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3DX SINGAPORE—DIGITAL 3D MOVIES FOR THE 21ST CENTURY

by Michael Starks 3DTV Corp.

3DX--the world's first digital 3D movie festival was held Nov 18-23rd in Singapore. I was one of over 200 persons who paid \$1000 and up to attend but some of the films were also shown in the evening to the general public.

Hollywood is taking 3D very seriously with some 40 films on the slate for the next 3 years and many others from majors and independents sure to come. Top execs from Fox, DreamWorks Animation, Disney and others, as well as reps from TI (the maker of the DLP chip that powers nearly all projectors used for 3D) and projector maker Christie (owned by 4600 screen global theatrical giant AIX) gave talks often accompanied by clips of upcoming films. Christie claims 80% of all digital cinema installations. They used two of their brightest (14fL) CP2000 SB's here.



Golden Village Multiplex Singapore

The huge lovely theater at the Golden Village Cinema in Vivo City was set up and run by teams from Technicolor, Disney and Dolby (which has now installed about 600 cinemas with the Dolby Digital movie server, including some 300 with the Dolby Active Infitec 3D system). Active Infitec, or more properly Dolby® 3D Digital Cinema, is Dolby's patented single projector system which uses a spinning

wheel inside the projector (it can be retrofitted on some models) with half right eye and half left eye Infitec anaglyph triple notch filters. It is licensed to Barco, who will also approach 300 installs in Jan 2009. However, since this process loses over 90% of the light, on this occasion two top of the line color corrected Christie projectors, one for each eye—i.e., the original passive Infitec system invented in Germany a decade ago—were installed.

Some persons told me there were two synced active Infitec projectors used, but I spent 15 minutes in the projection booth with the techs and I am sure it was a passive system. The active Infitec system is subject of various problems that the passive one does not have such as lower brightness, odd color artifacts, and the same motion artifacts as CP or LP switching or LCD shutters, as well as some unique color artifacts (as admitted in several Barco patents) and dual synced active projectors would almost certainly have further problems.

Dolby's systems (and perhaps all pro Infitec systems) are color corrected, meaning that the color imbalance that otherwise exists for any anaglyph method is minimized to the point where it's very hard to tell it's anaglyphic. This, combined with the superbly even luminance in the two eyes and over the entire screen, and the very high (compared with most 3D venues) brightness of 4.1 ft. lamberts gave a spectacularly good image. I heard many who have seen up to 60 different recent 3D digital theaters (e.g., Ben Stassen of nWave, producer of four 3D films originally done for IMAX but now in any 3D capable format) say it was the best they had ever seen.

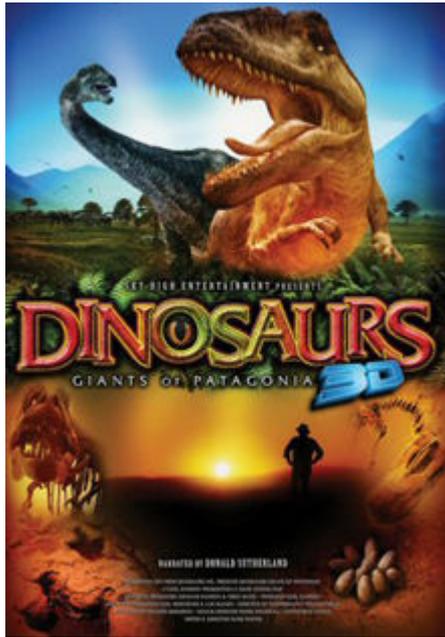
The huge (ca. 13x20M) white screen was also unusually large for digital 3D. In addition, all of the films had good to excellent image alignment and minimal binocular asymmetries, so the end result was stunning. I was able to watch as many as 6 full length films in one day with no more eyestrain than I would expect from sitting in the dark looking at a very bright screen with 2D images. It might be thought that I was insensitive to eyestrain due to 35 years of frequent 3D viewing, but in the few cases when things were not right I felt the strain immediately, as I note below. However it must be kept in mind that this system has essentially zero ghosting, which contributes to eyestrain and which is present to some degree in the other 5 competing systems. Likewise, it is critical that I always sit in the middle of the theater in the back and clean the lenses carefully, so as to minimize all the 2D and 3D contributions to eyestrain due to position and glasses. Sitting further away also tends to increase the apparent depth. It is interesting to note that many of the experts (e.g., the filmmakers) often sat in the front or on the sides—a peculiar phenomenon I have noticed at many 3D events. If I had sat in the front or to the side, or viewed the film thru a fingerprint or with CP glasses (i.e., with Real D or MasterImage systems which have higher ghosting), or in a theater with a less than perfect silver screen, or had suboptimal polarized

glasses, or the projector had a steep angle to a silver screen, or seen a dimmer or unevenly illuminated image, I would expect substantially more eyestrain.

