreds of articles by others, are on the two SPIE CDROMS containing all the papers from the Stereoscopic Displays and Applications conferences up to 2001. These CDs are mandatory for any true enthusiast.

Some people are surprised to learn that these problems are not new, nor are they unique to 3D video and photography. In addition to attention from stereographers for over 150 years, they have been the subject of intensive research in the fields of photogrammetry going back well over 100 years, and more recently in computer vision. Every book in these arenas has extensive discussions on multiple camera geometry and essentially the entire texts revolve around the problems of camera registration and image rectification for human viewing and/or computer image understanding. Algorithmic transforms for producing rectified images from single moving cameras, poly-dioptic (plenoptic or multiple image single lens cameras) or multiple cameras take up large sections of these books and thousands of papers, which blend into the literatures of robotics, machine vision, artificial intelligence, virtual reality, telepresence and every aspect of 3D imaging. I will cite only the continuing work from Kanade at Carnegie Mellon http://www.ri.cmu.edu/person.html?person_id=136&type=publications as I mention it elsewhere here and it is a good place to start research in this area.

One of the most pernicious problems in 3D film and television results from the use of converged rather than parallel lens axis cameras. There is absolutely no question that this causes vertical parallax and spurious horizontal parallax (even when a virtual camera is rotated for CGI stereo) and contributes significantly to eyestrain. This is basic knowledge in stereo photography, photogrammetry, and machine vision and has also been mathematically demonstrated for the stereoscopic community many times, e.g., in great detail by Diner and Fender in "Human Engineering in Stereoscopic Viewing Devices" (1993), and by Grinberg, Siegel et al in three SPIE papers a few years ago (available at http://www.ri.cmu.edu/person.html?type=publications&person_id=285). One only has to set up a pair of cameras and view the image with parallel axes vs. converged to see the problem. The closer the converged object gets to the cameras, the more eyestrain and a little closer and fusion is impossible. John Urbanic of Neotek, one of the more careful and experienced persons in the field made this comment to me recently.

> "If you require a more intuitive demonstration, I suggest you take a large piece of gridded paper and use TriD to view it with, and without, convergence using shutter glasses. Try it with them on if you want, but then take the glasses off and it will be very obvious on the screen where the left and right image lines diverge in what looks a lot like spherical aberration proportional to the amount of convergence. If you do the math, it is almost the same equation to first order. The parallel cameras will give perfect overlays (assuming no regular 2D aberration)."

In truth, even parallel cameras with "perfectly" matched lenses will give serious distortions and ideally aspherical lenses should be used. If one must converge, one can do so without the distortions by horizontal shifting of the lens (rather than toeing in the entire camera) and/or imaging chip (e.g., see Figure 7 in Woods) but I don't know of cameras suitable for high quality video use that permit this to be done reliably.

As noted, there is a large literature on stereo image rectification since those doing computer stereovision or stereo-photogrammetry have been dealing with these problems for over a century. One common type of rectification applies transforms to correct converged to parallel cameras. See e.g., the indefatigable Australian stereoscopist Andrew Woods SPIE article available here http://www.cmst.curtin.edu.au/publicat/1993-01.pdf, Diner and Fender Chapter 9 "Reducing Depth Distortions for Converged Cameras" et passim., or chapter 10 etc. in Goshtasby's book "2-D and 3-D Image Registration (2005). When visiting Wood's page be sure to get all the other superb articles there since, unlike most technical work in 3D, his is of immediate practical value. Zealots will want to download his 3D Map program which enables graphing stereo image distortions.

It is also possible to use converged optical axis cameras without (or more probably with minimal – see Diner and Fender) distortions by making a stereoscopic viewing system with correspondingly converged optical axes (Grebenyik R., Petrov V. "Stereoscopic Images without Keystone Distortions" – Proc. Eurodisplay 2007, pp. 140-142). Also K. Grebenyuk in his PhD thesis showed that in such converged axis stereoscopic viewing systems the errors can be completely corrected. This can be done optically with a standard semi-transparent mirror systems having non-right angle with respect to the axis of one or both monitors or by using a holographic screen with two virtual mirrors recorded nonparallel. Obviously, in addition to the optical methods or computer algorithms, it could also be done in hardware via electronic image rectification using offline or real-time transforms (e.g., polar transformation – Lee J. et al. "Stereo image rectification based on polar transformation". – Opt. Engineering, 2008/47(8), pp.087205-1....087205-12. – and references therein). Such capabilities (e.g., correcting keystone distortion) are now available in many projectors and processing boxes. However since every shot is different it would be optimal to create metadata during filming which could be used offline for rectification that could then be projected by normal projection or display systems. As noted below, projection with dual side by side projectors might provide some rectification for converged cameras.

If you shoot converged you have to worry that objects in front of convergence will have too much negative parallax and also that those behind will have too much positive parallax, both of which cause eyestrain in low degrees and unfusable images at high ones. Parallel shooting avoids this and the only problem is lack of total image overlap in the horizontal direction as objects get close to the cameras. This is seldom a serious problem and it has various solutions as 150 years of shooting parallel photos and film shows (see below). One can crop or mask the image and/or blow up the whole frame a few percent.

This should be the end of the matter, but it seems that many, including 3ality (the makers of the recent U23D film), Peter Anderson, Jim Cameron, Vince Pace, Phil Streather and many others normally shoot converged. One even hears it said that parallel shooting gives limited depth or minimizes control over the 3D effects, but I doubt if those who say this have bothered to spend time doing meaningful comparisons. I think it's more a matter of lack of concern and of convenience, since it's hard to get even small cameras very close to the desired normal human 65mm interaxial, so they'd have to do a lot of horizontal shifts and often blowups to eliminate non-matched right and left edges and/or use big mirror boxes with the two cams at right angles to decrease the interaxial for close objects (as was often done in the 50's and more recently with the immense IMAX rigs). Perhaps the biggest problem is that they are rushed and pressured in planning, on set, and in post and in any case the bottom line is that they can put almost anything they want on the screen, 3D or 2D and get away with it, as the movie game, like all games, is about deadlines, convenience, money and power and ego and the stereoscopists are rarely in charge of the project.

Every viewer has a daily "eyestrain budget" being used up in normal life and much faster for 2D or 3D viewing of screens of any kind. It gets used up fastest by sitting in a dark theater looking at a big, bright screen, much faster when it's in 3D and very fast when the film/projection are full of errors (i.e., always), when there are fingerprints on the glasses, when one is sitting close to the front or at the sides etc. It will always be best for one's budget if one sits far in the back at the center with clean glasses and without any reflections in them from theater lights.

A major reason people get away with shooting converged is that the subject is usually not too close and the convergence mild. Also the limited depth of field leaves the background out of focus and attention is on the subject even when it is in focus. I think that nearly all films shot prior to the creation of the single camera-single projector 3D systems in the 1970's and 80's had many shots basically parallel and most others with only mild convergence. Mostly they look great – superior to later work. In fact when I viewed these films (as have thousands at the nearly complete recent retrospectives in the USA of the 50 or so films and many shorts done prior to the 60s), I was stunned at how good the images were – this in spite of such impediments as the huge blimped cameras with slow film (necessitating huge lights, large apertures and limited depth of field), lack of modern wide angle lenses and projection, lack of perfectly matched dual camera and projection lenses, and the jitter and weave of the film in the cameras, printers and the dual interlocked projectors. I am sure a good part of this is the fact that most shots were nearly parallel, as one can see by taking the glasses off from time to time. They are mostly very easy on the "eyestrain budget," in comparison with subsequent work (see e.g., my IMAX reviews). Another reason they looked good is that they had the full resolution of two 35mm filmstrips. Also, when you project with two side by side projectors this to some extent automatically compensates for the convergence of the two cameras.

