

Many of these displays rely on displaying multiple views (typically 7 to 9 of them) on an LCD flat-screen married to a transparent plastic sheet of lenticular (cylindrically shaped) lenses. The lenticular array guides the corresponding left and right images into multiple viewing zones in front of the display. Portraying multiple views simultaneously means that the resolution is compromised. Also, many (such as those employing the Philips WOWvx file format) expect to be fed 2-D+ depth map data input. From this file data the display internally generates an autostereoscopic 3-D image. However,

this kind of approach can result in the occluded areas within the scene, generating objectionable artifacts because of missing scene information.

This year, Philips showed new displays, based on this technology in its WOW family of autostereoscopic monitors; it introduced a 52-in., a 22-in., and a small 8-in. unit.

VisuMotion of Jena (VMJ) and Sharp are apparently collaborating to create "the largest commercial 3-D autostereoscopic display in the world," which measures 65 in. with a base resolution of 1920 x 1080. It uses a parallel-pix-

el barrier rather than a lenticular lens to guide the left and right images to the appropriate viewing zones in front of the display.

A new Alioscopy autostereoscopic display was demonstrated at the Dimension 3 Expo in France. It too was impressive. Toshiba, NEC, Samsung, LG, RealD, and many others have various-size products in this emerging field. Apple has also filed a patent on its proprietary approach. Is an autostereoscopic 3-D iPod in the future? Next year will certainly prove to be very interesting. Keep both eyes open!

## The Digital Evolution of Stereoscopic (3-D)

By Howard Lukk, Walt Disney Studios

**T**he field of stereoscopic (i.e., 3-D) content creation and display has taken a dramatic leap forward in the past three years. With the introduction of digital cinema to the stereographer's toolkit, the palate has increased and the consumer seems delighted with the new renaissance of stereoscopic cinema. This resurgence has taken place on two sides of the workflow: on the camera capture and creation side, and on the display side. One could say that the introduction of digital cinema projectors as a stable platform for theatrical stereoscopic display has amplified the amount of capture and creation to take advantage of this surge.

### Theatrical Projection

In November of 2005, The Walt Disney Studios released the first commercial stereoscopic digital cinema feature, *Chicken Little*, using two standard MPEG-2 digital cinema servers synchronized together, supplied by Dolby. This provided the left and right eye signals via a 4:2:2; Y', C'R, C'B dual-link HD-SDI interface, supplied at 24 frames/sec to the digital cinema projectors supplied by Barco and Christie. The projectors then fed a framing pulse to a RealD switching polarizer panel called a Z-screen, set in front of the lens of the projector, along with a silver screen, to keep the polarized light coherent to the passive circular polarized glasses. Early tests indicated that content creators preferred a refresh rate of 144 Hz, also called "Triple Flash," which provides a sequence of L,R,L,R,L,R before moving to the next frame in the 24-frame sequence. The only issue with this was that the electronics within the projector head at that time would not support this bandwidth at the digital cinema pixel matrixes of 1920 x 1038 (1.85:1) out to the DLP chip; it could handle only 1628 x 858 (1.85) or 1920 x 803 (2.39). (Note: this was an output limitation at 144 Hz not an input limitation.) There were also international installations, which used QuVIS servers, which were already de-



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livering dual streams at 24 frames/sec with a single server, again using a Y', C'R, C'B format down the dual HD-SDI links. These units required a separate encoded file format because they used QPE for compression and not MPEG-2. These installations were brought online in a limited amount of time and the feature had a successful run in the theaters, especially in the stereoscopic installations.

The content for *Chicken Little* was created in mono by Feature Animation on the Disney lot, and the stereoscopic version was created by Industrial Light and Magic (ILM) because of the short time from the decision to release in stereo until the time of release. ILM took the mono files along with the 3-D metadata and created a more subtle stereoscopic effect to add a depth to the feature and not necessarily "theme park" effects.

Sony Pictures then released *Monster House* in stereoscopic, along with its normal D-Cinema release in July 2006. At this time, the digital cinema playback systems in the field had evolved into more than just the Dolby, QuVIS servers and RealD display systems. Doremi and Kodak JPEG servers were being installed into the field, overtaking the older MPEG-2 servers. Doremi built its stereoscopic file format, based on the DCI requirement for 48-frame content. This created a single interleaved track file in JPEG 2000 that played back the content using the ICT transform to move the Y', C'X, C'Z down the limited-bandwidth dual HD-SDI links to the projector. QuVIS continued with its QPE-encoded file format and Kodak duplicated the Dolby dual-track file approach with a small twist, in that it took advantage of the ICT transform as well, and provided Y', Cx', Cz' to the projector. Both Doremi and Kodak had to take the ICT output of the JPEG 2000 decode and round down the bits from 12 to 10 bits to fit within the conventional interface protocol. (They used 2,048 pixels, and so did other manufacturers of JPEG 2000 servers.)

RealD systems are commonly used for display in the U.S., however, in the international market Active glasses by NuVision are often used. These glasses provide an infrared transmission of the framing pulse to trigger the glasses to switch lenses on and off, timed with the left and right images that appear on a standard white screen. Other display systems have also been introduced in the installed base, including dual projectors with static polarizers. One company, Master Image, uses a polarized disk that rotates in front of the lens and is synchronized with the framing pulse to polarize the light for each eye for a silver screen, again using passive circular polarized glasses. Most of these new systems and the active shutter glasses are built around a 96-Hz refresh rate, also known as "double flash," with a sequence of L,R,L,R per frame.