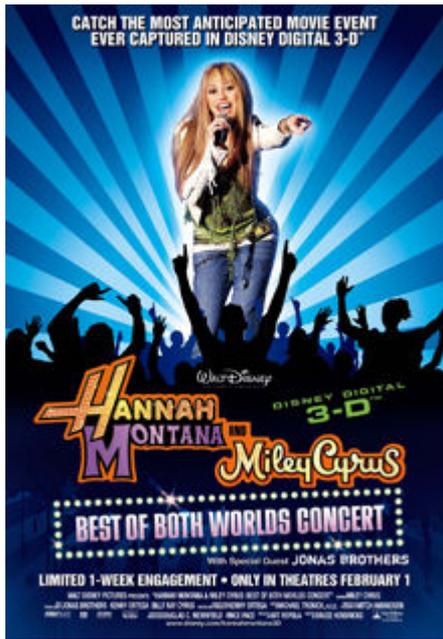
I find it useful to think in terms of an “Eyestrain Budget”, which varies from person to person, which is used up by every error in the image, expressed as a % deviation from perfect, multiplied by time viewed, the exhaustion of which produces eyestrain (i.e., headache, nausea, dizziness, blurred vision) in a given person with a particular environment and viewing modality. Non stereo image factors (e.g., dim image, excessive image motion due to camera movement or seat movement-i.e., ride films) must also be figured in. Problems with the original program add to those of projection, viewing method, viewing position and one’s own psychophysiology. Any use of our visual system uses up the budget, including reading and watching TV, but bigger, brighter screens in darker surroundings with lots of motion consume the budget much faster and 3D is the most difficult case.

The films were introduced by their makers and were interspersed with talks by persons from the movie industry (DreamWorks, Disney, MPAA, Texas Instruments, IMAX etc.). First I will briefly review the films and then make some comments on the direction of the industry.

“Dinosaurs: Giants of Patagonia” directed by Canadian Marc Fafard was the third large screen 3D dinosaur film I have seen in recent years and, from the standpoint of image quality as projected, easily the best. It combined footage of the current Patagonian landscape, thought to be little changed in 100 million years, with animated dinosaurs. Problems with parallax and skew and asymmetries of the cameras were minimal and the overall image was superb. They let the excellent animation and the austere landscape dominate the story of an Argentinian paleontologist’s recent discoveries of the world’s largest dinosaurs. No dumb stories directed at 8 year olds, as we see too often in other large screen films. Recommended!



“Hannah Montana/Miley Cyrus:best of both worlds concert” was a live action soft rock show by the American teen sensation and this summer in the USA it had the highest grossing opening weekend of any 3D or concert film in history. This was mainly due to the fact that 684 3D digital theaters were available in the USA and that they charged up to \$15, but also to Miley’s recent rise to fame among the teen and preteen set, and to her promotion by Disney. Her backup band The Jonas Brothers already have their own 3D concert film. They used the Pace cameras and the image and stereo were generally quite good, with apparently modest degrees of skew and little excessive parallax. However, with the rapid movement of cameras and the constant jump cuts it was hard to tell. The bottom line is that, as with most of the films here, I experienced essentially no eyestrain, so they did a pretty good job under trying conditions.



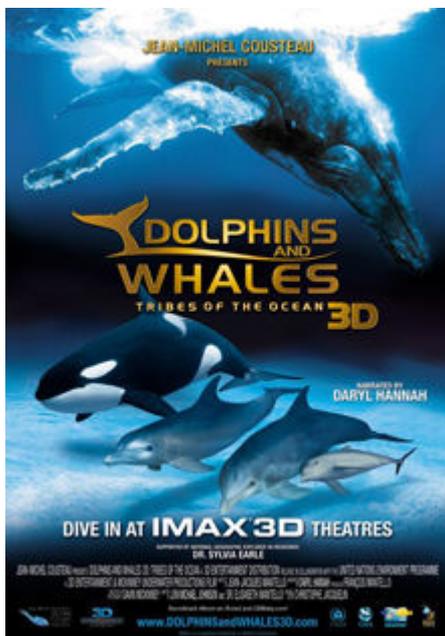
Likewise with the even more difficult shoot done by 3ality during U2's South American tour for "U23D". Other than logistics, the biggest problem I see was the mostly very dark concert halls, which makes any video tough and much more so for getting good depth in 3D. For me the biggest plus was the fact that the director Catherine Owens is an artist who turned the film into the most beautiful feature length 3D video art piece ever done, in spite of the fact she had to work with mostly very dark images and her entire subject was 90 minutes of nighttime concert footage. As with many concert films (including Miley Cyrus), the words were largely inaudible, so I just absorbed the visual and sonic beauty of it and had a great time. The film would have done better, but Disney pulled the nasty trick of releasing Miley Cyrus at the same time, taking many of the 3D screens that U23D was going to use. I discussed with Catherine the possibility of doing a release on HDDVD, TV or the net, but she said the band had no interest in lesser quality formats. Of course the releases of all recent 3D films (e.g., Lava Boys and Shark Girls, Spy Kids 3D, Miley Cyrus etc) on DVD has been in a very poor red/blue anaglyph format with no ghost reduction, so there is little 3D or color and lots of eyestrain. Also, I don't recall any instructions for optimal tweaking of the images, nor suggestions that they should only be watched with digital links to digital TV's (i.e., avoid analog) and to use only flat panels or projectors (i.e., avoid CRT's).