The 70's invention of the single camera, single lens systems of mostly modest quality, with a convergence control on the lens, resulted in "convergence abuse", and since the single projector lenses were also limiting and screen brightness low, these systems rapidly exhausted the eyestrain budget. I did extensive work in the 80's transferring 3D film from many different formats to videotape. Horizontal shifting with blowup made both single and dual camera films much easier to watch. Subsequently, classics such as "Dial M for Murder", "Creature from the Black Lagoon", "The French Line" and others have been released in field sequential format on video by various entities starting with the Japanese VHD disks in the late 80s and I have seen some of them many times. Even with the dramatic drop in resolution, limited dynamic range, tiny screen, etc. they are still mostly excellent and one can see that there is minimal convergence in most shots.

In the 70's and 80's Russian workers built and used the single camera, dual lens 70mm Stereo70 system and I saw projections of some of their films when I visited NIKFI in Moscow in 1985. I made a deal with them to transfer four Russian 3D films and half a dozen short works and 3DTV Corp has sold them on video for 16 years. One can see that most shots were close to parallel. I had previously spent 12 years finding just about everything technical ever written about stereoscopy and had many of the best Russian articles translated, since they have long been among the world's leaders in this field. The results of some of this work appeared in my articles and in Lipton's "Foundations of the Stereoscopic Cinema," some 25 years ago – now freely available online (see Woods page, Real D, etc). In addition, I wrote about these issues in American Cinematographer then and posted articles on my page 15 years ago.

The stereo-photographer might venture that nobody has to guess about the merits of shooting parallel as they can see it in the very common 3D slide shows or photos, virtually all of which seem to be parallel. Nearly all 3D still cameras made over the last 150 years have what look like parallel (and fixed) lenses and over 99% of all the mostly superb (and non eye-straining) 3D slides/ photos ever shot were done this way (i.e., without deliberate convergence). In half a century of viewing and discussing 3D stills I have never heard anyone say they lacked depth or realism nor heard any of the photographers say they did not have creative control over the images. Any pair of good 35mm cameras can produce slides that match or exceed the image quality, depth and comfort of anything that has ever come out of Hollywood or IMAX. Anyone who shoots and projects 3D stills or goes to a few of the many 3D slide shows knows this. And, for the higher resolution formats, I will be happy to match my dual 120 slides, shot with the humble, fixed-lens, 50-year-old Russian Sputnik cameras, with anything on the big screens.

Partly this is explained by the ease with which stills can be horizontally shifted and blown up or cropped and masked to overlap the two images and manipulate the stereo window. However, the fact that one can change the fixation point of the lens by horizontal shifting of the lens or the film has been understood from the beginning, and every good stereo camera has offset the lenses so that they provide a converged overlapping stereopair at the (often fixed) focal plane. Converging in this way produces an undistorted stereo pair, in contrast to the spurious H and V parallaxes unavoidable with convergence by toeing in the whole camera. Thus, most single camera stereo-photography is actually converged (though usually fixed by the factory with one convergence) and this, coupled with subsequent image shifting and masking and high resolution, color and dynamic range, account for the superior look of much stereo-photography. There are abundant discussions of these issues in the literature of stereo photography, photogrammetry and computer vision and an admirably clear one in Diner and Fender.

Unfortunately, most video-cameras have no provision for H shift of lens or imaging chip and this leads the stereographers to the drastic measure of converging the whole camera, with attendant distortions and abuse of the eyestrain budget. A wonderful pair of papers by Prof. Mel Siegel (of the world famous Carnegie Mellon Robotics Institute) a decade ago investigated the issue of reducing eyestrain by such means as horizontal image shift to overlap the images: http://www.ri.cmu.edu/publication_view.html?pub_id=2550. He also investigated, with Shojiro Nagata and others, various means to accentuate 2D image cues, simultaneous with H shift and reduced interaxial, in order to maximize viewing comfort http://www.ri.cmu.edu/publication_view.html?pub_id=3567. They were able to produce comfortable views with good depth by judicious manipulation of these parameters. However, as I mention in my article on stereo projection and viewing, the applicability of virtually all perceptual experiments to viewing commercial devices in real environments for prolonged times is unknown. Of course, they are hardly the first to pay attention to such issues, but they were first to attend to them all simultaneously. I normally shift all video to minimize parallax and then eliminate problems with non-overlap and the stereo window by blowup. My US patent 6,108,005 on 2D to 3D conversion discusses means to stimulate depth by 2D image manipulations and I employed some of these in the "solidized" videos I made beginning in 1989. A few of these ideas were incorporated in a program included in the hundreds of thousands of stereoscopic gaming kits sold by X3D Corporation for about $100 but now available for the price of a sandwich http://www.amazon.com/X3D-TECHNOLOGIES-Gaming-System-Windows-Pc/dp/B00007FY66/ref=sr_1_1?ie=UTF8&s=software&qid=1231301259&sr=8-1. A set top box including this program is still sold as the Virtual FX 2D to 3D Converter http://www.amazon.com/VirtualFX-Television-Game-Console-Converter/dp/B0006HJII2. This is an extremely simple program, which never made it to a second generation, and its effects are modest, but it is the only consumer device of this kind to appear. Curiously, though this is by far the best known solidizing device, and it can claim priority back to 1989 and may be regarded as anticipating many aspects of work and patents done since (e.g., the well known work of DDD and of In-Three), it is rarely cited, even in patents – which are required to cite all prior art.

Siegel et al used the well known effect of wide angle lenses to enhance the depth of their shots, even at the reduced interaxials. It has been noted by Diner and Fender that if video cameras have higher resolution, this alleviates the distortions and enables the reduction of interaxials:

> "…if camera resolution could be increased by an order of magnitude, a stereoscopic camera system might then reach the human stereoscopic depth threshold. Then wide inter-viewpoint distances would not be needed to increase stereoscopic depth resolution, and this in turn would reduce the distortion to resolution ratio. The inter-viewpoint distance would then not be needed as an independent variable used to control resolution, and could instead be used to control distortion".

What this amounts to is that higher camera resolution takes advantage of our high stereo-acuity and this will permit less distortion and better stereo at reduced interaxials. Since 60Hz color video-camera horizontal resolutions have increased from about 500 lines in the early 90s when they did their research, to 4K in pro cameras and even 8k in some experimental systems, this has now been realized. Consequently it looks like it should be possible to produce relatively undistorted 3D video that has good depth and is very easy to view by reducing the interaxials with high resolution cameras (and wide angle lenses when feasible). Of course clever use of lighting to create asymmetrical illumination and shadows, object placement, and textures and colors of sets and costumes will remain a subtle art.

The absolute arbiter is how the 3D looks on the display and how you feel at the end of the program, and this depends on lots of things besides how it was shot and edited including type of display, brightness, ghosting, viewing method, reflections, fingerprints on glasses, ambient light, distance from screen, the idiosyncrasies of the viewer, how bad all the other errors are, and especially on the length of the program. I am sure I could walk up to most people, including the 3D experts, after a film was shown and find fingerprints on the viewing part of the lenses up to 90% of the time. Yes, it happens to me as well!

