

3D at NAB 2009---Tools for Shooting, Editing and Displaying 3D Video

By Michael Starks © 2009

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As I have noted in my other articles, the installation of over 6000 3D digital cinemas, and an expected 20,000 more in the next 4 years, has stimulated the production of 3D films and this has led to a boom in nearly every aspect of stereoscopic imaging. I expected lots of products and interest at this years National Association of Broadcasters April show in Las Vegas and I was not disappointed. I even came out of semiretirement in China to put on my first exhibit of 3DTV Corp products www.3dtv.jp in 12 years. In the booth with me was Anthony Coogan of StereoMedia www.3dstereomedia.com who acts as our video production arm. We showed selections of StereoMedia's many commercial 3D projects as well as some superb surfing footage (shot by Per Peterson of Times Squared Films) on a 46 inch Hyundai CP (circular polarized) display using CP glasses made by 3DTV Corp. We also had the first public showing of our 3D Window Universal 3D Viewing system comprising the world's first multistandard LCD shutter glasses and emitters for home and Cinema. We had a Cunima HD SDI stereo camera connected to the new StereoBrain multiplexer and a Hyundai 24 inch CP panel and a 42 inch lenticular autostereoscopic panel from Magnetic 3D (www.magnetic3d.com).



Anthony Coogan (left) and Michael Starks in the 3D Pavilion NAB 2009

Let's begin with some comments about 3D acquisition means followed by editing and then displays.

The very compact Cunima HD SDI cameras (www.wige.de or www.sl-x.us in USA) , the MicroStorage solidstate recorder (cigarette pack size) and STAN stereoscopic image aligning software are all products developed by spinoffs from Germany's redoubtable Fraunhofer Research Institute. SI-x has also introduced the Megacine SSD field recorder which will record on HDD or flash drives up to an hour of uncompressed RAW or HD SDI from two Cunima's in Dual Link or Single Link mode.

As I have seen many times, various companies including Fraunhofer appeared in Bavaria's collective booth with cinema and video related products. They showed the STAN software controlling both a side by side pair of tiny cameras and a large

rig with a pair of Arri video cameras in a mirror box (various mirror boxes were shown by at least 6 from different companies at the show). Its simple GUI lets you control the stepper motors on which the cameras are mounted so that H and V movement is possible with one touch. They also provide for Y and Z axis corrections by image warping as TriD has for some years(see my TriD article). Warping is of course less than ideal as it will decrease resolution and tends to introduce other errors, so I suggested another pair of stepper motors and they knew this was a better solution. So the warping present in this device as well as in many other hardware and software solutions now being offered should be used only as the last step when misalignment is corrected as much as possible with mechanical and optical means. As I mention elsewhere here it should be easy to do automatic realtime stereorectification in cameras using algorithms such as those incorporated in Suto's StereoMovie Maker.

As I have noted previously, Pierre Boher of the French metrology instrument company Eldim <http://www.eldim.fr/> created the world's first stereoscopic metrology device, the VCMaster-3D in 2008 and it would almost certainly be of great help in creating well engineered 3D cameras and displays but I have not seen anyone refer to it.

It seems that none of the stereo videocamera makers and users have time to read my articles and they are unaware that for over 15 years there has existed the Ikegami LK33, a stereozoom camera that elegantly solves nearly all the terrible registration problems which they are struggling with. In addition to writing about it, I also shot 3D footage of Ikegami's LK33 expert Minoru Tsutsui demonstrating this camera at NAB in the early 90's, which I included in one of the four DVD's titled "3DTV Technology" which have been for sale on my page for 15 years. When I was CTO of 3DTV Japan in Tokyo in 2000 I met with the Ikegami 3D team and urged them to produce a digital version. I also showed them how they could make a single camera stereozoom system using a 120Hz camera and a rotating or electrooptic beam splitter (see my other articles for references).

The Ikegami LK33 uses a rotating prism to converge the lenses during zooms and is the only fully engineered professional stereozoom video camera ever made. However, it is standard definition and analog and, though it gives an almost HD image when upconverted properly, it needs to be updated to full 2K (or actually 4K--see my comments on SONY below)-not just to HD, as the 80 or so extra pixels of 2K permit horizontal shifting and cropping without blowup. Ikegami made 13 of them and Anthony Coogan of Los Angeles, who participated in the 3DTV Corp presentation at NAB, owns three which he has used extensively in commercial production. My collaborator Chang Lee of China has one, which he has used in the production of many commercial programs. They are a perfect choice for 3D intended for the small screen--TV, the web and videogames. All videogames are automatically stereoscopic if they are run with a 3D game driver and Nvidia has recently put much effort into supporting stereoscopic gaming. At NAB they showed a prototype of some Pro shutter glasses using RF sync (a concept I marketed in 1994) working with a Quadro card on an LCD monitor but it was quite dim. This seems to have been the only appearance at the show of the new 120Hz shutter glasses compatible LCD monitors which use fast LCD's synced with field sequential white LED backlights to achieve 120Hz.

Our contacts at Ikegami indicated that they would probably produce a 2K version for ca \$150K each if they get at least 6 prepaid orders. This makes far more sense than spending the vast amounts of time and money on the often bulky and rather imprecise and hard to use rigs that are available from Binocle, Pace, 3ality, and a dozen others. The Ikegami patents may be public domain by now so anyone could



Ikegami's original stereo zoom camera in 1990 cost \$90,000 & has been improved by them & several of it's users.

use the

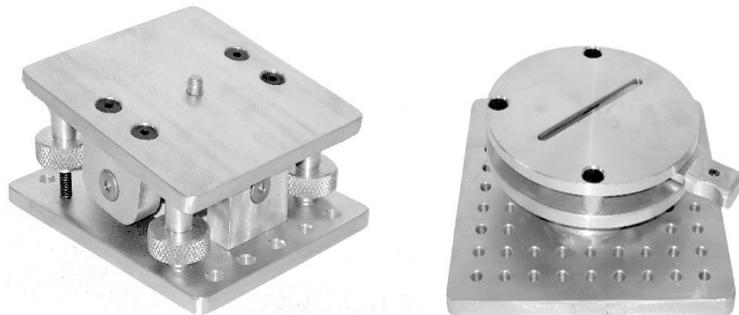
principle, or they could buy several of them used and reengineer them into 4K cameras. StereoMedia has modified the camera in various ways, including the creation of a remote. However, the best choice is for Ikegami to make them and I expect they would sell between 50 and 100 within a year of release. The point is that to make a pro stereo camera requires a sustained effort by a team of full time professional engineers with the resources of a major video camera company who will design it from the ground up, rather than the many heroic efforts detailed here to fix the binocular asymmetries in a pair of cameras with lots of tiny motors and software. Those who have read my article on 3DX –the world's first 3D Digital Movie Expo in Singapore last November—will recall how Cameron's special 3D message to the Expo was skewed slightly in all 3 axes. Considering that only God has more resources for making good 3D movies, this was discouraging. And, if I had the footage to examine, I suspect there would be other noticeable binocular asymmetries as well.

Of course there is a large patent literature on stereoscopic video cameras going back half a century (see my other articles), and the other Japanese camera companies have not been asleep. I cite only one recent patent on a stereozoom camera by Sony.



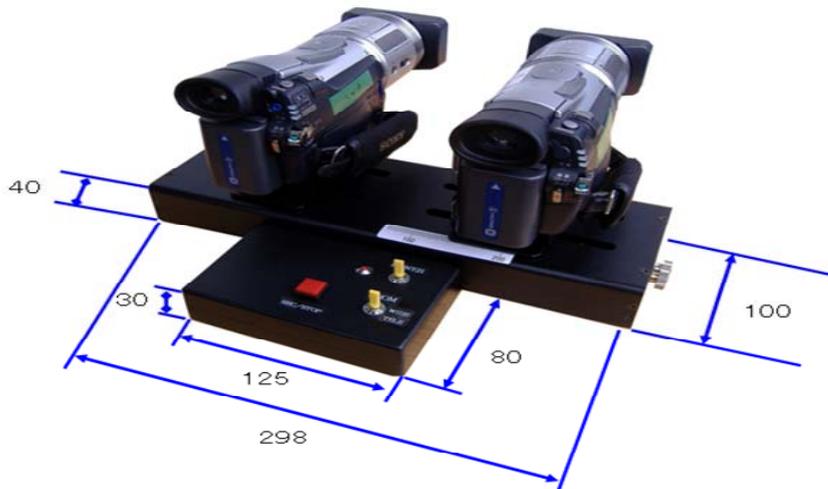
With a pair of these cheap (\$600) and small mounts one can quickly make fine manual adjustments.

Manfrotto makes a similar device but my one attempt to use it was not satisfying. For those with bigger cams and larger budgets there are several other choices also



sold by 3DTV Corp.

Below is another relatively low cost solution for those using small cameras—the \$6000 StereoBar Pro from 3DTV Corp. It permits convergence and horizontal adjust and with a couple Model 5 levelers its easy to align in all 3 axes. It also has a built in 3D LANC controller so most functions are synced for those Sony and Canon models with LANC ports.



There was much blather in the show media about a new "Holographic 3D" technique for live video, but as I have seen many times before when this word is used, it was just a multicamera technique and had nothing at all to do with 3D or holography. However the Japanese research institute NICT was at the show with its newest electronic holography display, which most viewers found unimpressive in image quality and is certainly a long way from commercialization. You don't get something (e.g., hires look around no-glasses 3D) for nothing and the huge bandwidth requirements of video holography have prevented it from becoming a practical reality. They also showed a small volumetric display in which the pixels are displayed in a Lithium Niobate crystal, which is excited by intersecting lasers. Display professionals or readers of my other articles know these are not new ideas, though technical advances permit their continual refinement.