There are very few people who have ever seen a really well done, full color, ghost reduced digital anaglyph film in red/cyan or (better) orange/blue (i.e., the 3DTV SpaceSpex format, which has been demonstrated on my page for 15 years), so probably nobody in Hollywood, nor anyone anywhere in a position to make this happen, understands the possibilities. Properly done and viewed on a tweaked digital display (preferably LCD or DLP), it is almost as good as the best polarized or shutter glasses. The Japanese 3D release of Cameron's "Ghosts of the Abyss" used the eyestraining ColorCode orange/blue process, with no ghost reduction, but at least it had color and depth. The only reasonably good full color anaglyph digital DVD I know of is an adult movie done in California in the Anachrome process 5 years ago, but again, neither of the ghost reduction processes (i.e., H shift or image processing) were used.

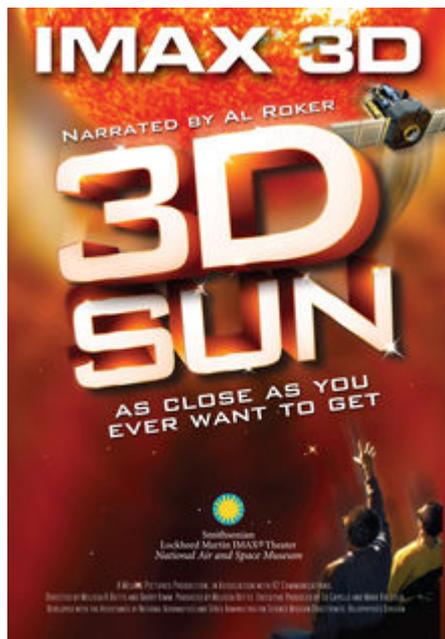


“Journey to the Center of the Earth” again used some version of the Pace cameras and on the whole was reasonably well aligned and binocularly symmetrical, with minimal 3D gimmickry (in fact- as often with 3D films-some people complained about the lack of out of screen effects). Though clearly shot on a modest budget with (by current standards) limited special effects, I found it enjoyable and pleasant to look at. Just don’t go expecting to see a \$100M epic.



The IMAX film “Dolphins and Whales 3D” by the Montello brothers was a very concise and moving (for those with sufficient higher nervous function to be affected by these giants, most of whom are likely doomed) documentary 3D

catalog of a dozen or so species of Cetaceans. It was shot with a series of seven prototype underwater stereo cameras over a period of years under extremely trying conditions in many locations. Excellent 3D in most shots, which is amazing considering the filming conditions. Actually, one should just say “large format film” since IMAX itself does not make films and everyone now releases the films in various formats all the way from IMAX film and digital down to DVD, unless they have an exclusive with IMAX.



Another IMAX release “3D SUN” by Minnesota filmmakers Melissa Butts and Barry Kimm was a short scientific documentary based on NASA’s stereoscopic pair of solar satellites. We saw the version narrated mostly by the scientists rather than a professional narrator, but it hardly matters as the stunning stereo views of solar activity dominate the film. Of course I wanted details on the stereo base, distance, imagers etc but these were not at hand.



Disney presented their animated film “Bolt” which met the new high standards for both stereo and animation. I am not an animation fan and normally you would have to tie me to the seat and glue my eyelids open to make me watch a 90 minute cartoon about a lost dog, but the 3D was good and it moved along so it was actually much more enjoyable than most Hollywood fare. The film’s failure to use the audience space (i.e., to pop things out of the screen) was commented on after the film and DreamWorks CEO Jeffrey Katzenberg said that most of his filmmakers felt this was good practice and he let them do as they liked. Most people I talked to felt this was a mistake and audiences demand to see at least some out of the screen effects for this kind of film. I think they are correct, though I have said many times that ideally 3D should not call attention to itself any more than color, contrast, resolution or smooth realistic motion.