There is a wealth of info on stereovision algorithms and camera geometry in the machine vision literature. A good starting point, http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.61.717, is the early paper by Murray et al on stereo camera mounts and for Murray's abundant work on wearable active vision systems, telepresence and related items since that time see http://www.robots.ox.ac.uk/~dwm/Publications/index.html. An excellent review of single or dual stereo camera methodology for 3DTV from the standpoint of computer vision is given by Stoykova et al http://citeseerx.ist.psu.edu/showciting?cid=1192076&sort=cite&start=20. For a clear explanation of the single lens approach, see http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.53.7845 and a further short exposition at http://www-bcs.mit.edu/people/jyawang/demos/plenoptic/plenoptic.html. These are concerned with the polydioptic (plenoptic) camera which forms numerous images via a lenticular array on the chip, and has not to my knowledge been used for 3D video except in the realm of machine vision. The lenticular array will give both H and V parallax and consequently (as Adelson and Wang note in the above citation) is a method of integral photography and harks back a century to the pioneering work in autostereo by Ives and Lippmann. One can use only a vertical lenticular array and then get only H parallax and then this art blends into that of the vast literature on lenticular photography.

Regarding 3D video, there is another single lens method that can create stereo video for human viewing. If one puts two apertures inside the lens and opens them sequentially in sync with the image capture by the chip, one gets perfectly registered and converged stereo. Please see the many citations to this art in my articles. Of course the small interaxial (i.e., the distance between the apertures) means that the subject must be close to the lens. This has led to these devices being used in stereo-endoscopes and microscopes by half a dozen companies in recent decades. I visited International Telepresence Corp in Canada about 15 years ago to see their stereo-endoscope and camera, both of which produced 60 Hz field sequential 3D output. I put some footage of surgery and of a horse race shot with these on one of the 3DTV Technology tapes I sold for many years. As expected, the stereo of the audience between the camera and the race track was good but flattened out by 20 meters or so. Sadly they seem to have vanished without a trace. The same appears to be true for half a dozen other stereo-endoscope companies that employed similar approaches. However other companies continue to pursue this method, and it is not that hard to do. The astute will realize that one could get depth this way at greater distances by using a wider lens (and hence dual apertures further apart). This has not been lost on some inventors such as Dr Maurice Tripp, whose work I have cited in my other articles, and who is pictured in them and on my page, during a visit I made to him long ago, with a very wide lens using Dove prisms, which he made for his work on a lenticular autostereoscopic TV system some 30 years ago.

One single camera 3D approach popular with engineers is 2D plus depth. The depth map is supplied by laser ranging, structured light, Time of Flight, or related means, so that each pixel of the 2D camera is assigned a depth value. This is Philips preferred approach for their lenticular autostereo displays and has been extensively researched by many including those in Europe's ATTEST stereo video program. Nevertheless, I don't see how the depth map with one picture can provide the shadow detail, sparkle, luster and texture that one gets from the horizontally asymmetrical parallax images, and it lacks monocular occlusion and transparency data, and until I see a side by side comparison or some stunning 3D footage done with depth maps, I remain skeptical. This was also the reception given Philips recent proposal, to a 3D panel in Beijing, that their method be adopted as a Chinese standard.

View synthesis enthusiasts know that it's possible to use multiple cameras with a suitable program to synthesize any arbitrary stereo view. A vast literature exists and of course it again blends into that of computer vision, artificial intelligence, robotics etc. NewSight Corp showed live 8 view synthesis from two cameras running on a laptop and displayed on an 8 view autostereo display at the FPD show in Tokyo in April 2008. This work resulted from the efforts of German image processing expert Dr. Rolf Henkel, who developed this technique initially already in the 90s to convert historic stereo-photos into lenticular prints. Dr. Henkel is a pioneer in this area so I let him comment directly. "The human visual system is doing itself a view-interpolation operation (compare my page http://axon.physik.uni-bremen.de/research/stereo/Cyclops/index.html). I used the same approach in the 90s in my company PixelCircus to convert historic stereo-photos into lenticular prints. To do so, I had to develop also basic algorithms for rectification and calibration of unknown camera geometries. It was at that time that I developed the "virtual camera" concept, which allowed arbitrary changes in 3D geometry of given stereoscopic data." Currently there is research directed at creating user controlled mono or stereoscopic view synthesis some of which is called "freeview" (not to be confused with the method of viewing stereo-pairs, nor with the set top boxes having a package of free digital channels).

Two cams will only do the views interpolated between them in a convincing way (i.e., not views to their right or left) but dozens of cams could be used to synthesize an entire environment. The dean of this approach is telepresence and robotics guru Takeo Kanade has created many such systems over the years. A few years ago, with assistance of colleagues from Carnegie Mellon, he created the famed Eyevision system first used for SuperBowl 2001, but only a few times since http://dev.web.cs.cmu.edu:6666/testReleases/demo/40.html. Nearly any point of view can be created real-time, as though there were thousands of cameras. This has 25 cameras mounted on robotic arms distributed around the stadium. Time and money did not permit real-time view synthesis so it was done by morphing, but it looks very good, as can be seen by the demo on his page. The pan/tilt/zoom of the robotic arms was done by supercomputer programmer and stereo expert John Urbanic of Neotek http://www.neotek.com. A few years ago, with Chang Lee of TJ3D Corp., we formed a company named SeeAll with the intention of updating the system to HD and stereo, instant playback etc. which we hoped to implement for the Beijing Olympics, but none of us were inclined to run around looking for funding, so it has not come to fruition. Much smaller and cheaper systems could be used for martial arts, movies, security applications etc.

So, the bottom line would seem to be that, while we wait for a modern stereo video camera with horizontal lens and/or chip shifting and other niceties, we should try to shoot as near to parallel as possible by using small cameras and mirror boxes, with image shifting, masking and blowups to overlap images and control the stereo window. When this is not possible try to avoid large negative or positive parallaxes of in-focus objects to which attention is drawn. Look for and correct window errors. When possible use wide angle lenses to stress perspective. Become familiar with all the 2D depth cues and use them to maximum effect. Use lighting, sets, costumes and the environment to get shots rich in asymmetrical illumination cues and shadows. Carefully calibrate the lenses and mounts to minimize all binocular asymmetries during shooting, rather than trying to fix them in post. Use experienced stereographers from early planning to final showing in theaters and listen to what they have to say.

3D game review

Prototype

by Eli Fihn

Eli Fihn is a gaming enthusiast who has become intrigued by the capabilities offered by 3D gaming. He is currently a 12-year-old who is home-schooled in central Texas. In addition to gaming, he enjoys soccer, swimming, reading, and playing with his friends.

Prototype is a sandbox action/adventure game developed by Radical Entertainment. You are Alex Mercer, a genetically modified test subject and fugitive. You have incredible abilities, including, but not limited to, increased speed, strength, and sight. You must fight the military and various infected monsters, all while trying to find out who you are.

First off, this game is *fun*. I could spend hours running around the open-world city, experimenting with abilities. I only wish that Prototype had a multiplayer mode, pitting players against each other. It would add hours more of enjoyment. The story was easily predictable, and very repetitive. However, the open world makes up for those. The graphics are, sadly, low quality for a "next-gen" game. This is usually unnoticeable in-game, but in a few of the in-game cut-scenes, the graphic quality is painfully obvious. Sound in Prototype is both good and bad. The voice acting is horrible. There is no other word to describe it. It sounds artificial and unrealistic. The other in-game sounds are average.

For 3D effects, I found it difficult to get rid of the large amounts of ghosting. I found no doubling effects or shadow inconsistencies. However, whenever you use an ability, some of the animated tendrils were not 3D Models, therefore making them appear 2D where everything else was 3D.

Gameplay:	8/10
Graphics:	6/10
Sound:	4/10
3D:	7/10

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The effect on children of 3D content created by adults for adults

by David Seigle

David C. Seigle is president of In-Three, Inc. a firm that converts 2D content to 3D films. He has held line and management positions with companies in the software and Internet industries: He was the president and chairman of SeatAdvisor, Inc., a San Diego-based developer and supplier of Web-based performing arts and sports venue ticketing services. A founder of the workflow automation pioneer, FileNet Corporation, Mr. Seigle was its senior vice president of international operations, establishing and managing subsidiaries in France, England and Germany and distribution relationships with Olivetti and Mitsui. Mr. Seigle earned his degree from Yale University.