The Japanese TV company NHK was again present with some advanced video and 3D technology. They showed a small integral autostereoscopic display. Also called 'fly's eye lens photography', this method uses numerous small lenses to capture and display hundreds of small images which provide H and V parallax 3D without glasses. The astute will deduce that it also requires very high bandwidth and in fact the small grainy display needed the high bandwidth of NHK's

experimental 8K cameras and projectors. Integral imaging was first done by Lippmann over a century ago and has never had any practical application. Nevertheless, it is technically intriguing and there is continual work on it by various private and public institutions.

They also had a small 3D theater showing still images of the moon taken from their Kaguya satellite. The enchanting pictures had stereo bases (i.e., interaxial) up to 2km but they were inevitably full of binocular asymmetries and were a bit difficult to view. NHK has installed some 8 special purpose 3D theaters, all in Japan, except for the Olympic 3D Theater in Lausanne.

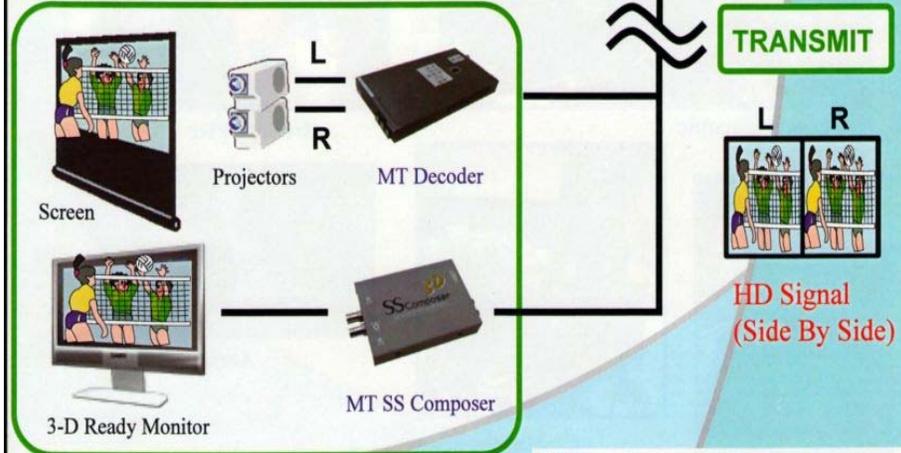
Of greater interest is the entry of NHK MT (not NHK which is a television network like BBC or NBC) into the international commercial 3D arena. Like about 20 other companies at the show, they had 3D flat panel displays viewed with circular polarized glasses showing 3D content they had made. They have an extensive array of specialized 3D camera rigs including aerial units, lens shifters, micro, high speed, hyperstereo, underwater and remote and of course, both side by side and mirror box 3D cameras (see photos), with a whole van full of supporting equipment which they can contract out, complete with crew if desired. Nearly all the info on 3D equipment and software of NHK Media Technology (NHK MT --affiliated but independent of NHK) is described on their Japanese page (i.e., not in English) at (www.nhk-mt.co.jp/nts/eng/index.html) but they now have a branch NEPA, located in the USA (www.nepamerica.com) which, in addition to doing 3D production (principally with SONY HD 1500's as of mid 2009), will sell and rent hardware such as the L/R Composer, S/S Composer and L/R Composer 24(24P) and the corresponding encoder and decoders for the various formats. One should understand that it is NHK MT which has worked on 3DTV for 20 years while NHK is concentrating on the 8K Super HiVision system, which (as I commented in my other articles) is currently installed in various locations in Japan.

3-D LIVE SYSTEMS WITH YOUR OWN CAMERAS & CREWS

STADIUM



THEATER



NHK Media Technology, Inc.
<http://www.nhk-mt.co.jp/nts/eng/index.html>



NHK Enterprises America, Inc.
<http://www.nepamerica.com/>

3-D HDTV Variations Available From NT

Live Ready 3-D Cameras



Lens Shift Adapter × 3sets



HDC-1500 Beam Splitter



HDC-950 Side By Side



Remote Camera System

Special Effect 3-D Cameras



Hyper-stereoscopic



Underwater



Miniature



High-Speed



Aerial



NHK Media Technology, Inc.
<http://www.nhk-mt.co.jp/nts/eng/index.html>

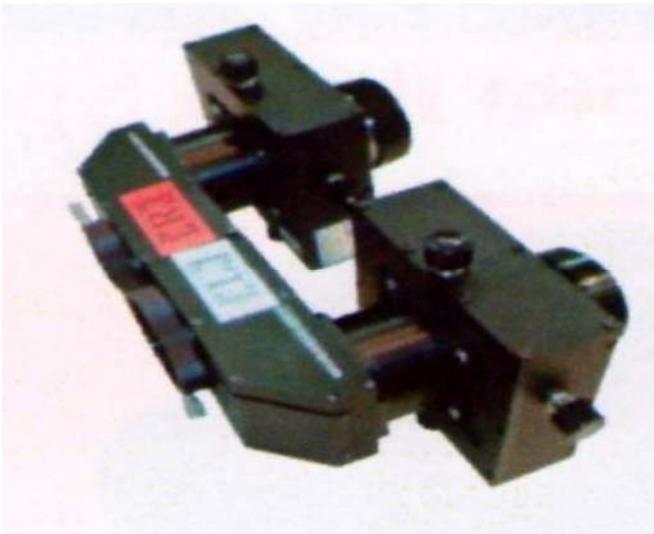


NHK Enterprises America, Inc.
<http://www.nepameric.com/>

The item which I find unique and of greatest interest was shown, but not emphasized, and that was the MT 3D Lens Shifter. This is an optical device that sits in front of both lenses of the two cameras and permits horizontal shifting of camera lenses without moving the camera nor its primary lens. That is, it enables one to get the normal desired 65mm interaxial with any cameras. It disposes of the need for the costly, bulky and problematic mirror boxes and solves the horrible problems I discuss in my recent article on Stereo Camera Geometry--how to control

the interaxial and stereo window without moving the camera and thus creating alignment and convergence problems. I don't think anyone else has given this serious thought and NHK has solved it. Score one for the Japanese! In its current form it is fixed at 65mm and it's a brand new patent pending device not yet available. Fujinon, in conjunction with NHK MT, has so far (mid 2009) built only two and the second one cost MT ca. \$65K to make. Sale or rental has not been decided. Clearly the cost could be reduced to maybe a tenth if it were made in China.

It is an obvious design to any good optical engineer, once the problem is described to them, and other designs are possible, and are likely to be present in the vast prior art in the patent and technical literature. One could make it with a variable interaxial (say from 300mm to 1 mm) and control it remotely and even let a program like Suto's (see below) automatically change the interaxial as the subject or camera moves. Stereographer A. Melkumov of NIKFI in Moscow has built a related prismatic device. Until then, everyone will stumble along with painful slow setup and misalignment issues, the clumsy and bulky mirror boxes, and the attendant horrible problems in post. To my mind, in spite of the many brilliant electronic, optomechanical and programming works of others, this gets Best of Show in 3D, not for technical complexity, but for showing the first step for lens shift devices, which should greatly facilitate shooting and the progress of the entire 3D industry.



NHK MT Lens Shift Adapter

Although I have great admiration for NHK, it annoys me that for 10 years they have bought up the 3D rights to the Olympics, and then never shown them to anyone, except in the 3D theater they designed for the Olympic Museum in Lausanne, Switzerland. However it is the IOC one must blame for this as they make it expensive and difficult to get any Olympic footage even in 2D which seems to me an outrage. The member nations should force them to release all the 2D and 3D Olympics on DVD immediately!

NHK has been making 3D programs since 1989 and have produced some 400 titles, so this constitutes one of the largest bodies of nonfilm stereo in the world. However most of them are very short and owned by the entities who paid for them. About 30 programs were done solely by NHK and are available for rental of about \$15,000/year.





Synchronous Zoom Lens



Hyperstereo Rig



Standard 3DHD Camera Rig



Bug-Eye Ultra-Wide Lens





Underwater Housing and an Arctic example



Image Splitter Rig



Aerial shooting using a remote-controlled helicopter

PHOTOS OF VARIOUS NHK 3D CAMERA SYSTEMS -- Courtesy of NHK Media Technology

Though I did not see it being used in a stereo pair, Canon's 5D Mark 2 21 Mpixel camera is a stereographer's dream, but it has been such a success that it seems to be sold out in advance until well into 2009. With pixels to burn, it is feasible to shoot stereo with one Mark 2 using a side by side 3D lens, as my friend Allan Silliphant demonstrated at the show. It looks like one of Canon's 35mm still cameras and a wide range of filming accessories are being made for it. It is currently limited to 3.9 fps at max. res. With suitable inbetweening it still may be useable for much video work and it will undoubtedly be copied and the frame rate increased.

Panasonic had a 3D camera prototype in its booth (with poorly registered images), but for the shutter glasses 3D show on its 103 inch Plasma Panel there was footage from Pixar's 3D animation of CARS. This is the world's largest PDP but it is a dinosaur and I expect the whole PDP market to disappear in a few years as LCD, DLP and other technologies replace it. However Panasonic(Matsushita) is one of the world's largest electronics companies and they have a huge investment in PDP so

they are continuing a major push for large screen 3D PDP and it is not out of the question that they could find a niche in theatrical screens using shutter glasses as a replacement for projectors (as I have noted elsewhere).

NHK made a prototype 3D PDP a decade ago and Samsung has fielded a 42 inch PDP with shutter glasses over a year ago but most people find that it has excessive ghosting. My friend Mr. Lee made a 103" PDP into an autostereoscopic barrier display about two years ago, but it showed one of the severe limits of the PDP when it's vacuum seal broke during shipping and, due to the huge cost of shipping and repair, it is now a \$100K paper weight. Those in Las Vegas who have a compelling urge to see 103" PDP (in 2D) can go to Sam's Town about 2 miles from the strip which claims to have the world's largest number of them in one location.