The modest budget indie "Call of the Wild", loosely based on Jack London's novel, had its world premiere here. Shot by New York stereographer Jason Goodman with his 21st Century 3D camera rig, it lacked the image quality of the Pace and 3ality cameras (though this was the premiere and later image processing might fix this to some extent), but it was very well aligned on most shots. A few shots had excessive horizontal parallax but the overall impression was quite good and it should do well as a family film in both 2D and 3D.



Ben Stassen's independent (nWave Productions) feature length animation "Fly Me to the Moon" was easily the equal in quality to products from the major

studios--an amazing feat, but one which they have now pulled off several times with their previous IMAX releases (several available on field sequential DVD). Overall it was excellent, but they felt it necessary to use a lot of horizontal parallax in many shots, which caused eyestrain and will produce ghosting in most systems. As usual, I confirmed my impressions with judicious questioning of other attendees. In Malaysia a year ago, I saw a short version of this film that is shown with NASA's touring space show and it was very well projected.

Jeffrey Katzenberg (the K in DreamWorks SKG) brought a short clip from his upcoming animated feature "Monsters and Aliens." Nice animation, but after a couple minutes I started to get a bad headache, which I told him about in the Q&A afterwards. It was the film and not some personal anomaly, since others agreed and I did not experience any serious eyestrain with as many as four consecutive full length 3D films on the other days, so I am sure it was major error in the image. This has been the nearly universal practice in 3D film and video--nobody who knows 3D well is overseeing the project. If there is a stereographer at all they usually have modest experience, they are not there from planning thru screening, and nobody has to listen to them anyway. Really too bad but I doubt it will change.

One thing I noticed in nearly every film—even several animated ones—was incorrect stereo windows in many shots. This means the right and left eye vertical edges of the screen do not match (or have the opposite of the normal situation where the right eye sees more to of the left side of the image than the left eye) giving an anomalous black edge in one or both eyes which can be quite annoying. This is due to the way the images are filmed and/or aligned for parallax control in editing (though it can be due to projector misalignment in dual systems). I had to deal with this constantly some 20 years ago when I reduced horizontal parallax of 3D films I transferred to video. The simple solution is to blow up the entire frame of that shot (or the whole film) by a few %. At least some of the filmmakers did not know about this easy fix or perhaps they did not see it as a problem. I am reminded of some glaring stereo window errors in Cameron's otherwise superb "Ghosts of the Abyss."

One of the most surprising films at the show was Mummies 3D, which I saw at its long run location at the Singapore Discovery Center in a SimEx-Iwerks theater, which uses their single projector 8 perf/frame above/below 70mm film and 7000 watt xenon projector with their own brand of 20x15M silver screen and Circular Polarized glasses. The ghosting from the CP was quite bad so I suspect that either the screen was depolarizing a bit or the polarizers on the projection lens were burning out or the glasses were not good or a bit of all 3. Of course I checked with my colleagues and they all said the same thing so I am sure it was not a problem with my glasses. The projection was remarkably steady (i.e., little

of the jitter and weave that is universal with film) but brightness, resolution, color, and ghosting were all noticeably inferior to the 3DX projections. However, it was probably similar in brightness, and overall image quality to what the average 3D digital theater will have.

Iwerks (an old and revered name in Hollywood) uses dual 70mm cameras with about 65mm interaxial, usually with about parallel axes, in a beam splitter (i.e., a mirror box with right angle cameras--similar to what has been done on many of the IMAX films and those from the 50's as well). This led to most of the image being flat when objects were more than about 15M distant. However I was stunned to see something I had never noticed in over 30 years of viewing 3D film and video—perfect dual camera alignment in all 3 axes in every shot! I looked e.g., at the z axis registration in shots with objects near the cameras and others simultaneously as much as several km away without any detectable vertical parallax and with no skew in the x or y axes either.. I have never seen such perfection in live action stereo (in a theatrical film that is--the Ikegami synced zoom cameras can do it but have not been used for feature films). So far as I could tell there were no zooms in any of the films either, which is not surprising since it is quite difficult to perfectly sync a pair of zoom lenses.

However, Anthony Coogan of StereoMedia <http://www.3dstereomedia.com/> has made many programs with the Ikegami 3D zoom cameras, which have nearly flawless registration and which, with recording on dual digital, should give excellent quality, especially with image processing and uprezzing that is now standard in most editing programs.

In contrast, there was detectable, but mostly modest, skew in those few shots in U23D, Miley Cyrus, and all the other live action films, where the action stopped long enough for me to get a look. The only scene with some version of twin HD video cameras where it was possible to get a really good look at alignment was in a short 3D video message to the conference from director James Cameron. It was clear that the cameras were skewed a degree or two in all 3 axes. Clearly, with the budget for Avatar supposedly in the \$100M range, they have the resources to correct this problem, so I assume they didn't notice it, or maybe they don't know to look for it. This is the normal, almost universal, situation—huge efforts with dozens, even hundreds, working on 3D projects but nobody minding the store—i.e., no well experienced stereoscopist overseeing all aspects from planning thru projection. They just assume that they will kind of pick up the stereo art as they go along and everything will be OK. It never is. As in nearly all human endeavours, the guiding lights in media need not achieve perfection as they can get away with it, whatever they do. But admittedly, doing 3D for a commercial production is tough.