I recently discussed 3D with my ophthalmologist who mentioned that his 3 year old son had thrown off his glasses at a 3D movie. That led me to wonder what the interpupillary distance of very young children is and how that affects their perception of 3D. I have known that children age 6 to 11 have an IPD of around 2 inches (compared to an adult's 2.5 inches) and believe that this should inform the degree of parallax (separation on the screen of left/right eye images) that 3D content providers use for family fare. (See www.In-Three.com for detail.) But this anecdote suggested that younger children might be even more affected by 3D content created by adults for adults.

With this in mind, I created Chart 1 which shows IPD as children grow. This information is incorporated in Chart 2 which shows the convergence of children's eyes when they watch 3D material created to achieve certain convergence or perceived depth to adult eyes. As an example this chart reveals that material with a perceived depth of 500% (five screen distances) from adults will cause four year old eyes to diverge.

Chart 1: Interpupillary distances of individuals age 1 to 18 (n=1311)

	MALE		FEMALE		DIFFERENCE	
AGE	MM	INCHES	MM	INCHES	MM	INCHES
1	45.0	1.8	43.6	1.7	1.39	0.05
2	46.6	1.8	45.3	1.8	1.22	0.05
3	48.0	1.9	47.0	1.8	1.08	0.04
4	49.5	1.9	48.5	1.9	0.98	0.04
5	50.8	2.0	49.9	2.0	0.91	0.04
6	52.1	2.1	51.2	2.0	0.88	0.03
7	53.3	2.1	52.4	2.1	0.89	0.03
8	54.5	2.1	53.6	2.1	0.93	0.04
9	55.6	2.2	54.6	2.1	1.01	0.04
10	56.6	2.2	55.5	2.2	1.12	0.04
11	57.5	2.3	56.3	2.2	1.27	0.05
12	58.4	2.3	57.0	2.2	1.46	0.06
13	59.2	2.3	57.6	2.3	1.68	0.07
14	60.0	2.4	58.0	2.3	1.94	0.08
15	60.7	2.4	58.4	2.3	2.23	0.09
16	61.3	2.4	58.7	2.3	2.56	0.10
17	61.8	2.4	58.9	2.3	2.93	0.12
18	62.3	2.5	59.0	2.3	3.33	0.13
19	62.7	2.5	58.9	2.3	3.77	0.15

* MacLachlan, C., & Howland, H. C. (2002). Normal values and standard deviations for pupil diameter and interpupillary distance in subjects aged 1 month 10 years. *Ophthalmic & Physiological Optics*, 22, 175-182.

Notes from "Variation and extreme of human interpupillary distance" by Neil A. Dodgson (University of Cambridge Computer Laboratory, 15 J.J. Thomson Avenue, Cambridge, UK CB3 0FD

Negative parallax of 10 inches, which appears at one fifth of the screen distance to an adult, when held more than momentarily on a screen, is typically quite taxing. (This is due most likely to the brain trying to adjust converging and focusing muscles to the same point in space.) For young children it might be too difficult to view.

Note the low outliers of girls' IPD at the bottom of Chart 1. Also remember that the numbers used in these charts are averages; half the children have even narrower IPD.

My ophthalmologist, at my request, measured his son's IPD. It turned out it was 57mm or about 2.2 inches. So even though his IPD was wide for his age, the 3D experience needed to be toned down for him to enjoy it.

For us to ensure comfort for the greatest number of viewers, especially the young, we content creators should probably err on the side of modest parallax. The shaded area in Chart 2 indicates a reasonable parallax for 3D created for children of various ages.

(*Unless otherwise noted, the opinions provided are based on private research and are shared to assist others in improving the quality of 3-D content. The range of parallax suggested represents best practice from the viewpoint of In-Three. We encourage further research).

(In-Three produces 3D from 2D content using a process called Dimensionalization®. Dimensionalization allows In-Three to "depth-grade" its 3D content to get each element of a scene in proper position in "z space" or depth. Parallax is thereby controlled for each element and positioned properly for comfortable viewing).

Chart 2: Effect of children's narrower interpupillary distances on their perception of 3D in terms of perceived distance to the screen (i.e., where their eyes converge)

(The shaded area represents the range of parallax that probably is appropriate for each age group).

			FOR AN ADULT SEEING OBJECTS AT A PERCEIVED DISTANCE TO THE SCREEN OF:						
			15%	20%	30%	50%	250%	500%	INFINITY
ON SCREEN SEPARATION* (inches):			-14.2	-10.0	-5.8	-2.5	1.5	2.0	2.5
	CHILD'S IPD		A CHILD WILL SEE THE SAME OBJECT AT A PERCEIVED DISTANCE OF:						
A CHILD OF THIS AGE SEES	MM	Inches							
3	47.5	1.9	11.7%	15.8%	24.3%	42.8%	505.3%	Divergence	Divergence
4	49.0	1.9	12.0%	16.2%	24.9%	43.6%	449.5%	Divergence	Divergence
5	50.4	2.0	12.3%	16.5%	25.4%	44.2%	411.0%	Infinity	Divergence
6	51.7	2.0	12.6%	16.9%	25.8%	44.9%	381.2%	6076.5%	Divergence
7	52.9	2.1	12.8%	17.2%	26.3%	45.4%	358.3%	2578.0%	Divergence
8	54.1	2.1	13.1%	17.5%	26.7%	46.0%	338.9%	1663.1%	Divergence
9	55.1	2.2	13.3%	17.8%	27.1%	46.5%	324.1%	1281.4%	Divergence
10	56.1	2.2	13.5%	18.1%	27.4%	46.9%	312.3%	1067.6%	Divergence
11	56.9	2.2	13.7%	18.3%	27.7%	47.3%	302.7%	932.8%	Divergence
12	57.7	2.3	13.8%	18.5%	28.0%	47.6%	294.4%	836.2%	Divergence
13	58.4	2.3	14.0%	18.7%	28.3%	47.9%	287.7%	768.4%	Divergence
14	59.0	2.3	14.1%	18.8%	28.5%	48.2%	282.3%	719.5%	Divergence
15	59.6	2.3	14.2%	19.0%	28.7%	48.4%	277.6%	680.6%	Divergence
16	60.0	2.4	14.3%	19.1%	28.8%	48.6%	274.0%	652.2%	Infinity
17	60.4	2.4	14.4%	19.2%	28.9%	48.7%	271.2%	631.9%	Infinity
18	60.7	2.4	14.4%	19.3%	29.0%	48.9%	269.0%	615.7%	Infinity
19	60.8	2.4	14.5%	19.3%	29.1%	48.9%	267.8%	608.0%	Infinity

* That is, the distance between the left eye's view of the object on the screen and the right eye's view of the same object. For example, if you measure the distance on the screen, for a viewer's eyes to coverage 20% of the way to the screen, the object's right eye's image of the object must be 10 inches to the left of the left eye's image of that same object. This is explained in more detail at http://www.in-three.com.

A scientific perceptual basis for stereo display design?

by Robert Patterson

Dr. Robert Patterson received his Ph.D. in Experimental Psychology from Vanderbilt University in 1984, and he was a post-doctoral research fellow at the Cresap Neuroscience Laboratory at Northwestern University from 1985-1987. He is currently an associate professor in the Department of Psychology, and the program in neuroscience, at Washington State University. Dr. Patterson frequently collaborates with members of the Air Force Research Laboratory in Mesa, AZ, on issues relating to visual cueing in flight simulation and visual suppression in head-worn displays. He has published widely in the area of visual perception and applied vision, particularly on the topics of binocular vision and stereoscopic depth perception.