Elementtechnica (www.elementtechnica.com) is another S. California firm with new hardware and software (mirror boxes, stereobars, software). For the 3D film "The Dark Country", they provided a rig small enough to fit in the Alien Revolution (a camera stabilizing device from MK-V (<http://www.mk-v.co.uk/>) and use it with a Steadicam (the original camera stabilizing device). They will rent such rigs for ca \$3K/day. In their new persona Technica 3D they were somewhere at the show, but I did not have time to track them down.

P&S Technik (www.pstechnik.de) of Germany is a rising star in the 2D and 3D video hardware industry. With Silicon Imaging, they have developed the SI2K digital video camera that is seeing lots of action in 2D (e.g., the Academy award winner Slumdog Millionaire) and 3D --shoots by 3ality and others. They also make four models of finely crafted mirror boxes for various size cameras/lenses) starting at \$28K as shown here from various angles.



The P&S Technik Mirror box beam splitters start at \$28K

P&S has also partnered with the video software company IRIDAS -www.irdidas.com -to put some of their software into the OneBox, which permits realtime digital effects and playback with their SpeedGrade software, which supports RAW including the newest realtime RAW 3.0 (the format of many digital cameras including RED, SI, Weisscam, VR, ARRI etc) and CinemaDNG. CinemaDNG RAW is an industry-wide open and documented file format for digital cinema acquisition currently developed by a consortium of hardware and software manufacturers, led by Adobe. IRIDAS software also interfaces with other industry standard hardware and software such as Cine-Tal's Davio (offering realtime display of 3D SDI for approx. \$4500), Adobe's Flame, Blackmagic's HD Link Pro SDI-DVI converter, Tangent's CP-300 Wave control panel etc. Like most companies in this field IRIDAS now offers stereoscopic support. In their own words: "Stereoscopic playback on your workstation using shutter glasses or stereo displays. Supports all common postproduction file formats, including frame sequences. Full movie length review in your digital screening room includes the latest technologies such as dual SDI, dual DVI, interlaced, TI-pattern..."(i.e., the Texas Instrument checkerboard format 3D Ready DLP TV). Their cheapest software is \$299 but the most expensive exceeds \$45K! Mini remote head for handheld or stereo-3D shooting and Iridas Speedgrade is also embedded in cameras such as the SI-2K for 3D-LUT and live green screen keying visualization and this and other new cams now have detachable

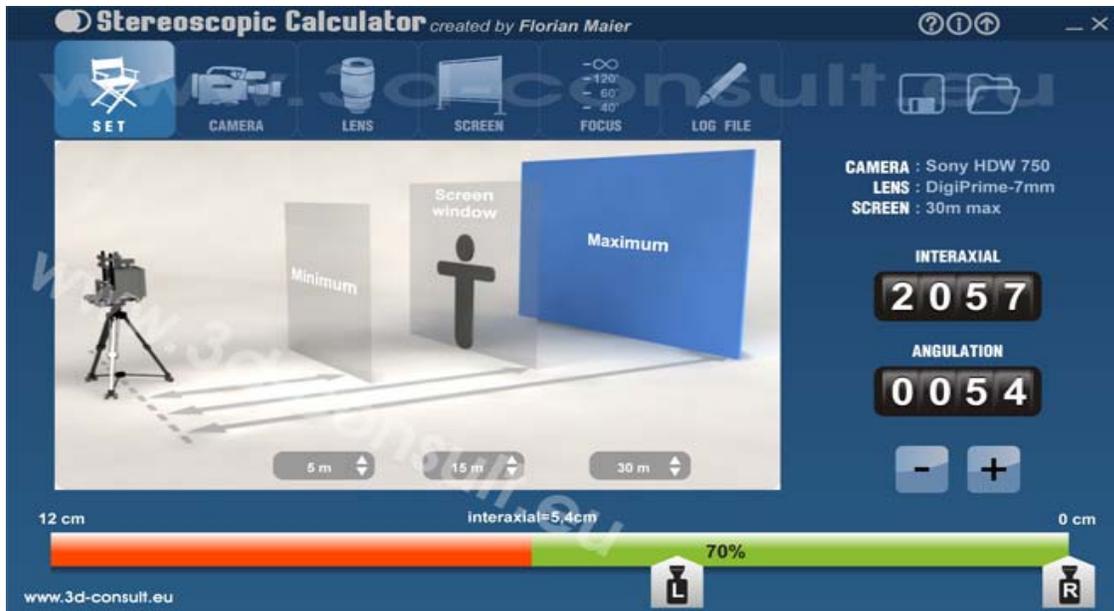
imaging heads so they can be remoted (usually by wire now though wireless is feasible) in 2D or 3D up to 50M or more from the CCU (i.e., the rest of the camera electronics and recorder).

High end video editing hardware company Quantel (www.quantel.com) showed a plug-in by Spatial View called Waszabee 3DeeShell that enables 3D images to be displayed on autostereoscopic displays, including the iPhone 3G (fitted with a special screen). Spatial View is a Canadian entity that seems to be funded by a Swedish health care company, with other connections in Germany, and like DDD, Sensio, Virtual Motion and many others, their continued survival in niche 3D markets is amazing.

Doremi's (www.doremilabs.com) previous involvement in 3D has been its 3D compatible digital cinema servers and they have now produced the GXH-3D 3D encoder/decoder to enable 3D on their (and others) 2D equipment. Like the other devices mentioned here, it can accept dual SDI and put out SDI, HDMI or DVI in various 3D formats. With their Asset Manager software, 3D files can be played back with Doremi's Nugget and V1-UHD boxes.

Keeping up with the others, Da Vinci Systems has introduced the Resolve R-3D editing system with capability of realtime stereoscopic color grading (i.e., color correction). The DaVinci has always been at or near the top in high end editing hardware and I used it to reduce white gamma for flicker reduction in 60Hz field sequential 3D video almost 20 years ago.

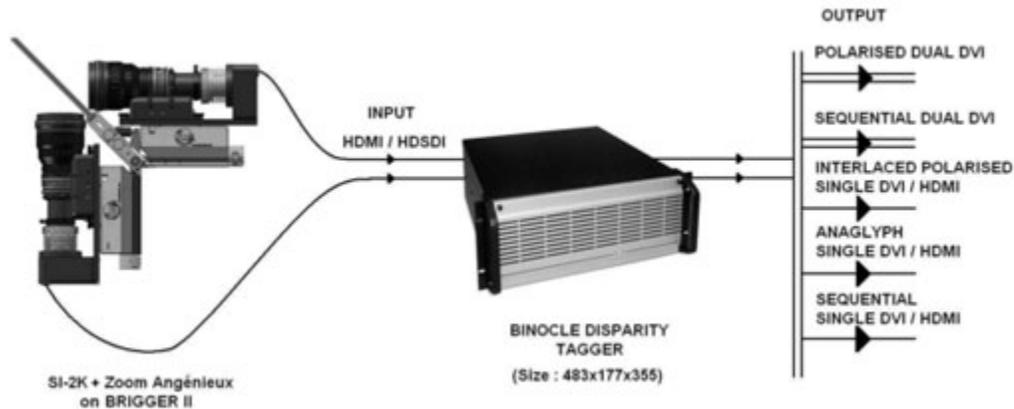
P&S Technik is also collaborating with German Engineer Florian Maier who, in addition to designing various stereo hardware, runs workshops on 3D cameras and has created the lovely Stereoscopic Calculator software to facilitate setup of cameras (www.stereotec.com, www.3d-consult.eu) shown here.



Florian Maier's Stereoscopic Calculator

The basics of how to shoot have been understood for at least 50 years and my extensive research into the prior art was presented in the book *Foundations of the Stereoscopic Cinema* (1982), now freely available on the net (e.g., <http://3d.curtin.edu.au/library/foundation.cfm>). Various researchers have programmed calculators to facilitate setup and rigs with computer control of 3D camera functions have a long history. As noted in my recent review of stereo camera geometry (www.3d.tv.jp), a definitive reference is the book by Diner and Fender *Human Engineering in Stereoscopic Viewing Devices* (1993). Bernard Mendiburu has just published a book- *3D Movie Making*(2009) which is very useful, in spite of it's many imperfections (which will doubtless be corrected in the 2nd edition).

Binocle (www.binocle.com), a small French company specializing in 3D, has created various rigs which appeared in the booths of Angenieux Thales and of Silicon Imaging. Here is a diagram of one of their mirror boxes with attached image processor and photos of their mirror rigs.