With some 40 titles big and small coming for 2009-2011 from Hollywood alone there is a huge 3D blitz developing. Theater owners pay ca. \$30 to \$80K over the

costs of digital itself to convert to 3D, but, based on recent USA results, they can recoup this with the extra revenue from 1 to 3 films. The world box office for all films is ca. \$25 billion and the cost to convert all the world's 100K theaters to digital is about \$8 billion. It is likely that 50K screens will be digital by 2013 and 1/3 of these or ca. 16K will be 3D. Now (Jan 2009) 7% of the world's cinemas are digital and about 2% 3D digital.

A short clip of Cameron's "Titanic" converted to 3D showed the joys and sorrows of this process. There was depth for sure and better than seeing it flat, but the people and objects were flat, most parts of the background were flat, and there were many, many problems which got worse as the scene got more complex. Just what one would expect. I would anticipate a serious headache well before the end of a feature converted to 3D like this. Supposedly, Lucas is converting the Star Wars series to 3D, but I think it would be a much better idea to spend the money on new films. I'll bet neither he nor any of the others who rave about this process have ever tried to loop the short clips available and watch it for 2 hours. That would likely be the end of it. If they must convert, then set up a lab in China and hire some real experts to oversee it. This way you can throw ca. 10X more resources at it than are feasible in the USA. Assuming a huge amount of effort is spent on reducing the eyestrain, how receptive audiences will be is likely to depend on how much real 3D they have seen recently. It is likely to be counterproductive to show the solidized stuff along with the real stuff. Please note that I am not hostile to solidizing as I have one of the basic patents in this field, so a little piece of my brain is in every one of the thousands of Virtual FX 3D Converter set top boxes sold, as well as in hundreds of thousands of CD's included in the gaming kits sold by X3D Corp (the former name of NewSight Corp). Also I like very much the demo conversion of "Alien" done by DDD a decade ago (which appears to practice my patent).

MasterImage of Korea, who has resuscitated the spinning bipolarized disc placed in front of the projection lens, a method patented long ago for 3D movies, claims to have 140 installations (20 in China) and say they get some 19% light transmission. They charge about \$32K for an installation. In the theater they were provided, the image had bad ghosting, but they said this was due to the very steep projection angle necessitated by the theater. It is true that light depolarizes more as the angle of projection and viewing increases and their system is apparently certified by the studios for use without ghost reduction, so I think this is true. Nevertheless, it showed a basic problem with all polarized projection methods—any deviation from orthogonal projection or viewing gives ghosting in addition to that which is inescapable even on the orthogonal. So far as I know, only Real D is required to use ghost reduction. However, like Real D, they must use CP and this gives more ghosting than LP, with shutter glasses having less and Infitec least of all.

In this digital era, every projection setup (2D or 3D) must be studio approved before they will certify the theater and ship them the hard drive with the movies. This means the projector, server and 3D equipment must be DCI (Digital Cinema Initiative) compliant. Since the actual DC organization has faded away, this seems to mean whatever Christie/AIX, Dolby, Barco, the studios and the SMPTE say it is. Presumably they would approve a dual polarized setup but it would still require DC qualified projectors/servers. I am not sure what the cheapest DC compliant setup costs, but I assume at least \$50K each, so it appears that small theaters with less expensive equipment are just out of luck so far as first run releases of Hollywood 3D (or 2D) movies are concerned. This setup serves to guarantee quality, regulate distribution and inhibit piracy in 3D and 2D, but it also smacks of monopoly and I am sure it is irksome to many. The dominant hardware force is Christie (owned by cinema giant AIX who has 4600 screens worldwide) which claims 80% of the DC projectors installed with Barco, Digital Projection, NEC and SONY among the other DC compliant projector providers. They say that their 3 chip, Tripleflash (i.e., 144hz), Brilliant3D, 17K lumen (with max. brightness option) CP2000-ZX is the most cost effective for digital cinema with up to 15M wide screens, with the top of the line (as of Jan 2009) CP2000-SB delivering 14 fL (foot lamberts) on up to 33M screens. Two of these were used for 3DX.

Apparently, Disney (and others?) have been subsidizing the cost of the CP (i.e., Circular Polarized plastic) glasses for their Real D theaters (i.e., Disney's Shamrock Holdings invested at least \$50M in Real D), but one expects that this cannot continue. The president of Disney gave the opening address, which makes it all the more odd that Real D did not show their system here.