I am now a Professor of Psychology and Program in Neuroscience at Washington State University, and I am also a Research Scientist Consultant at Link Simulation and Training at the Air Force Laboratory in Mesa AZ.

As I read across the literature on the continued creation and use of stereo displays, I am always in awe of the pace of technological development. The engineering feats are remarkable as shown in the many pages of this newsletter every time it is published. Indeed, there appears to be many smart and clever engineers who are responsible for the new and currently explosive interest in 3D displays.

However, there remains, in my view, one criticism of the field of stereo displays that is serious and deserves greater attention: it is the apparent cursory interest in the scientific basis of how the human brain and binocular visual system actually perceive stereo depth information. This is not to say that there is no interest in how we humans perceive stereo depth, rather it is the apparent cursory interest in its scientific basis. Over the years I have seen many statements about stereo depth perception in trade publications and in the public domain that, to me, lack scientific credibility.

Consider, for example, a recent paper by Hamagishi et al. (2008). These authors discuss undesirable biomedical effects that result from the viewing of 3D displays. In their paper, they report the case of a 4-year old child who presumably developed strabismus immediately after viewing stereoscopic images and suggest that the possibility exists of many similar cases that likely go unreported, a claim that was given without attribution. Note that strabismus is a clinical condition that involves misaligned eyes and a disruption of normal binocular vision owing to a brain disorder, or a disorder of one or more of the extraocular eye muscles. In my professional opinion, this claim is, well, unbelievable.

It is unbelievable because, over many years, many children, and even infants, have been scientifically tested for their ability to perceive stereo depth perception and no such cases have ever been reported. To take just one example, years ago Fox, Aslin, Shea and Dumais (1980) reported that human infants at several months of age can detect binocular disparity information, the cue for stereopsis. In this research, many human infants were tested and no medical problems were reported; I know this because I was in Fox's lab at Vanderbilt University at the time and helped test the infants. As another example, Fox, Patterson and Francis (1986) reported that children at about five years of age possess a level of stereoacuity (the ability to detect fine depth differences) that is commensurate with adult stereoacuity. Again, we found no medical problems as a result from the testing. And neither have any other scientific labs involved in the investigation of infant perceptual abilities over the years. In short, to claim that an individual develops strabismus due to a single viewing of a stereo display is analogous to claiming that a color vision defect develops from a single viewing of a color TV. No wonder no attribution was given for this claim.

As another example, in a recent article in Slate magazine published on April 2, 2009, Daniel Engber discusses the problems with the viewing of 3D movies and focuses upon the issue of accommodative-vergence mismatch.

Accommodative-vergence mismatch refers to the condition in which the stimulus for accommodation is the display surface (in this case the movie screen) but the viewer verges to a depth plane different from the display surface. Such mismatch would likely create eye strain and headache when the stereo display is viewed for a long period of time, but it would likely only occur for near-eye displays (e.g., head-worn displays). This is because accommodation-vergence mismatch becomes less of a problem when stereo displays are viewed from a distance of a couple meters away or greater, due to the increase in the viewer's depth of field.

For example, in a review paper I published a few years ago (Patterson, 2007), I give representative values for a typical observer's depth of field at several different viewing distances: taking the total depth of focus to be about 0.66 diopters (this can change somewhat due to different viewing conditions), the total depth of field of the human eye would range from a distance of about 0.25 meters in front of fixation to about 0.5 meter behind fixation for a fixation distance of 1 meter; the total depth of field would range from a distance of about 1 meter in front of fixation to about 4 meters behind fixation for a fixation distance of 2 meters; and the total depth of field would range from a distance of about 1.5 meters in front of fixation to an infinite distance behind fixation for a fixation distance of 3 meters.

More recent estimates, based on the total depth of focus being about 1 diopter, are the following: For a fixation distance of 0.5 meters, the total depth of field would be 0.1 meters in front of fixation to 0.17 meters behind fixation; for a fixation distance of 1.0 meter, the total depth of field would be 0.33 meters in front of fixation to 1.0 meters behind fixation; and for a fixation distance of 2.0 meters, the total depth of field would be 1.0 meter in front of fixation to an infinite distance behind fixation.

Thus, there would be very little change in accommodation when the observer directs his or her gaze to a 3D display located a couple meters away or farther, which would lessen the problem of the mismatch. The point here is that 3D movies are typically viewed from distances greater than several meters and no problems from accommodative-vergence mismatch would be expected. (There are likely other problems with 3D movies whose discussion is beyond the points made in this current article; see Patterson & Silzars for discussion.)

So what are we to make of these examples? These examples, and others, reveal that there are many common misconceptions about stereo depth perception in the media, and in society in general, that seem to penetrate to a significant degree into the display industry. Moreover, such misconceptions do a serious disservice to the stereo display industry because they serve to engender poor system design from a human factors perspective, which in turn makes the public less receptive, over the long haul, to the use of stereo displays. My prediction is that, despite the current excitement about recent 3D display technologies, including 3D movies, there will still exist serious human factors problems with their use until a more scientifically-grounded appreciation of the human factors issues occurs within the engineering community. Consideration of the scientific basis of human stereo depth perception will only serve to make the development of new stereo displays better.

Citations:

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TV Ecosystem Conference

TV After the Digital Transition - Finding the Next Big Thing

September 2, 2009, San Jose, California

With the transition from analog to digital broadcasting and the conversion from CRT and rear projection to flat panel complete in most developed markets, the TV industry is facing slower growth. This conference will explore how new forms of content, connectivity, and technology could drive renewed growth in hardware. Featuring presentations from display and TV manufacturers, branded vendors, semiconductor design, retailers/channel participants, content developers and wireless/connectivity providers, this conference will be a forum for discussing growth drivers for the TV market.

Agenda-at-a-Glance

Session I:	Supply Chain Analysis: Market trends and forecasts
Session II:	System Architecture
Session III:	TV Connectivity
Session IV:	3DTV

DISPLAYSEARCH
AN NPD GROUP COMPANY

"3D HDTV" watch

by Andrew Woods

Photo: Mark Coddington

Andrew Woods is a consultant and research engineer based at Curtin University's Centre for Marine Science & Technology in Perth, Australia. He has 20 years of experience in the design, application, and evaluation of stereoscopic video equipment for industrial and entertainment applications. He is also co-chair of the annual Stereoscopic Displays and Applications conference – the largest and longest running technical stereoscopic imaging conference worldwide.

In April Mitsubishi announced its 2009 range of 3D DLP HDTVs. These displays range from a huge 60-inch diagonal to a massive 82-inches. Like previous releases from Mitsubishi, these sets support the time-sequential 3D method using Liquid Crystal Shutter (LCS) 3D glasses. The input method is again the checkerboard 3D format via one of the display's HDMI ports. The full range of 2009 models is listed below.

Make and Model	Screen Size (diagonal)	Native Resolution	Display Type	Street price
Mitsubishi WD-60737	60" (152cm)	1920x1080 (1080P)	Lamp DLP	US$1300
Mitsubishi WD-65737	65" (165cm)	1920x1080 (1080P)	Lamp DLP	US$1500
Mitsubishi WD-73737	73" (185cm)	1920x1080 (1080P)	Lamp DLP	US$1900
Mitsubishi WD-82737	82" (208cm)	1920x1080 (1080P)	Lamp DLP	US$3900
Mitsubishi WD-65837	65" (165cm)	1920x1080 (1080P)	Lamp DLP	US$2200
Mitsubishi WD-73837	73" (185cm)	1920x1080 (1080P)	Lamp DLP	US$3000
Mitsubishi WD-82837	82" (208cm)	1920x1080 (1080P)	Lamp DLP	US$5000

In October of 2008, Mitsubishi also announced the retail availability of the Mitsubishi L65A90 65-inch LaserVue Rear Projection DLP HDTV. This display users a laser light source rather than a lamp so as to provide a richer color gamut. The recommended price of this display is US$7000.