Binocle digital hardware and mirrobox rigs

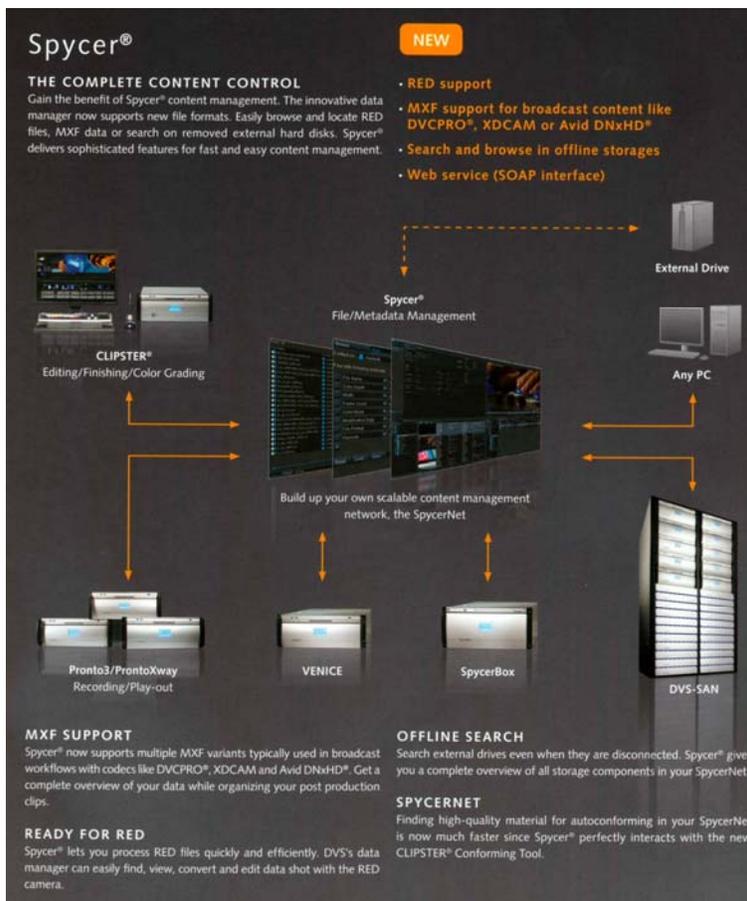
Here is an example of the 3D digital flow for the recent 3D film *My Bloody Valentine*. 3D digital files from pairs of RED and of Silicon Imaging's SI-2K cameras were converted to SONY HDCAM SR (1920x1080) for offline editing and then converted into DPX files and conformed in Autodesk's Smoke. The two image files were then color graded in a Da Vinci using a projector calibrated in DCI-P3 linear color space and re-rendered as DPX files, which are converted to TIFF files in XYZ color space. These files were transcoded by Technicolor Corp into JPEG 2000, combined with the 24 bit 48K WAV audio files and wrapped into the encrypted MXF files for the final DCP (Digital Cinema Package) of approximately 200GB for mailing as hard drives (the normal method) or DVD's to those 3000 or so licensed DCI (i.e., Digital Cinema Initiative) theaters currently (mid 2009) able to

play 3D. There are numerous other hardware and software options at each step, except the last one, where only a handful of companies are licensed to create software to encrypt the film into the DCP compatible with playback in DCI licensed theaters. DCI theaters have 3 Chip 2K DLP, one chip SONY 4K LCOS or Dual 2K projectors with servers and 3D viewing means, all of which have been approved and serialized by the DCI consortium (i.e., the monopoly established by Hollywood to control distribution of digital films to the 8000 or so Digital Cinema theaters). The other 120,000 or so cinemas still use film and so the films must be printed and distributed to them in the classical way on reels. It is my impression that the current crop of 3D films are not being printed on 35mm film and are shown only in the 3000 digital 3D theaters. In any case initial release is certainly digital.

Technicolor has revamped the old top/bottom split frame format with new lenses for 35mm 3D film projection with crossed polarizers, and we may see wide releases in this form as the costs and trouble will be small compared to a new digital installation. Afaik, it does still have all the problems of binocular asymmetries in dual polarized projection, and the possibility of pseudoscopic images that always plagued the 3D cinema. It will also make it easy to pirate 3D DVD's but nevertheless it will greatly increase revenue so I assume it will happen.

DVS (www.dvs.de and www.dvsus.com), one of the suppliers of hardware and software for DCI compliant DCP's, showed their newest products including a slick silver box named Clipster which enables realtime production of a final DCP complete with KDM (i.e., encrypted with Key Delivery Message for transmission to the theater) if desired. The DCI Mastering Wizard makes it very easy to conform your files into a stereo master. Once you have made your file Right and Left EDL's(i.e., the Edit Decision Lists generated by standard digital video editing software) you just drag and drop them into the timeline and both streams will edit simultaneously with output in HD-SDI or DVI in a variety of stereo formats. Following the DCI stereo specs the R and L files as BMP, TIFF, PNG, DPX etc are converted into a single RLRL alternating 48fps JPEG2000 X'Y'Z' file. For 3D films

this is played out as 96 or 144fps and can be tested with Clipster's D cinema emulation mode in just about any stereoscopic format. Subtitle emulation and multilingual DCP's and formats up to 4096x 2160 at 24fps are also supported. DVS has a whole series of elegant boxes for just about any type of Digital Cinema function possible including the Cine4K for playing uncompressed 3D at 4K and 24fps or compressed at 60fps out dual channels, the ProntoXway for playback of 2K 3D content and the Venice videosever supporting common broadcast formats such as AvidDNxHD, XDCAM and DVCPRO.



The 3D ready Clipster and the rest of the Content Control System from DVS

You can find the DCI stereoscopic specs for the DCP at [http://www.dcmovies.com/DCI Stereoscopic DC Addendum.pdf](http://www.dcmovies.com/DCI%20Stereoscopic%20DC%20Addendum.pdf) and info on

JPEG2000 and security issues at <http://www.intopix.com/>.

Nearly all the editing, effects, and compositing packages used for professional film work already have at least some stereoscopic functionality and this is being upgraded rapidly. E.g., Adobe's Lustre 2009 permits color grading of stereoscopic timeline both for live action and CGI stereo content so that colorists can access the full toolset in 3D (with various display modalities such as dual projector output) or in separate right and left layers at all times. Color grading, timeline, parallax etc are prioritized and integrated with Maya (for modeling and animation) and Toxik (for compositing) with ganging (i.e., automatic simultaneous correction of both eyes-now standard in stereo editing software).

Avid has begun offering stereo 3D editing with Media Composer v3.5. HD 3D images can be combined by their free program MetaFuze in various formats including the proxy 1920x540 top/bottom compressed format (I.e., the classic format supported by many companies for 25 years including the hardware and software of Neotek and 3DTV Corp.). With the dongle (hardware interface) from 3DTV Corp and any of the new DLP LINK 3D Ready 120Hz projectors (e.g., the PJD6220-3D Viewsonic) coming available from various manufacturers, this format can be projected for viewing on any screen with shutter glasses. R and L file metadata from tapes or digital files can be exported by Avid EDL Manager or by Avid Filmscribe (XML).

The 3D@Home consortium (www.3dathome.org) held another in their series of 3D symposia, which provided talks on various aspects of 3D imaging relevant to broadcast and home viewing. I interjected a few comments to create awareness of some points not widely known: 1). I introduced the world's first home electronic 3DTV system using LCD shutter glasses at the CES in Las Vegas in Jan. 1990 so there is a long history that few are aware of. 2). The excellent schema presented by Chris Chinnock on stereo imaging modalities is nicely supplemented and extended by the paper of Vasily Ezhov published in EuroDisplay last year, which I cited in

the review on my page (the review also published in the 3D Newsletter http://www.veritasetvisus.com/3rd_dimension.htm). 3). The chaos of incompatible LCD shutter glasses protocols will be ameliorated by the Universal glasses and emitters which 3DTV Corp will release this year. 4). Though I too am fascinated by the many technical advances, we ought to keep in mind that it is likely that 3D video will come to the masses in our lifetimes in a major way only via anaglyphs and it appears to me that the best of these is a variant of the orange/blue method, which I call SpaceSpex, which has been illustrated and described on my page since 1993 (<http://www.3dtv.jp/spacespex/spacespex.html> and in my recent SpaceSpex article downloadable from the opening page). E.g., if one looks at live action 3D such as the Chuck 3D ad on [www.youtube.com](http://www.youtube.com/watch?v=vNyqwgI5jic) (<http://www.youtube.com/watch?v=vNyqwgI5jic>) also available on many other sites or the full show from series 2 episode 12 on p2p or at the 3D stills available on ColorCode's page (www.colorcode.com) with the ColorCode glasses vs SpaceSpex you will see better color and more than double the brightness. No contest, provided the H parallax is minimal, either due to good editing of the film or to use of one of the stereoplayers with image registration and manipulation abilities such as Suto's StereoMovie Maker. Keep in mind that all these images were created for the ColorCode filters, and the difference is even more striking when the images are tweaked to match the SpaceSpex filters, such as those mentioned above in the SpaceSpex gallery and the SpaceSpex article on my page. There are four models of SpaceSpex, A, U, C and E, so that one may experiment and pick the one that's best for each application. This will vary depending on the type of program, its dominant colors, the color reproduction of the camera and editing and playback system and of course the display. They are all brighter and have better color than ColorCode glasses.

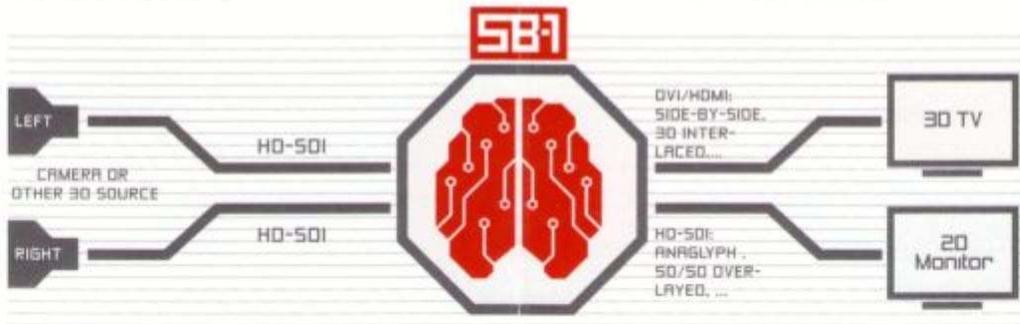
Several excellent players for stereo video files are available which permit realtime anaglyph output in various formats including yellow/blue. One of the best is the player in Suto's StereoMovie Maker <http://stereo.jpn.org/eng/stvmkr/index.html> which permits H and V adjust, R and L gamma correction, stereo window

manipulations, and even automatic image registration with file save --and it's free! Wimmer's StereoScopic player http://www.3dtv.at/Index_en.aspx also has many nice features but it times out in 5 minutes unless you buy it for ca \$50. A new version appeared in October with many improvements, including support for 3DTV Corp shutter glasses hardware. There is also the editor and player in ColorCode's new software, downloadable for ca. \$200. Please see the latest version of (currently October 2009)my recent article on SpaceSpex for further details on anaglyphs.