3DTV Corp Universal Cinema wireless LCD shutter glasses -stronger, fit everyone & over glasses, replaceable batteries, autosync to any emitter brand.

XPAND is currently the leader in cinema shutter glasses systems and they had their own theater for the day of the digital 3D shootout. I was told by several persons that the XPAND glasses broke frequently and that they did not fit people who had to wear glasses. Of course all glasses break eventually and none fit everyone. XPAND is making new ones with built in RFID tags and other features (e.g., you can now wave a special wand over them to determine remaining battery life) and they said that the batteries last 300 hours. This means ca. 150 movies and amortizing what they said is the average cost to the chains of \$65/pair this means ca. 40 cents per film, assuming minimal breakage. But smaller chains pay ca. \$100 so that doubles the cost. They charge about \$14K for installation. They claim 500 installations by Jan 2009, which about ties them with Infitec (i.e., 300 each by Dolby and Barco). Even if their nonreplaceable batteries do last an average of 300 hours, this makes XPAND by far the most expensive of the 6 alternatives followed by Real D, Twin Polarized, MasterImage and 3DTV Corp, with Infitec the least costly. I exclude the supercheap bicolor anaglyph (e.g., SpaceSpex) which is unlikely to appear as the DC powers are unlikely to approve it, whatever its virtues. However, it seems very likely to eventually appear in smaller theaters.

What all this seems to amount to is that the sun is setting on the Real D empire. In spite of Real D's continuing claims (e.g., as I write this they repeat this prevarication in the media releases re their NFL test) that they have over 90% of the world's 3D theaters, the fact is that they have less than 50% worldwide and are quickly losing share even in the USA, where their angels (Disney, AIX etc.) deep pockets have been keeping them alive. About three years ago Real D had essentially all of the 400 or so 3D digital theaters then existing, and nearly all were in the USA, but now there are ca. 2200 worldwide and Real D has less than 1000 total. They are the only one of the six systems required to ghost reduce and the only one who charges an annual fee (\$25K). The roughly 1000 Real D theaters will pay them ca. \$25 million in license fees in 2009, most of which will be saved by those using the other five methods (except XPAND where the cost could be more). This only makes sense if their major installers such as AIX own stock in Real D and even then they would have a better image and save a bundle as well as freeing themselves from ghost reduction, the expensive CP glasses and silver screens, if they switched technologies. There were no Real D systems at the show. One suspects they did not want to risk a comparison. One knowledgeable person who saw "Journey to the Center of the Earth" at a Real D theater in Oahu, Hawaii said it gave him a bad headache. Neither I nor anyone I talked to had a problem with it at 3DX with the Dolby Infitec system. Potential reasons for the difference are numerous. There could have been excessive ghosting due to depolarization by substandard glasses or screen or by fingerprints on his glasses or by sitting close to or to the sides of the screen or by deterioration of the CP switcher. It's possible the cinema server/projector or CP switch malfunctioned or even that the theater did not receive a ghost reduced version of the digital film.

A theater with a 3D capable projector could install the 3DTV Corp 3D Window shutter glasses system in less than an hour for just the cost of the glasses (\$50 to \$100 each dep. on qty.) and emitter (\$500 to \$5000 dep. on theater size). If they replaced an Infitec (Dolby or Barco) system the brightness would about triple , with the downsides of the cost of glasses and a slight increase in ghosting. If they had a Real D system, by changing they would (on average) pay for the glasses in the first year by shedding the license fee and would have a brighter image with lower ghosting and no need to get a ghost reduced film and constantly monitor the quality of the polarization chain (i.e., CP switcher, screen, glasses). If they had MasterImage or dual polarized they would (on average) have a somewhat brighter image with lower ghosting and drop the need for paying for (or getting their customers to pay for) paper or plastic glasses. If they had XPAND disposable shutter glasses they could (due to compatibility) start phasing them out immediately and reduce glasses costs to as little as a tenth (i.e., pennies per customer) depending on how long the XPAND batteries last and the relative breakage rates. I have not seen anyone estimate the market for 3D Cinema hardware so I have put my estimates in Table 1.