Samsung have been notable in that they have not announced any new 3D DLP HDTV models this year and availability of Samsung's 2008 range is getting in short supply. Samsung were the first to release this class of display in April 2007. They also released a new batch of 3D DLP HDTVs in 2008. Samsung were also leaders in this field with the release of the of LED illuminated models which were only moderately more expensive than the equivalent lamp-based model, and yet had a much larger color gamut, had a significantly longer illuminator life (perhaps 10 times the equivalent lamp based model), and most significantly virtually no color-breakup (rainbow effect) due to the use of a much higher color cycle speed. Time will tell whether this means that Samsung are departing this particular 3D display category. Samsung are still retailing the 3D Plasma HDTVs they released last year, but unfortunately the 3D image performance of these displays is not as good as the 3D DLP HDTVs.

The number of 3D-capable LCD HDTVs and monitors has also expanded rapidly in the last 12 months – see list below. Most of the 3D LCDs use the micro-polarizer technique (variously named µPol or xPol) and are viewed through polarized 3D glasses. NVIDIA cracked an important technical problem and released LCDs compatible with time-sequential Liquid Crystal Shutter (LCS) 3D glasses – in cooperation with Viewsonic and Samsung. The dual LCD (variable polarization angle) monitor from iZ3D also reached new levels of popularity this year. It is important to note that there is considerable variation in the level of 3D image quality between all of these displays.

An illustrated listing of 3D HDTVs and monitors is available at: www.3dmovielist.com

Product Image	Make and Model	Screen Size (diagonal)	Native Resolution	3D Display Method	Type of Glasses	Street price
	Viewsonic FuHzion VX2265wm	22" (56cm)	1680x1050	120Hz time-sequential 3D LCD	NVIDIA GeForce 3D shutter glasses	US$330 +glasses US$200
	Zalman ZM-M220W	22" (56cm)	1680x1050	micro-polarizer LCD 3D (row-interleaved)	custom circularly polarized	US$660
	Hyundai W220S	22" (56cm)	1680x1050	micro-polarizer LCD 3D (row-interleaved)	custom circularly polarized	US$600
	iZ3D 22W	22" (56cm)	1680x1050	Dual Panel LCD 3D (modulo-angulo)	custom circularly polarized	US$300
	Samsung 2233RZ	22" (56cm)	1680x1050	120Hz time-sequential 3D LCD	NVIDIA GeForce 3D shutter glasses	US$400
	Hyundai W240S	24" (61cm)	1920x1200	micro-polarizer LCD 3D (row-interleaved)	custom circularly polarized	US$1300
	Hyundai P240W	24" (61cm)	1920x1200	micro-polarizer with black stripe LCD 3D (row-interleaved)	custom circularly polarized	US$2000
	Miracube G240S	24" (61cm)	1920x1200	micro-polarizer LCD 3D (row-interleaved)	custom circularly polarized	
	Miracube G320S	32" (81cm)	1360x768	micro-polarizer with black stripe LCD 3D (row-interleaved)	custom circularly polarized	
	Miracube G460X	46" (117cm)	1920x1080	micro-polarizer with black stripe LCD 3D (row-interleaved)	custom circularly polarized	
	Hyundai S465D	46" (117cm)	1920x1080	micro-polarizer LCD 3D (row-interleaved)	custom circularly polarized	US$6500
	JVC GD-463D10	46" (117cm)	1920x1080	micro-polarizer with black stripe LCD 3D (row-interleaved)	Custom circularly polarized	US$7000

DVD Review: Friday the 13th Part 3

Paramount treads the 3D home video water with an anaglyph 3D video release

by Greg Kintz

Greg Kintz has worked with 3D video content for the last 15 years. He is a video technician for a Midwest television hub facility in Fort Wayne, Indiana.

After reading some comments on the Friday the 13th Part III DVD presented in anaglyph 3-D, I decided to give it a closer examination. Here's my take on the 3-D aspects: The good, the bad, and the ugly- (And grab your anaglyph 3-D glasses for comparisons! Red lens over the left eye).

The Good: What's nice is the original theatrical "2-D notice card" that ran before the Friday Part II 2D flashback is in the anaglyph version, and is the first time it's ever made it video. The Japanese 3D VHD released in the late 1980s just stayed in black where the text should have been. This 2D notice let the audience know the intro "flashback" from Friday Part II was not in true 3D, but they should keep their 3D glasses on.

The anaglyph color encoding used on the Paramount 3D DVD is actually somewhat decent most of the time when viewed under optimal playback conditions. ..When the alignment is correct, the 3D (for video anaglyph, that is) isn't too bad. But more on the 3D alignment below…

The Bad: It's like someone loaded up the left & right sides and made NO attempt to correct or monitor alignment errors. (More on that in the "ugly" section) Sometimes the misalignment is outright horrible, as can be seem in the jpeg examples below. This is NOT something that should be seen from a major studio such as Paramount. Forgetting what color anaglyph 3-D video can do already, extended viewing of misaligned 3-D video of this degree is sure to cause eye-strain. At a conservative estimate, I would say 25 to 40% of the anaglyph DVD has vertical alignment issues of differing severity.

The Ugly: It would be one thing if Paramount simply had "locked and loaded" the original 3D elements for Friday III and "let her rip", so to speak. But that's not the case. Unlike the VHD 3D video release made some twenty years ago, which were known to typically be direct port-overs of the original prints, this new anaglyph version of Friday the 13th Part III has far WORSE vertical 3D misalignment than what was transferred over to VHD in the late 80s.

Sometimes misalignment is shifted drastically, other times the convergence is shifted for no logical reasons, etc. Sickening…

And the other inexcusable blunder of this release was the studio's decision to present the opening stereoscopic credits (which IMHO are some of the best opening 3D credits of the 80s wave) in 2D! Does someone at the studio not know how to encode bright reds in anaglyph 3D?

To put up, or shut up: I make NO claim to fame on being "King 3D", or anything even close to that effect. Others can argue over the title. With that out of the way, outside of my professional "daytime job" as a video technician, I have worked on enough 3D material over the years to easily say some 3D common sense can go a long, long way.

To that effect, I've allowed myself one evening to select some scenes from the anaglyph DVD and then to make my own anaglyph versions. I also provided a 3D image from the opening credits, which was "not" presented in 3D on the Paramount 3D DVD. The parallax on these stereoscopic credits is very wide, and pushes the limits of anaglyph encoding. But it IS possible to do. You be the judge:

In summary: Paramount could have done a far better job with this. Outside of my given elements at hand, if I had the transfer elements that Paramount used to perform alignments, I could easily do a better job than what was provided on the DVD, and even better than what I have provided here. And there are others out there that could do the same thing I did, if given the chance. Let us hope that Paramount strongly considers these options in the future.

Breaking news: When this first anaglyph 3D DVD was released this February, I had hoped my sample images that were sent to Paramount would help them rethink their slop job, and at a minimum, reconsider giving this release some deserved TLC before releasing it on Blu-Ray. I'm sorry to say they have not. The just released 3D Blu-Ray sports the same bad misalignments and "2D only" presentation of the original stereoscopic opening credits.