One of the more useful pieces of hardware introduced at the show is the modern successor to the analog stereomultiplexers I introduced in the early 90's--the StereoBrain SB1 (ca. \$3500) from the British media firm Inition (http://www.inition.co.uk/inition/product.php?URL_=product_stereovis_inition_stereobrain_p&SubCatID_=81). Small enough to easily fit in a cigar box, it will multiplex a pair of HD-SDI cameras or the dual spigot workstations such as Quantel and Avid, for output in various DVI/HDMI stereo formats such as anamorphic (squashed) Side by Side, anamorphic above/below (e.g. 3DTV Corp, Neotek, TriD etc), subtractive, frame sequential (page flipped), vertical line interlace (e.g., for the now common CP LCD panels from Hyundai etc), anaglyph or 50/50 mixed (for alignment on 2D monitors) or all the above as HD-SDI single channel except for frame sequential. It includes mirroring on either axis for use with beam splitter rigs (i.e., mirror boxes). Upcoming models SB-2 and SB-3 will include vertical and horizontal adjustments, zoom, dekeystoning and dual HD-SDI output (e.g., for dual projection or dual polarized displays). The DVI and HD-SDI can be used simultaneously with different formats. Inition also has a program called StereoBrain which can be used for calculating stereo shooting parameters. A trial version can be downloaded and is also on Mendiburu's DVD included with his book "3D Movie Making". It should be easy to include automatic image registration and stereowindow algorithms such as those included in Suto's StereoMovie Maker (see above).

STEREOBRAIN 3D PROCESSOR (SB-1)

This model is designed for monitoring of live stereoscopic camera systems, or output from a post production workstation, on one of the latest breed of 3D TVs. It is also capable of showing a mixed left/right feed or anaglyph on a standard 2D HD monitor which is an alternative for camera alignment during shooting.



It should be kept in mind that if one has genlocked cameras, the old model analog composite muxes or mixers are cheap and as useful for aligning the two cameras as the costly modern digital ones. Also the ability to correct binocular asymmetries with image warping does not obviate the need to optomechanically align the cameras as precisely as possible since such warping always has a cost in terms of image quality, to say nothing of the huge amount of time it takes. The extreme case is stereosynthesis in which the missing stereo video image is created by a program from a single 2D image and Sensio of Canada presented their attempt at this miracle in the JVC booth, as they have done for the last 4 years. It looked the same as other realtime 2D to 3D work--some depth but profoundly unsatisfying. Offline efforts work better but are hugely expensive as they require the only program that knows how real stereo should look--the human brain. There are numerous companies banging the drum for their own 2D to 3D conversions but I have yet to see one that is truly suitable for a feature film and I am sceptical that it really makes sense to spend the money required to do the careful manual scene to scene correction required for top quality 3D.

A related, but much more generally useful user programmable device for digital

cinema workflows, with some stereo image processing functions which could enable its use as a camera mux or display playback unit is the Cine-Tal Davio (www.cine-tal.com). This cigar box sized item selling for ca. \$4K is a MAC or PC user configurable interface for digital video and computers, has an LCD display, USB, ethernet and CF card (Compact Flash card) ports and has I/O for HDMI 1.3, DVI-D and HDSDI. It has separate 3D LUTs (Look Up Tables) for both inputs and one D LUTS for all 3 outs. You may download the manual here http://www.cine-tal.com/products/PDF/Davio_lo.pdf. It accepts separate left and right inputs with display as pixel mesh (L/R alternate pixels at 1080/60P on DVI output), line mesh (aka KORD, left/right alternate lines, line interlace, MicroPol, Arisawa), frame sequential, SbyS or anaglyph for all outs (SDI 1, SDI 2, HDMI) at SD-SDI, HD-SDI, H-SDI 4:4:4 Dual Link(dual 1.5GB/s) and HD-SDI 4:4:4 single link (3.5GB/s).

HDMI™
HIGH-DEFINITION MULTIMEDIA INTERFACE

Supports both DVI-D and HDMI 1.3
Davio supports DVI-D based digital computer displays and HDMI video support for devices supporting HDMI 1.3. Use Davio as the ultimate bridge between professional equipment and consumer devices or computer graphics cards.

3Gb/s HDSDI IN
3Gb/s HDSDI IN
HDMI / DVI IN

3Gb/s HDSDI OUT
3Gb/s HDSDI OUT
HDMI / DVI OUT
USB A/B
Gb Ethernet

CF Card

3Gb/s SDI

Davio offers two full HDSDI 4:4:4 3Gb/s inputs that supports both standard definition SDI, HD-SDI, HD-SDI 4:4:4 Dual Link (two cables at 1.5Gb/s) and HDSDI 4:4:4 at 3Gb/s (single cable).

3Gb/s HDSDI
4:4:4

Davio is the ideal solution for HDSDI 4:4:4 RGB and 2K film monitoring. 3Gb/s SDI provides full resolution 2K feature film quality 2048 x 1080 video to be connected via SDI

Cine-tal's Davio

Another stereo camera manipulation tool was shown by the Fraunhofer-HHI Institute in the Bavaria collective booth, which had film and video related products from a dozen companies with 4 or 5 featuring 3D devices. Fraunhofer produces a large body of high tech work with many spinoffs and has always had some stereo projects. The tiny (182g) self contained Cunima HD-SD microcamera (full HD with 2K model 2 to appear soon) marketed by Wige (www.wige.de) is one such spinoff. It was shown in several booths in a 3D configuration.

Fraunhofer's Stereoscopic Analyzer (STAN)(http://www.hhi.fraunhofer.de/fileadmin/hhi/downloads/IP/Stereoscopic_Analyzer.PDF) is hardware and software which controls stepper motors that align the cameras interaxial and zoom at the touch of a button and display the results graphically. In addition to output in various stereo formats, it also calculates and displays the stereo disparity and other metadata for realtime analysis or for use by editing or image processing programs in post. STAN enables automatic correction



(i.e., one touch) of geometric, colorimetric, vertical and zoom disparities by image warping. However, as I pointed out and they agreed, it would be better to add other stepper motors to minimize these errors mechanically and only apply the

warps as a last resort. It was demonstrated both with a large pro rig using a pair of Arri videocameras and a mirror box and with a tiny (i.e., even smaller than the Cunima) S by S pair of their newest MicroHDTV cameras. (photo below).



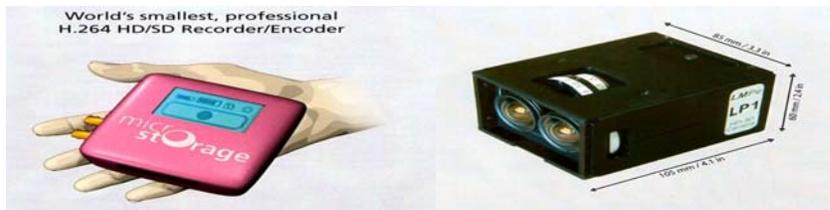
3D display was on a Miracube 32 inch monitor with CP glasses. As with several other booths I provided 3DTV Corp's own CP paper glasses for them once all the nice plastic ones had disappeared. As with all Fraunhofer-HHI products STAN and the MicroHDTV will be commercialized by licensees, probably including Wige and Arri.

They have also created a fully DCI compliant DCP (Digital Cinema Package) software for converting edited content into a form ready for theatrical release. This software, easyDCP comes in 3 versions each of which provides some support for stereoscopic films (www.dcinema.fraunhofer.de for a free trial download).

Another company with 3D products that I believe are Fraunhofer spinoffs was MikroM of Berlin (www.mikrom.com). The LP1 is an ultracompact (8.5x6x10.5 cm) SidebySide HD 3D camera with a 34mm interaxial sealed in a box with separate CCU. They claim adequate 3D up to 4M and I think that's about right. They also showed what they say is the "World's smallest professional H.264HD/SD Recorder/Encoder" the MicroStorage. With a touch screen for control and up to 8

hrs recording on a single 32GB CF card, and options for ASI out, DVR functions and Metadata capture and TS ingestion, it is a bit larger than a pack of cigarettes. For those needing uncompressed field recording they have the Megacine, a box containing 16 notebook HDD's (also available in a flash version) with up to 2 Terabytes capacity, Dual Link support, 3D features and a wide variety of supported video formats. Here is how MikroM describes the 3D Workflow of their current compact field recording system:

"For Presentation we show the new JPEG2000/MPEG-2 Player called MVP200 that features perfect picture quality at 2K over HD-SDI and DVI also for 3D (stereoscopic) Cinema. The featured 3D workflow combines two Cinema cameras of WIGE with MikroM's portable Field Recorder Megacine. It's uncompressed recorded material is transferred to the IT back-up system using MikroM's software MediaPort and there converted into JPEG2000 MXF by MikroM's MediaEncode software. The playout is done by the MVP200."



The MikroM MicroStorage Recorder and LP 1 Camera

In the last few years the use of the MicroPol technology developed by Arisawa Engineering of Japan has become common for flat panel displays. The simple idea is to create a matrix of horizontal lines of circular polarizer which is then aligned with the alternate rows of pixels on a flat panel display. This was done by them about 15 years ago and afaik first marketed internationally at that time by VREX as a laptop. It has angular limitations in both the vertical and horizontal direction as well as distance but this varies a great deal depending on how the panel is made and the more recent ones are superior. Hyundai quotes angular viewing zones of 178H and 20 vertical for the 46 but less for the 22 and 24 inch models, which I find

unsatisfactory. They offer a 3D Visualizer/Open GL Driver for displaying various graphics apps. Like some of the other panels they contain the TriDef chip from DDD for demuxing stereo content into the panel's format.