TABLE 1 Estimated 5 Year World Market for 3D Cinema Viewing Hardware 2009-2013

is # 3D Cinemas by 2014 Cost is Lowest cost/5 years = 1 Maint is Lowest Maintenance = 1 Best Image Quality (IQ) = 1

Startup/ 5 years is Startup Cost/1000 Screens /Total Cost/5 Years in Millions \$

METHOD/# Theaters	COST/MAINT/IQ	STARTUP/5 YEARS
3DTV Corp (5000)	2 /1/1	\$30M/ \$55M (if all break in 5 years) \$30M/ \$105M (if all break in 2.5 years)
XPAND (2000)	6 /1/1	\$39M/ \$139M (150 shows/year) \$39/ \$239M (150 shows/6 mo) \$39M/ \$414M (150 shows/month)
INFITEC (3000)	1/3/2	\$22M/ \$34M (if all break in 5 years)
Real D (2500)	5/3/6	\$35M/ \$135M + glasses
MasterImage (1500)	3/4/5	\$42M/ \$42M + glasses
Twin Polarized (1000)	4/2/4	\$60M/ \$60M + glasses

NOTES:

3DTV Corp 3D Window® LCD shutter glasses system can replace any other 3D system in an hour with payback cost in from 3 months to a year. 30M = 5M install + 25M glasses 55M = 5M install + 50M glasses Only these shutter glasses are compatible with other brands (XPAND, NuVision, CrystalEyes). Also they are strong, fit nearly everyone and fit over glasses (unlike all others made to date). Estimates for LCD shutter glasses assume 500 seat theaters with glasses at \$50 each.

The XPAND system should cost from 3 to 10 times more than the 3DTV system, with cost differential increasing with higher use. If battery life is less than the claimed 300 hours the cost rises accordingly as the batteries are not replaceable. 39M = 14M install + 25M glasses 139M = 14 install + 125M glasses Again this assumes 500 seat theaters with glasses at \$50 each in large qty. In small qty they now cost ca. \$100. If batteries last longer than 300 hours cost drops but breakage will rise.

The 10K license fee for Infitec is the estimated extra cost to buy an Active Infitec enabled projector (ie the Dolby 3D Digital system). 22M = 12M glasses + 10M license premiums on projectors 34M = 24M glasses + 10M license premiums

Real D 35M = 25M license + 10M silver screens 135M = 125M licenses + 10M silver screens

MasterImage 42M = 32M install + 10M silver screens

**Twin Polarized 60M = 10M silver screens + 50M for second projector
Cost of projector is not included except for Twin Polarized which includes cost of the second projector.**

Infitec is rated 2nd in IQ since it is expected that on average the image will be significantly less bright, less well color corrected and more blurry due to fingerprints and reflections, than shutter or polarized theaters. In addition, active Infitec will show the same motion artifacts as CP or LP switching (i.e., Real D or MasterImage) or LCD shutters, as well as some unique color artifacts-as admitted in several Barco patents.

Due to it's zero crosstalk, the color corrected Dolby® 3D Digital Cinema system ((i.e., the Dolby Active Infitec system also licensed to Barco) is clearly the hands-down winner for those theaters with the very brightest projectors and

smaller screens (i.e., brighter because all the light is on a smaller area). However as noted, many persons here commented that this projection was the best they had ever seen (including IMAX 3D projections of some of the same films), and teams from Technicolor, Dolby and Disney brought in lots of equipment including two giant state of the art Christie DLP projectors, put one eye into each projector for 4.1 lux at the screen (incredible) and tweaked it to the max. Unfortunately, virtually all of the 600 Dolby/Barco/Infitec installs are the single projector Active Infitec with significantly less brightness and possibly less than perfect color correction (i.e., a less pleasing image with poorer depth and more eyestrain). I assume the color correction (and Infitec filter wheel sync) must be done on site and details will vary with each projector model.

Two other problems with the Dolby® 3D Digital Cinema system (i.e, Infitec) were the reflections off the inside of the glasses from aisle lights and rear lights in the theater (a problem with all types of glasses but notably worse here) and, by far worst of all, the near impossibility of removing the very obtrusive fingerprints. I solved the former problem by changing my seat but, unlike the case with polarized or shutter glasses, I was unable to completely remove the prints on these with clean tissues. I have been told that alcohol wipes have been mandated for use in French 3D theaters and these would appear to be essential for Infitec.

SONY was not at the show, but as I predicted in my previous article, they have introduced a split lens polarized system for their high end LCOS projector. However, this necessitates losing pixels and also the brightness takes a big hit, so the future of their LCOS for 3D is problematic. I do not know of any theater using it for 3D (though it has been used in twin polarized format a few times).

Now for a little non-3DX 3D info from Singapore. TI's rep. (i.e., the maker of DLP engines) told me they have sold 2 million of the Samsung/Mitsubishi 3D DLP TV's in the USA now, and it being intro'd worldwide this year, but of course there are still no compatible 3D movies on HD DVD. TI has made a hires, very bright 240hz (i.e., no motion blur) DLP engine but so far no takers for manufacturing it into sets or projectors.