PARAMOUNT 3-D DVD


GK TWEAKED 3-D STILL

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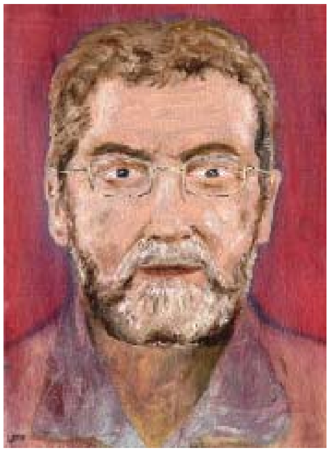
Last Word: Reality and Illusion

by Lenny Lipton



Lenny Lipton is recognized as the father of the electronic stereoscopic display industry, Lenny invented and perfected the current state-of-the-art 3D technologies that enable today's leading filmmakers to finally realize the dream of bringing their feature films to the big screen in crisp, vivid, full cinematic-quality 3D. Lenny Lipton became a Fellow of the Society of Motion Picture and Television Engineers in 2008, and along with Petyer Anderson he is the co-chair of the American Society of Cinematographers Technology Committees' subcommittee studying stereoscopic cinematography. He was the chief technology officer at Real D for several years, after founding StereoGraphics Corporation in 1980. He has been granted more than 30 patents in the area of stereoscopic displays. The image of Lenny is a self-portrait, recently done in oil.

To paraphrase Einstein: Space is what keeps everything from happening at the same place, and stereoscopic imaging helps us visualize space. The concept of space, or distance, is so fundamental, that a tentative understanding of our perception of it has taken the human race centuries. Stereoscopic imaging heightens our perception of space and it is so fundamental to our existence that any idea that the stereoscopic cinema is a passing fad is ridiculous.

Looking at a projected stereoscopic image is not the same as looking at the real world, or what psychologists call the "visual field." I don't think anybody working in the field would quarrel with that statement. You might modify it and say, "In some ways it is like looking at the visual world, and in some ways it isn't." You don't look at the visual world through a rectangle unless you're looking through a window; that's one obvious difference. Your field of view in the real world is unbounded, you might say. But there are other differences that aren't obvious, and the language people use to describe the cinematic experience tells us that there is a lot to be discovered, a lot to be thought through, about the differences between looking at a projected image and looking at the visual field.

The two words that are used often when discussing the stereoscopic cinema are "realism" and "immersion." The commonsense definition of "realism" or its variant realistic, in the context of the stereoscopic cinema, is that an image that posses this quality looks real – like life. "Immersion" or immersive implies that you are in the image, not outside of it looking in. Does that mean that you are drawn into the screen or that the screen emerges outward to enfold you? Or does it matter?

Throughout the history of movies, photography and painting, most of the time you are outside the image looking in at it. An artist, Robert Barker, used the word panorama to describe his eighteenth century paintings of Edinburgh. The paintings, an attempt to immerse the viewer, were done on the inside of a large cylindrical surface. One hundred fifty years later Fred Waller's Cinerama opened on Broadway and projected images onto the surface of a large cylindrical screen. Cinerama's successor, IMAX, uses a large more or less flat screen to achieve much the same effect.

Photographers and cinematographers make their living by understanding the difference between perception of the visual field and the perception of an image. The images they depict of the visual world tell a story but these effigies are not the same as looking at the world. The departures lead to creative expression. The departures define the art.

Stereoscopic images have additional aspects that don't apply to conventional three-dimensional cinematography. You may be taken aback by my use of the phrase "conventional three-dimensional cinematography." But cinematography has always been three-dimensional. It has all the usual three-dimensional monocular depth cues, but without the cue of binocular stereopsis – the only two-eyed cue. Stereoscopic cinematography adds one additional depth cue, and that additional depth cue has (no pun intended) profound implications for how the image must be created and displayed.

Once the stereoscopic depth cue is added to a projected image certain interesting things happen, especially for distant objects. When you look off in the distance the hills don't look flat as a painted backdrop. Yet with the projection of stereoscopic cinematography that's what happens. If photographed with the usual interaxial separation the stereoscopic projection of distant hills can make them appear to be flat in a way that doesn't correspond to their perception in the visual world.

The stereoscopic depth cue works best in close, because the distance between eyes – or the human interocular – is two-and-a-half inches or so, and simple trigonometry can be used to help demonstrate that past, say, a few hundred feet the stereoscopic depth cue doesn't count for much. Stereoscopic acuity falls of rapidly with distance. But even though the stereoscopic depth cue rolls off with distance, images in the visual world don't flatten. Yet when you add the stereoscopic element to projected images, objects in the distance do start to noticeably flatten out, especially very distant objects like mountains or cityscapes. Yet, when perceived in the visual world one doesn't have that sense of collapsed of depth.

This brings to mind stereo cards of distant vistas, like Niagara Falls, which when viewed in a stereoscope look as flat as a board because the interaxial separation for the camera was only two to three inches. Little parallax information can be recorded of such a distant vista with such a lens separation. I've asked myself, "What's the point of a stereo card with no stereo information?"

The people who are producing computer-generated images at the major animation houses (Rob Engle at Sony Pictures Imageworks, Robert Neuman at Disney, Phil McNally at DreamWorks, and Jayme Wilkinson at Blue Sky) have become masters at the manipulation of stereoscopic space. That's because a computer-generated world allows for complete control. They can control the distance between their virtual cameras' lenses, which controls the strength of the stereoscopic effect, but they can also control it differentially for different objects and different distances from the camera. So a background that would ordinarily appear to be as a flat backdrop can have stereoscopic depth. By the same token distant characters can be molded by being "shot" with an interaxial separation that is different from the interaxial separation that's used for the close characters. This manipulation of space allows for the maximization of the stereoscopic effect in a composition. Varying the interaxial differentially allows for amazing freedom of stereoscopic composition and modulation of depth effects.

Recent examples of these works are the films Bolt, Beowulf, Meet the Robinsons, and Monsters vs. Aliens. These films are outstanding examples of stereoscopic cinema. They are so well modulated and controlled – the shot-to-shot flow is so perfect – that there is nothing jarring, there's nothing disturbing, they do no harm. But they tell the story, and they tell the story with beautiful images – beautiful images that aren't the way you see the world, because of the departures that I've discussed and the means used to plastically manipulate space. These filmmakers have created a modulated three-dimensional universe – a perfected three-dimensional universe suitable for projection on a big screen.

But you can't accomplish the same effect today it with live-action capture. Today's technology does not allow us to do it. Live-action camera photography is accomplished with a fixed interaxial. The backgrounds are not going to have a different interaxial separation from the foreground. Today, for live action, we cannot engage in the manipulations possible within a computer graphics universe, and that shouldn't be a surprise. A major exception is with bluescreen or greenscreen. If you're adding CG backgrounds, then you have the ability to change the depth effect, which is produced, let's say, by one interaxial separation for foreground and another for background.

Stereoscopic cinematography has another limitation. Once the photography has been accomplished and an interaxial separation has been chosen, which controls the depth strength of the stereoscopic image, it's hard to change. We don't have a flexible technology that allows the manipulation of stereoscopic space in post, with this exception: the zero-parallax plane can be altered. But that's trivial; that just means by horizontally shifting the images you can produce the effect you want. All you can do by changing the zero-parallax point is to establish the boundary condition – that which appears in the plane of the screen and thus that which appears in audience space or in theater space. What we are missing with live-action capture is the ability to modulate the strength of the image to make it appropriate to telling the story, and you certainly can't control the stereo strength differentially.