Miracube (Pavonine) has had various sizes of CP flat panels for at least 5 years but the Hyundai 46 inch panel has gotten most attention recently and it was the one we used in the 3DTV Corp booth. Panels using this tech from JVC and Sony were shown in various booths and they were at least the equal of the Miracube and Hyundai. Of course without seeing the identical images on them it is impossible to say which has the edge. The JVC's are being introduced into the market now, but the Sony's are prototypes. The 46 inch JVC's have their own chip for demux and will accept both side by side and line interlaced images and, unlike the Hyundai, it is full HD, has 3 HDMI jacks and a dynamic backlight. At the present time most of the displays are fed direct from pc's but it is feasible to use suitably formatted BluRay DVD's as we did in our booth.

I have long attempted to interest the security market in stereocameras and finally someone else has tried it. Astrodesign (www.astrodesign.co.jp) showed an HD-SDI stereo zoom camera with automatic convergence control, set in an industrial weatherized PTZ housing. It was created by Digital Design Studio (www.ddstudio.co.jp) but don't waste your time looking on either page for info now --as of the end of June 2009 there is none.



Astrodesign 3D Security System

As in previous years, the 3D Content pavillion in the entrance hall featured a RealD theater for a session on stereo with 3D clips accompanying short talks, but I had no time to spend on it. There were also talks on 3D via satellite at the Super Session and at the 3D@Home symposium. Gerry O'Sullivan of BSKyB noted that their existing Sky+HD set top box (with internal HD PVR), already in the hands of some 800,000 UK customers, can receive 1080i 3D and display them on suitable consumer TV's. Various other satellite broadcasters around the world have been doing 3D tests for many years. I provided technology and consulting for a year of regularly scheduled 3D satellite broadcasts using LCD shutter glasses by C3D in the USA and 3DTV Japan almost a decade ago. Lack of 3D content, financing problems and the rise of shutter glasses incompatible flat panel displays killed these ventures. There have also been many 3D broadcasts via terrestrial links since the earliest days of color TV. A Milwaukee Brewers baseball game was broadcast in anaglyph 3D in 1953 and James Butterfield (see his photo in my SpaceSpex article) did broadcasts in Mexico with side by side images viewed with prism glasses. There have been countless others since.

Anaglyph is the only way to do 3D at home without selling everyone a new TV, and with a digital chain from camera to TV, proper technique, and (optimally) a few minutes of tweaking the TV, a very high quality full color 3D experience is feasible. As noted above and in my SpaceSpex article, I favor the orange/blue SpaceSpex™ anaglyph I introduced 16 years ago, which I think is hands-down superior to the common ColorCode™ used for SuperBowl 2009, provided offline or realtime stereo image rectification to reduce horizontal parallax is performed.

Also supporting dual camera 3D was the Austrian company Cmotion (www.cmotion.eu), with offices in Vienna and Hollywood, who have a variety of very slick new camera and lens control devices which they demonstrated on stereo cameras. The Camin features wireless automatic calibration and control of up to 3 motors with various special functions including some specifically designed for 3D camera pairs is shown here with the Coperate Mono multifunction wireless lens

control.



Although not specifically directed at 3D, I must mention the multitude of camera stabilizers now appearing from many companies since the original SteadiCam patents have expired. GlideCam seems to have the most elegant of the offerings but there are new ones appearing almost monthly including new models from the master Garrett Brown under the SteadiCam name. The low cost SteadiCam Jr, which I shot 3D with almost 20 years ago, has now been replaced by the Merlin, which weighs just 0.36KG and can accommodate up to 5KG, so it could easily hold a pair of any of the more compact cameras with recorders.

The broadcast video hardware company Evertz (www.evertz.com) has prototyped and was showing on a CP 3D monitor several cards that together permit 3D camera capture and display. They soon will condense these into one card so that a pair of them in one of their dual card frames will provide a handy solution, but as with most pro stereo hardware it will not be cheap.

Sony of course had a huge presence, but other than the prototypes of several CP 3D monitors I did not see any obvious 3D hardware, as their elegant 240 fps 3D cameras and LCD monitors were not ready for NAB, but I bet they will be there in 2010. However, they reside at the top of the food chain in this market with equipment in their CineAlta and XDCAM lines amply displayed. They have recorders such as the SRW-5000 that can be fitted with a pair of cards so that a pair

of their cameras such as the HDC-F950 operating in single link rather than dual link mode (i.e., at half resolution) can be captured as a 3D pair. One can also record direct to pairs of HDD. The recorder is about \$70K, the cards about \$17K and the top of the line cams about \$110K without any lens or accessories. So a full rig will cost in the \$350K range and some of the outfits in use by PACE, Cameron, 3ality, NHK and others are of this quality.

By far the biggest 3D related news since Texas Instruments introduction of the 3D compatible 2K DLP projectors a decade ago and the Dolby/Infitec DD3D viewing system several years ago, appeared around NAB time, but I did not see a word about it there. This was Sony's signing with the world's two largest cinema chains to install a total of up to 11,000 4K projectors in the US alone by 2012. An April \$315M agreement with AMC (www.amctheatres.com) to install their 4K LCOS projectors in most of the 4600 screens in their 309 international theater locations by 2012 was followed in May by another with the world's largest chain Regal Cinemas (www.regmovies.com) for at least 5000 installs in their 550 locations with about 1500 in 3D. While on the Regal page you might wish to check out the 39 3D films currently slated to show during the next 3 years (<http://www.regmovies.com/digital3d/>). This is a huge coup for Sony and a major blow to TI's DLP projection efforts and perhaps to RealD whose CP switcher cannot work with the Sony LCOS projector (and likewise for the shutter glasses and rotating CP wheel systems). Sony has been aggressively pushing the 4K projectors and 4K cameras for several years and it is puzzling that TI did not market a 4K DLP since it appears they have solved the technical problems of making an 8 Mpixel DLP. Rumors of a TI 4K DLP projector abound and I expect to see them in 2010.

The consequences of these 4K deals are likely to be profound and reverberate throughout the video and computer hardware and software industries for decades. With at least 10% of the worlds cinemas already slated to be Sony LCOS, there is now a compelling reason to make all 2D and 3D films in 4K and there will be a market for 4K DVD systems, home and pro displays, cameras, projectors, computer

cards and editing and playback software. And why not 4K broadcasts (compressed or dual channel with 3D demux by the TV or STB, cable and satellite? It is huge news.

Since the LCOS cannot do frame sequential, RealD has created for Sony an above/below frame splitting lens that uses special high quality polarizers for use with a silver screen for dual image polarized stereo. There are currently over 150 4K Sony's with some 30 in 3D in AMC theaters. However since neither Sony nor AMC or Regal currently has a list of 4K 3D theaters, I have not seen the 3D, but some say it lacks brightness and resolution relative to other stereo projection methods. As with other methods, reducing screen size and/or curving the screen when possible can ameliorate the brightness issue. I assume this lens can be adapted to 35mm film projection but I don't know if Technicolor plans to use it for their new 3D Cinema system.

Although RealD is still ahead of the pack with more 3D screens than all other methods combined, Dolby will have over 1100 of their DD3D Infitec type single projector theaters installed by the end of summer 2009, and of course Dolby does not need (but can also use) silver screens and does not charge for the reusable glasses. Via their partnership with Barco, Dolby has also begun installing some double projector DD3D systems for high brightness on large screens. However Sony may be in a position to exceed 3D installs of Dolby and RealD DLP combined within a few years. It seems certain that their 2D installs will surpass Texas Instruments approx 5500 DLP digital theaters in North America in 2010. Perhaps it is feasible to install the DD3D (i.e., passive Infitec) system in Sony 4K projectors and thus use white screens and get lower ghosting and wider viewing zones but I am not sure of the technical issues. This would be most amusing since it would put Sony, RealD and Dolby all in the projection booth.

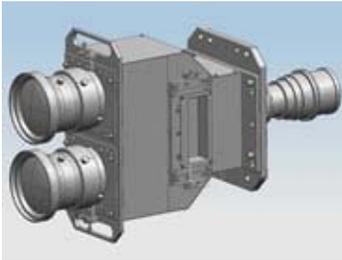
RealD has an agreement with Sony for exclusive distribution of the RealD/Sony 3D lens for 4K in the USA and some other countries and also has agreements with

AMC and Regal to install about 1500 3D DLP theaters. Rick Heineman of RealD tells me that “The RealD 3D platform now accounts for over 8,700 screens under contract and over 3,200 screens installed in more than 45 countries with over 200 exhibition partners”. So, in spite of the competition, it appears the RealD DLP system will remain the leader by a considerable margin. It's unclear whether AMC will pay (for the RealD/Sony 3D Lenses and 3D EQ) the \$5K to 10K license fee and the 50 cents/ticket RealD normally charges and also to buy the costly RealD plastic glasses (for which customers are forced to pay \$3-even if they have their own 3D glasses!). However, the glasses charges are up to distributors as RealD supplies them at a much lower price. The RealD lens and 3D EQ decreases ghosting and should greatly enhance the 4K 3D experience and likewise with their Z screen, XL light doubler and 3D EQ in 2K DLP theaters.