I finally got a chance to see the autostereo lenticular display from Pierre Alio and colleagues on display in the cinema lobby. It was bright and reasonably sharp with decent depth as expected, but it had bad diagonal Moire bands due to misalignment of the lens sheet with the display pixels. This is the normal problem for lenticulars and it's almost impossible to totally and permanently eliminate it, as one has to make a whole new metal master for every change and that can cost in the \$100,000 range for a 42 inch display. Also the plastic will tend to expand and shrink with heat and produce Moire even if it was not there to begin with, and this gets worse with time and in more extreme locations as the plastic shrinks, the glue degrades and the lens sheet yellows and dehisces. Of course none of the

manufacturers of such displays mention these issues in company literature.

I checked out most of the other 3D experiences available while I was in Singapore. There are two on the hill on Sentosa Island near the Imbiah station of the express train from Vivo City (where 3DX took place). CineBlast is another of the 10 minute motion platform ride films from SimEx-Iwerks which sits 6 in each car that rocks and rolls more or less in sync with the 3D computer graphics on the screen. There were 9 cars for the 12M wide screen. They used dual LP projection, which is quite odd since nearly everyone who does rides that jerk you around as much as this uses circular polarizers-- which permit head tipping (unlike LP's). In addition to the ghosting caused by head tipping, the rapid movement of the images and the discomfort (in my case) from the excessive car motion, the two projectors were seriously out of register, with about 8cm of vertical parallax and excessive horizontal parallax. I guess from the look of the images that there was an excessive angle between the two stereo views in the original graphics as well, but with all the other problems it was impossible to say. Like all the 2D and 3D ride films I have seen, the graphics look quite dated with no ray tracing etc, and inferior to the better current videogames.

The other Sentosa 3D attraction was "Pirates"--also a SimEx-Iwerks attraction, which I had seen before in Beijing, and which I think was shot with dual 70mm film (perhaps with the HinesLab rig). I believe it premiered at Busch Gardens in Florida maybe 10 years ago. This company has about 30 short 3D films with over 100 worldwide locations. As in Beijing, the seats rocked back and forth and the film was synced with leg whips, air jets and water sprays. This really dumb 15 min. comedy about clueless pirates with Leslie Nielsen and Eric Idle had reasonably good 3D and dual LP projection, but again the two projectors were seriously out of alignment H and V and skewed right to left and this, combined with asymmetrical illumination and the slight jitter and weave from the film cameras, significantly diminished the effect.

It was, however, far from the worst 3D projection I have seen in recent years. That honor belongs, hands down, to the short 3D film I saw at the Mars M&M store in Las Vegas two years ago. I presume the projector was originally OK when they installed it but bad things had happened and there was horrific mismatch of the registration, ghosting (possibly due to burnt out polarizers) and brightness of the images in all directions, and such a dim image and huge H and V parallax it was impossible to watch. I had my glasses off most of the 10 min. but the others had no clue and their headaches must have been extreme compared to mine. I talked to the projectionist who told me he knew something was wrong and said it had been that way for a long time. I explained the situation and gave him my card for the manager. Subsequently I wrote a letter

about this disaster to the Mars company telling them what was wrong and suggesting this was a major liability as people could easily get dizzy enough to fall down the several flights of stairs or throw up in the store. I managed to locate Michael Mars' home address and sent him a copy of the letter. As expected (after 35 years in the 3D industry), I never heard a word from anyone. If anybody happens by Las Vegas I would like to know if they have fixed this. So far as I know this is the only place where this 3D film is shown.

Another 3D rarity, called the "Tiger Beer Experience", is located across the street from Vivo City. You have to endure 20 min. of history on Tiger Beer to get to the 10 min. 3D movie, presented with dual LP projection on a 7M screen with rotating elevated platform. The whole theater was done ca. 3 years ago by NHK and I suspect it cost at least \$10M. The film combined 3D video and graphics to tell you about how beer is made and the visuals looked quite good considering that the projectors were seriously out of whack. Misregistration H and V and skewed images with asymmetrical illumination. Also, the glasses were very beat up. I talked to the manager and he was aware it was not perfect but when we took a look at the projection and AV set up I saw he had a major job on his hands. The extensive NHK installation was racks and racks of equipment and lots of wires running all over the building as well as going to a pair of large projectors set in an almost inaccessible place up in the air. It was going to be a lot of work to get a test image into them and adjust the mounts. He was quite receptive but had to go thru Tiger to make any changes, so we shall see.

The final short 3D film was X4D at the Discovery Center, probably also a motion base ride film from SimEx-Iwerks, but it had not opened yet, so some other intrepid stereopath will have to check it out.

Singapore has made a decision to get into media production, including feature films, and Lucasfilm has a studio there. This accounts for the government sponsorship of this and other events and one can expect a lot of film activity here in the future, both 2D and 3D. If 3DX 2 takes place here next November it should be quite spectacular.