In October 2006, Disney created a stereoscopic feature from the original pre-released files of Tim Burton's *Nightmare Before Christmas*. ILM was asked to take a 35mm film capture of stop motion animation and create a stereoscopic feature, building on what was learned from the *Chicken Little* experience. By this time, the installed base in the field had blossomed into the same problem that faced digital cinema in the early days before Digital Cinema Initiatives (DCI) was introduced and SMPTE's digital cinema effort began—the proliferation of multiple formats for stereoscopic digital cinema release. One had to create a single-track JPEG 2000 file format to play on the systems installed in the field, and also make a dual-track JPEG 2000 file format, dual-track MPEG-2 file format, and a QPE file format. In addition, these file formats were created using "ghost busting" for the silver screen polarized systems or "non-ghost busted" content for the non-polarized systems that used standard screens. Ghost busting is the process of pre-compensating an image to make up for leakage between the left eye and the right eye caused by the display system. This leakage causes a "ghost" image to appear around defined objects with a

high contrast ratio and a stereoscopic disparity in the image. Display systems with little leakage do not require ghost busting, compared to display systems that have greater leakage.

Realizing the difficulty of delivering multiple 3-D formats and anticipating four more 3-D titles (*Meet the Robinsons* in March of 2007, *Beowulf* in November of 2007 and *Hannah Montana* and *U2 3-D* both in February 2008), Disney began serious efforts to convince the industry to come to a consensus on a single format. Unfortunately, this did not come to fruition before *Meet the Robinsons* was released in March. However, a consensus between the "dual-track" approach and an "interleaved" approach took shape, although it did not reach the marketplace until the autumn of 2007. Even with this consensus, not all sites worldwide would be upgraded to support this new "3-D Inter-Op" format, which was based on a new proposed SMPTE standard. Therefore, to provide for all the releases of *Meet the Robinsons*, including the international markets, eight separate encodes were created along with multiple language versions of each of those separate encodes to supply the different markets. This totaled 32 separate digital cinema packages. By this time the domestic (U.S. and Canada) installed base of stereocapable theaters had increased to 582 screens and an additional 204 screens in international territories, resulting in an overall release of 786 screens.

Content creators eventually took notice and began announcing the completion of more productions in stereo, as well as the normal release. Jeffery Katzenberg, of DreamWorks announced that all DreamWorks animation would be provided in stereo and many other studios began to make similar announcements of not only animation titles, but also live action titles. There are now approximately 1,084 screens in the domestic market and 255 in the international marketplace, for a total of 1,339 3-D screens.

## Live Action Capture

Before 2008, the major 3-D digital cinema releases were in animation. Live action capture methods had advanced dramatically over the years, especially with the introduction of digital motion picture cameras. James Cameron, while shooting an underwater documentary for IMAX called *Ghosts of the Abyss*, began shooting all of the sequences with new digital motion picture stereoscopic camera rigs. In cooperation with Vince Pace, Pace HD was formed. Two other companies working in the same arena, Steve Schklair of 3Ality, and Pete Anderson, ASC, along with Paradise FX, had been shooting and modifying stereoscopic camera rigs for many years. Most of these rigs gravitated to using the Sony HDC F950 cameras because of the quality and the size in both side-by-side configurations and a beam-splitter configuration. The side-by-side rigs usually have a hard time getting the interocular range down to 2 3/4 in. (average human vision distance) because of physical limitations. This makes these rigs good for objects that are not closer than 20 ft. This is where a beam splitter camera

rig comes into play, with the ability to set the interocular measure to a very small distance as needed.

In a tour d'force, many of these cameras were assembled together to capture *U2* during their South America tour in 2005. While *U2 3-D* moved through post-production at 3ality, Pace HD shot the *Hannah Montana/Miley Cyrus the Best of Both Worlds Concert Tour* live in Salt Lake City in October, using seven of the Fusion 3-D camera system rigs and a newly-constructed stereoscopic remote truck. The behind-the-scene material was shot in mono and then conformed into the final feature for release.

## Live Events

Pace HD worked with the National Basketball Association (NBA) to demonstrate live transmission of the NBA All-Star Game. This was sent over fiber to a 600-seat stadium theater and a smaller sports bar-style auditorium, both specially constructed inside a ballroom at the Mandalay Convention, where two Sony projectors displayed the event in 1920 x 1080i to a private

audience. Pace HD captured another basketball game with the Cleveland Cavaliers during the NBA championships, transmitting an away game back to the Cavaliers home stadium for the fans.

Japan Broadcasting Corporation (NHK) has also captured live events with stereo camera rigs since the 2002 Winter Olympics in Salt Lake City. Along with the NHK work in Japan, recently, one of the broadcast channels "BS11" began broadcasting 3-D for a short time each day, in partnership with Hyundai, using a polarized interlaced system and polarized glasses.

Stereoscopic 3-D technology has taken a great leap forward with the advent of the digital cinema projector and seems to have driven other related technologies. For 2009, 10 stereoscopic feature films have already been announced. There is also a big push in the technology sector and with the standards bodies, to get stereo into the home. The results appear to be evident on the screen and this time it looks like stereoscopic may be here to stay.

# SMPTE PDA Now

**September 25, 2008**

**1:00 PM – 2:00 PM Eastern**

**Installing BXF Messaging:  
A case study**

**Guest Speaker: Rick Stora,  
Sundance Digital, part of Avid**

Want to know what you might expect when you install BXF messaging in your facility? During this SMPTE PDA Now session, Rick Stora, Sundance Digital, part of Avid, explains what lessons were learned during an early installation of the BXF (SMPTE 2010) messaging technology at WJCT in Jacksonville, Florida.

Topics in this educational webcast include Beta site candidate selection, application software preparation and coordination with the facility and the traffic vendor. In addition, our speakers share what went right and what didn't.