It's important to be able to control the image and its stereoscopic aspects in terms of creating a sequence. A sequence or a scene in a movie is made up of a many shots cut together. These shots have to be stereo timed, just like shots are color timed in post. You can't time one shot in a sequence to look like it's on the beach and another that looks like it's at night. And you ought not to do the same kind of things for stereo-timing where one shot follows another with unmatched stereo strength.

We're now at a time when we're learning to look at stereoscopic images. What works today may be conservative tomorrow, but right now we have to be concerned with audiences accepting the images that are produced, and doing no harm. Do no harm, so that the audience feels comfortable when they are looking at a sequence. But the only manipulation we can use right now for cutting sequences is to control the zero-parallax position (and adding floating windows – but that's another story). But it's not enough.

I know that the stereoscopic cinema will flourish creatively once the kinds of creative controls I'm talking about can be fully manipulated by live action filmmakers. It will be a better stereoscopic cinema as the CG stereo supervisors have demonstrated. They are leading the way and there is no reason why we should accept limitations of live capture in the long run. In the short run there are technology problems, but in the long run what the stereoscopic supervisors of CG animated films have shown us is that it is possible to create a beautiful stereoscopic image flow.

What's the answer? The answer may be the process "conversion," or I call it "synthesis". There's a trade name for it that In-Three uses: Dimensionalization. In the Los Angeles area there are three companies that can take planar images and turn them into stereoscopic images: Sony Imageworks, In-Three, and Sassoon. There may be others, and if I've left you out, forgive me. The essence of these techniques – and the technology varies from house to house – is to synthesize one of the perspective views from the other. The process places the work in a world, for editing or post production, which is similar to computer graphics space where one can manipulate the strength of the stereoscopic image, effectively vary the interaxial separation between foreground and background, and produce a beautiful images and a beautiful flow.

The conversion process involves outlining objects in the shot, which in the movie business is called rotoscoping, filling in missing background material, and adding molding -in some cases by means of a depth map or some kind of a mesh so that the objects are not simply cardboard cutouts. There are other things that needed such as address transparency and reflections. Once you've created a database for a shot it's possible to manipulate the image – and, in some facilities, to manipulate it on the fly so the image can be tweaked just as you can tweak an image in a color timing session.

This is very important because visualizing a stereoscopic image is difficult at the time of cinematography. It's difficult to do because you're not, generally speaking, able to look at the image on a theater-size screen real time. A theater-size screen is anyplace from 20 to 70 feet across. It's hard to tell what a stereoscopic image is going to look like if you're looking at a small monitor. Now we have five- and six-foot and larger stereoscopic monitors. Those help a lot, and make it easier to compose stereoscopic images on the set.

Why is it hard to understand what a stereoscopic image looks like? For one thing stereoscopic images are weighted and scaled by extrastereoscopic cues, and therefore the choice of focal length or an interaxial alone doesn't determine the effect. It is a difficult art. It's hard to visualize what stereoscopic images are going to look like when they are projected during photography and next to impossible to visualize how the shots are going to cut together. That's because even if you've storyboarded the film, there are going to be changes. So when it comes to producing sequences it may become difficult to live with what you've shot. But synthesis can overcome these difficulties.

Display Industry Calendar

A much more complete version of this calendar is located at: http://www.veritasetvisus.com/industry_calendar.htm. Please notify mark@veritasetvisus.com to have your future events included in the listing.

June 2009			
June 22-25	Cinema Expo	Amsterdam, Netherlands	
June 22-25	CEDIA Expo Europe	London, England	
June 23-25	LOPE-C -- Large Area, Organic and Printed Electronics Convention	Frankfurt, Germany	
June 25-26	Korea Display Conference 2009	Seoul, Korea	
June 30 - July 2	Advanced Lighting 2009	Prague, Czech Republic	
July 2009			
July 8-10	China International Flat Panel Display Exhibition	Shanghai, China	
July 8-10	China International Touch Screen Exhibition & Seminar	Shanghai, China	
July 8-13	National Stereoscopic Association Convention	Mesa, Arizona	
July 9	Green Display Expo	Washington, D.C.	
July 10-13	SINOCES	Qingdao, China	
July 13-17	International Symposium on Display Holography	Shenzhen, China	
July 14-16	Semicon West 2009	San Francisco, California	
July 14-16	Intersolar North America	San Francisco, California	
July 15-17	E3 Media and Business Summit	Los Angeles, California	
July 16	2009 Small-Medium Display Forum	Taipei, Taiwan	
July 19-24	International Conference on Human-Computer Interaction	San Diego, California	
July 29-30	Japan Forum	Tokyo, Japan	
August 2009			
August 2-7	Chemistry for Electro-optic Displays Symposium	Glasgow, Scotland	
August 3-7	SIGGRAPH 2009	New Orleans, Louisiana	

August 16-18	Australasian Gaming Expo	Sydney, Australia	
August 20	Printed Electronics Workshop	Binghamton, New York	
August 31 - September 4	SLIDE 2009	Linz, Austria	
September 2009			
September 1	Digital Signage 2009	San Jose, California	
September 1-5	HCI 2009	Cambridge, England	
September 2	TV Conference 2009	San Jose, California	
September 3	Touch Conference 2009/Emerging Technology Showcase 2009	San Jose, California	
September 3-4	China FPD	Shanghai, China	
September 4-9	IFA 2009	Berlin, Germany	
September 6-9	China International Optoelectronics Expo	Shenzhen, China	
September 7-10	Foundation in Displays	Dundee, Scotland	
September 9-13	CEDIA Expo 2009	Atlanta, Georgia	
September 9-14	International Stereoscopic Union Congress	Gmunden, Austria	
September 11-15	IBC 2009	Amsterdam, Netherlands	
September 13-16	PLASA '09	London, England	
September 14-17	Eurodisplay	Rome, Italy	
September 20-25	International Conference on Digital Printing Technologies	Louisville, Kentucky	
September 20-25	Digital Fabrication 2009	Louisville, Kentucky	
September 29 - 30	Organic Semiconductor Conference 2009	London, England	
September 29-30	RFID Europe	Cambridge, England	
September 28 - October 1	Liquid Crystal Displays	Oxford, England	
September 29 - October 4	CEATAC Japan 2009	Tokyo, Japan	
September 29 - October 3	OLEDs World Summit 2009	San Francisco, California	
September 30-October 1	Printed Electronics Asia	Tokyo, Japan	
September 30 - October 2	Semicon Taiwan 2009	Taipei, Taiwan	

September 30 - October 2	Symposium on Applied Perception in Graphics and Visualization	Chania, Crete, Greece
October 2009		
October 4-7	Symposium on User Interface Software and Technology	Victoria, British Columbia
October 6-8	Semicon Europa 2009	Dresden, Germany
October 6-11	CeBIT Bilisim EurAsia	Istanbul, Turkey
October 7-8	Displays Technology South	Reading, England
October 7-10	ASID'09	Guangzhou, China
October 12-16	International Meeting on Information Display	Seoul, Korea
October 13-14	Asian Solar/PV Summit	Seoul Korea
October 13-15	Image Sensors	San Diego, California
October 19-22	Display Measurement -- Physical and Human Factors	Dundee, Scotland
October 19-22	SATIS 2009	Paris, France
October 20-22	LEDs 2009	San Diego, California
October 21-23	Integrated Systems Russia	Moscow, Russia
October 26-29	Plastic Electronics 2009	Dresden, Germany
October 26-29	Showeast	Orlando, Florida
October 27	Smart Textiles 2009	Dresden, Germany
October 27	Printed Silicon and Hybrids 2009	Dresden, Germany
October 27-29	Solar Power International	Anaheim, California
October 28-29	Plastic Electronics 2009	Dresden, Germany
October 28-30	FPD International	Yokohama, Japan