Theory says the 4K gives viewers a superior image within 2.3 screen heights or ca. 69 ft. from a 30 ft high screen (the same issue as for HDTV at home), though there are almost no films 3D or 2D shot in 4K at present, 4K cameras and infrastructure are coming available rapidly (most of the edit systems and software at NAB were 4K ready and there were a variety of 4K cameras). Sony presumably made the sale based on 4K readiness, easy convert to 3D and a reduced price which matched that of TI's 2K projectors. However, most theaters have a smaller screen and one would generally have to sit in the front half to see the improved resolution and this is generally not optimal for comfortable 3D viewing (see my other articles). In any event it would appear TI and their distributors Dolby/Barco/Christie etc must intro a 4K DLP soon or become irrelevant to the high end digital cinema (and Sony is almost certain to intro a lower end 4K as well). Those who did not see the 4K revolution happening this fast should not feel too bad. Here's RealD CEO Joshua Greer commenting on the impracticality of 4K in an interview that appeared in ICG magazine's April, 2009 issue: “Remember, going from 2K to 4K is four times the information for 4K 3D. There is no pipeline in the world that could manage that.” He may have had in mind a full 4Kx2K per eye, which could only be achieved by dual 4K's, 4 edge blended 2K's or the new 8Kx4K laser projector from E&S(see

below). To achieve the standard 2:1 aspect ratio, 4K 3D with the split lens would have a pair of 2Kx1K images--the same as achieved by 2K DLP's, but they could do a pair of 4Kx1K 4:1 aspect images--a sort of 3D Cinerama. Dual 4K projectors would be a natural for special venues and IMAX. So, it would appear that for most 4K theaters 3D will be projected as a simultaneous pair of over/under 2Kx1K images, rather than as frame sequential 2Kx1K pairs, as they are for 2K DLP theaters, so 3D video can still be shot with dual 2K cameras for some years, regardless of projection resolution.

It is also feasible to use anamorphic means to bring 4Kx2K per eye to the big screen. One 4K camera can film with 2:1 vertical anamorphic lenses, matched with vertical deanimorphizing lenses in the projectors--analogous to the horizontally anamorphic Panavision system that has been standard in the cinema for many years. Two cams that film at 4K each can be compressed with lenses during filming or digitally in post for projection at dual 4Kx2K with a single Sony 4K projector with above/below split vertical deanimorphic lens or perhaps with the normal RealD lens and deanamorphizing by the projector.



The RealD 3D Lens for Sony 4K projectors (or Technicolor 35mm 3D film?)

4K 3D could of course be done with pairs of 4K cameras or in 4:1 aspect ratio with a single 4K camera with prismatic or mirror box split lenses such as have been used with 3D film systems for decades. The 3D surfing footage shown in our booth was shot this way (on film) by our colleague Per Peterson (per_peterson@yahoo.com). These lenses are subject to binocular asymmetries but he has a set that is pretty good. The Canon 5D Mark 2 with 21MPixels could easily make two 4Kx2K images

with a split lens (but 3.9fps) and the NHK 8K camera could do it as well.

Days after I wrote the above, veteran computer graphics company Evans and Sutherland announced the release of their long awaited 3D compatible 8Kx4K MEMS (Micro Electro Mechanical Systems) laser projector --<http://www.es.com/news/2009/2009-06-09.asp>, which is superior in many respects to other projection technologies for 2D or 3D. How fast it will displace DLP and LCOS is unclear, but its superior image is irresistible. Like all laser projectors, it has a huge color range, very high saturation, high brightness of 5K lumens, native polarization --meaning no need for polarizers, 30,000 hour life—i.e., no burned out \$2000 bulbs after 1000 hours. It can do 4Kx4K 120Hz frame sequential or dual polarized at 4Kx2K or even 8Kx2K and by next year 8Kx4K fs 3D with 8K lumens on ca 20ft wide screens in 3D or much wider if the brightness is at the lower levels typical for 3D theaters. Now there is a good reason for rapid deployment of the 8K cameras from Red, NHK and others as well as dual 4K 3D shooting. Those desiring tech details will find them at <http://www.pc-w.com/es/>. It's lenses (and much else) are currently being completed and revised, but it can do anything from a flat screen to dome with up to 270 deg horizontal FOV. It looks to me like it can be made to work with the Dolby (Infitec) system as well.

E&S Laser Projector: **ESLP 8K**



- 8K x 4K pixels
 - 4K x 4K in 3D format
- Up to 8,000 lumens
- > 15,000:1 contrast
- Solid-state laser sources
- 4K MEMS line modulator
- 12 ESLP units installed and operating in specialty theaters (5K version)

E&S Advanced Displays

An interesting, and in some ways strange technical angle, is that the Sony LCOS projector (Liquid Crystal On Silicon) is a gated light valve method, which was the basic tech used in the classic Eidophor projectors (the king of high end projection prior to DLP) as well as that in the very first serious videoprojector, the Scophony, over 80 years ago. Actually, it's not so strange to the technically minded who are cognizant of the physical limitations on putting light thru an imaging device (see my 2008 article on Digital Projection for further info on all these issues).

RealD has scored a number of other major advances for 3D digital cinema recently. In addition to the twin lens for the Sony 4K and the realtime (in the projection booth) ghostbuster 3D EQ, they have produced, after 3 years of research, a device to roughly double the light output in DLP theaters-- the XL Filter called the RealD XL Cinema System. Intended for RealD's 2K DLP theaters, the XL Z Filter is a 60 lb glass relay lens system. As noted, RealD has also introduced their realtime

ghostbuster RealD 3D EQ which runs with the other server software, and is compatible with the 4K stereo as well so it will be provided alone with their 3D lens in all Sony 4K 3D theaters.

RealD also introduced (May 2009) a DLP Polarization Switcher using LP (linear polarized) glasses, suitable for use with screens up to 17 feet wide, the RealD LP. Their press release says it works with 3D-enabled projectors (i.e., those working in the frame sequential or active stereo mode) such as NEC NC800, Christie Mirage HD, and Lightspeed Design HD DepthQ, along with a silver screen from Harkness, MDI or Stewart (and many others). However it will also work with countless others projectors such as the professional active stereo compatible DLP projectors from Digital Projection (www.digitalprojection.com) as well as the numerous 3D Ready consumer and pro models outfitted with TI's DLP LINK that have begun to appear. The first 120hz 3D Ready DLP LINK model appeared from View Sonics (PJD6220-3D)(ca. \$1K street price) in May 2009 with a dozen others due from various manufacturers before year's end.

As I have noted in my other articles, LP and CP switchers go back over half a century (and I made and sold one 15 years ago) so this is not a new concept, but RealD spends lots of money on engineering and the RealD LP should be a good product.

Speaking of active stereo projectors, one must mention Digital Projection of Atlanta which is one of the world's major suppliers of DLP projectors (e.g., 16 in the new Atlanta Grammy museum) and has perhaps 200 3D theater installs, but since they have so far chosen not to pay the huge fees required to join the DCI monopoly, and so are not in the big cinemas that play first run Hollywood films, they get much less press than Dolby, Christie, Barco etc. However, with 14 models suitable for use with the RealD LP or CP switchers or with shutter glasses (<http://www.digitalprojection.com/NewsMedia/tabid/56/mid/370/newsid370/118/DIGITAL-PROJECTION-REVEALS-FULL-LINEUP-OF-14-ACTIVE-3D-CAPABL>

E-DISPLAYS/Default.aspx) , and of course all their projectors suitable for dual passive stereo, they will doubtless get a big piece of the 3D Cinema pie. And for InfoComm 2009 “The TITAN 1080p Dual 3D, our most advanced TITAN projector, will also make its debut at the show. Featuring an incredible 9000 lumens, the smallest, lightest, most efficient 3-chip DLP chassis in the industry now projects active 3D imagery – up to 120 Hz at native 1080p resolution.” See <http://www.digitalprojection.com/Portals/0/Documents/TITAN/TITAN%201080p%203D.pdf>

TI's new DLP LINK engine has an ASIC that enables the new DLP LINK projectors to accept various 3D formats including (in conjunction with the dongle (sync device) made by 3DTV Corp (www.3dtv.jp) the 120hz top/bottom format used by Neotek's (www.neotek.com) educational software and TriD 3D video system. Although 3DTV Corp is introducing low cost universal LCD shutter glasses and emitters that will work with any active stereo projector, it is not generally understood that all DLP LINK monitors and projectors have an internal emitter that will activate new DLP link glasses being made by 3DTV Corp and others.

In spite of constant badmouthing from purveyors of the various passive glasses 3D viewing modalities, there are over 600 cinema (and probably hundreds of non cinema) active shutter glasses 3D theaters in operation and they can have significant advantages in cost, convenience and image quality that I have detailed in my other recent articles. Shutter glasses are used by the Panasonic 3D PDP's, the Sony 240 fps LCD tv's and the new line of Mitsubishi 3D Ready DLP tv's (the 53 inch selling at CostCo etc for \$1700 after rebate). What appear to be the most advanced wireless LCD shutter glasses have recently been introduced by 3DTV Corp. The Model E Cinema glasses (part of the new 3D Window™ series of stereoscopic viewing and display devices) will be the first multistandard (i.e., work with all professional IR protocols) and first advanced 270 degree STN (Super Twisted

Nematic) shutters, the lightest (ca. 25-30g), and the only ones that “put themselves on” (i.e., once on part way they slip on and cling firmly but comfortably to just about any size head and over glasses as well). Such STN shutters (doped with chiral LC) have fast transient times (0.5 and 2.5 ms for rise and decay times), high contrast ratios on axis (ca. 100:1) without use of compensation films, and optical transmittance about 25% in the open state. Previously, high ratios were achieved by CrystalEyes and NuVision by using compensation films with Pi cells and with more complex forms and higher values of driving voltage, thus increasing cost and complexity. With addition of compensation films such STN shutters can achieve ratios as high as 1000:1 but it is not clear how many viewers in the average theater would actually see a better image. This compensation tech with TN has been understood for many years, with a-plates for STN with azimuth twist angle more 180 degrees (Sahena et al. US patent 5982465) as well as for positive and negative uniaxial and biaxial plates for TN with various twist angles (Yang & Wu-Fundamentals of Liquid Crystal Devices, Wiley (2006) p202.), but that did not stop RealD from trying to patent it recently (US 2009/006683 A1).



Model E 270 STN Multistandard Wireless Cinema Glasses by 3DTV Corp

It has been known for hundreds of years that suitable image manipulations can induce a 3D effect in a 2D picture, even when viewed with one eye, and there is a large patent and technical literature on this. I have seen the patents and papers of Christopher Mayhew of Vision III Imaging (www.inv3.com) for many years but had never seen his device nor met him until I found both in the Angenieux booth. The V3 AX3 lens constantly rotates the position of the iris and is integrated into certain ENG lenses of Angenieux and Fujinon.

"The AX3 features conveniently located on-board parallax scan operator controls. The unit software offers function parameter preset features that can be set and easily "triggered" while shooting. Parallax scan tracking is automatic and changes according to focal length while zooming. Software presets and automatic parallax scan functions can be customized by the operator. Additional remote controls are also available for wireless and tethered operation."

When used correctly, it provides a slightly varying image which the brain integrates to create an impression of depth. It is not ever going to be a substitute for stereo pairs but it may find a certain market. I asked the obvious question and yes they have done some tests using it with stereo cameras. The V3 MOE (Moveable Optical Element) prime lenses are now available for rental through [Clairmont Camera](#) in North Hollywood.

In my other articles I have discussed the history of efforts to create true stereo by placing two irises inside one lens or by alternating one iris to obtain true stereo pairs. It is also feasible to obtain synthetic stereo images, or images altered and presented similarly to the V3 method, by image warping as I have described in detail in my US Patent 6,108,005. It is amusing that this patent is rarely cited by the many subsequent patents on stereosynthesis (or by the dozens of companies worldwide doing 2D to 3D conversions), though it would seem to clearly constitute prior art that obviates many of their claims.

There is a vigorous competition going on between various companies each of which want their HD 3D codec to be adopted as the standard. One of the most active, TDVision (www.tdvision.com), is collaborating with another NAB exhibitor, Magnum Semiconductor (www.magnumsemi.com) in order to put their codec in silicon for realtime use. The 3D images shown on several CP monitors were excellent. They have also shown realtime 3D decoding of BluRay on the PlayStation and other platforms.

Other companies which will soon bring 3D HD DVD playback software to market are www.next3d.com and all of the well known DVD software players (WinDVD, PowerDVD etc).

3ality (www.3ality.com), one of the more active 3D production companies, showed superb footage of football on one of the new JVC full HD 46 inch CP monitors. Their rock film U23D, which I reviewed in my article on the 3DX 3D Movie Expo, was shot with 8 stereo rigs, some from Pace, and was a technical but probably not economic success. They have some nicely engineered parallel and mirror box rigs with computer control of stereo parameters apparently designed partly inhouse and partly by the German company 3DIP of Augsburg which they bought several years ago. However, perfect registration of even one stereocamera from shot to shot as zoom and interaxial changes is a major engineering challenge, and registering 8 is a nightmare. It is said that they spent many months and substantial money in post and the delay in release resulted in overlap with that of the hugely successful Miley Cyrus 3D concert film, which took up many of the 3D screens, leading to a substantial decrease in revenue. This is sad since U23D is a fine effort, as I have noted in my review of the film in my article on the Singapore 3DX festival. They have also spent a huge amount of money developing special 3D post tools, specifically the Digital 3flex™ SIP2100.

Quantel has written a white paper on the SIP2100 (on Mendiburu's DVD and also at [http://www.quantel.com/list.php?a=Library&as=White Papers](http://www.quantel.com/list.php?a=Library&as=White%20Papers)) and it may

have been in their booth, but I did not have time to find out. The SIP2100 looks like a wonderful tool but it is extremely expensive and I think most will find they can get by with the other hardware and software described here. 3ality also has the 3flex SIP2200 ruggedized unit and the 2flex SIP2900 blade rack for use with up to 9 processors for multicamera shoots. The 3flex's can be bought for \$80K to over \$200K. The 3flex series 2, 3 and 4 use mirror or S by S configurations for various cameras and lenses and all have Stereoscopic Platform Controllers (SPCs) which sync camera functions and correct binocular asymmetries.

3ality has been involved in various other 3D shoots such as that for the Pepsi SoBe ad for the 2009 SuperBowl. I will describe how their 3D footage was integrated with graphics for the creation of this piece. In addition to the normal issues of compositing green screens of the real people and the CG animations together (supervised by Jay Barton of Digital Domain and Phil McNally of DreamWorks), they had to consider their positions in depth. The zoom, convergence and interaxial of 3ality's Sony HDC 1500 3D rig provided metadata somewhat like those from motion control cameras and these were used to help set up the virtual cameras in Track--Digital Domain's inhouse tracking system. Both companies then used this data to render Maya scene files of the animations. First David Burgess (lead animator for DreamWorks 'Monsters vs. Aliens') spent several weeks putting the CG 'Lizard Lake' characters into the 3ality footage. DD did 20 shots with 3D backgrounds for a total of 40 shots that had to be rendered to see that all the live action characters fitted in and none overlapped inappropriately. Improving the previous year's ad, they repainted the displacement maps for texture of the subdivision surface characters. DD's Maya animations (with some touches from Houdini) were rendered in Lightwave. The stereoscopic features in the now famous compositing tool Nuke and its stereoscopic plugin Ocula (for a manual and video tutorial see http://www.thefoundry.co.uk/pkg_overview.aspx?ui=39DEE70B-C88F-48F1-9BEC-99A9BAFE2850) were used to warp and tweak the live action plates as needed. Enthusiasts will want to download the whitepaper "The Role of Ocula in Stereo Post

Production" from their page or you can find this and many other good papers on the DVD with Mendiburu's "3D Movie Making". Ocula was used to warp and position the live characters for proper stereoscopic positioning. As is now common, the artists used anaglyph glasses while working, but the dailies were viewed with shutter or CP glasses. Since the programs can use the now common panels with CP glasses it may be that these will replace the use of anaglyph completely, but if they used SpaceSpex E or A, they might find anaglyph just fine. My view of the SuperBowl 3D is that it was a failure due to a lack of understanding of anaglyphs by the people who were responsible for it. They should have changed the colors in the ads substantially to make the 3D work and they should have used SpaceSpex.

For the episode of "Chuck" that was broadcast for ColorCode glasses soon after the SuperBowl, 3ality provided two rigs using SONY HDC-1500's with 22X HD Fujinon lenses and a SIP2100 for conforming in conjunction with the Stereo toolset on the Quantel Pablo.

Paradise FX of Los Angeles has now switched from film to video and uses their Para Cam (two REDS) in a mirrorbox controlled by two FI-Z3 handsets, one for interaxial and convergence and one for zoom, focus, iris and record. They provided the B camera for "My Bloody Valentine" and a mini mirrorbox version using SI-2K's mounted in a MK-V AR Steadicam for handheld work. The A camera was a custom developed rig with two REDs. Technicolor handled most of the digital workflow and provided their "Dailies on Demand" system for remote nonlinear 3D viewing of 3D HD dailies. It is basically a portable server that converts files to MPEG-2 for playback on a flat panel for viewing with CP glasses as described elsewhere here.

Another common polarized display that has been around much longer than Arisawa's MicroPol is the dual monitor configuration with a semisilvered 50% mirror in the middle. These are bulkier and no less expensive than the CP type

and impractical in larger sizes, but the high brightness, good resolution, low ghosting and wide viewing angles provide them with a niche. Planar (www.planar3d.com) is one of several companies that has marketed them for about 10 years and the 26 inch display in their booth showed its advantages. They are also available from Tru3D and from a new Hong Kong company that has no page at the moment.

Also in the 3DTV Corp booth was a 42 inch lenticular autostereoscopic panel from Magnetic (www.magnetic3d.com). It was amazing that most of the presumably technically sophisticated audience had never seen an autostereo video display and could not make the connection with the ubiquitous lenticular postcards, which work the same way. Also amusing and sad was the fact that throughout the 4 days people were continuously standing in front of it trying to see the 3D while wearing CP polarized or the anaglyph ColorCode glasses they got from our booth or others. Of course those in the sweet spots actually did see the 3D and must have wondered what was the big deal about seeing 3D animations.

Finally, I will tell another short 3D story that illustrates how naive most people still are about 3D films and how eternal vigilance in all the world's 3D theaters is essential. At the end of the NAB show I went to the M&M store on the strip to see the short 3D film that I had seen two years earlier. In 2007 it was the worst stereo projection I had ever seen--so horrible that I wrote letters to Mars parent corp. and Michael Mars himself. I told them the images were so bad they induced nausea and dizziness and they had to fix them ASAP, so I felt they certainly would take care of it. However, Anthony Coogan and I were amazed to find that it was just as I had seen it two years earlier--5 feet of negative parallax, so dim it was hard to see, and a foot of vertical parallax, in a tiny theater where the most distant seat was about 35 feet away. As I had done two years earlier, we talked to the manager and were told that nobody had ever complained -but who would bother for a short free movie? So, during 2 1/2 years some 500,000 people saw a 3D film projected so badly that there was almost no 3D and that was quite unpleasant to watch for even a

minute. This time I found out that a company named ShowPerfect, with decades of experience installing 2D and 3D theaters, was responsible for maintaining the theater. An email to them brought a quick response that they had immediately fixed the problems. I will pay it another visit next time.