2010 Home Theater Cruise™ Sailed On Norwegian Cruise Line's Epic November 13-20, 2010

An Epic Technology Conference At Sea™

As our 9th annual cruise has now passed, this is a wrap-up of the proceedings of the Technology Conference At Sea™ program.

The first in this series of articles and interviews created during the 2010 Home Theater Cruise™, on November 13th through the 20th, appeared in Issue 153, January 2011. The focus of the conference was on dimensional imagery and sonics, with seminar topics on the ins and outs of optimizing 3-D home entertainment, HDMI v1.4 connectivity, mixing and reproducing aggressive surround sound soundtracks, and guidance on how to address the challenges of the home theatre environment. The conferences spanned the three days at sea aboard the new Norwegian Cruise Line's Epic and presented notable home theatre technologists and practitioners in a program of intimate group participation seminars. The Technology Conference At Sea was held in the ship's luxurious 150-seat conference center.

During the cruise our group partook in shore excursions during our stays in ports as well as onboard entertainment. Entertainment headliners aboard the splashy new ship included the popular music, comedy, and multimedia theatrical troupe, the Blue Man Group. Meanwhile, at the 280-seat Comedy Club, the famed Second City improv group staged productions. In the only big top at sea, Cirque Dreams & Dinner featured high-flying acrobats, jugglers, and baton twirlers, which accompanied our evening meal.

For consumer electronics companies, the Home Theater Cruise offers a one-of-a-kind opportunity to create sales incentive contests and reward dealers, representatives, and distributors, as well as serve as an exotic getaway for company meetings in conjunction with our group activities.

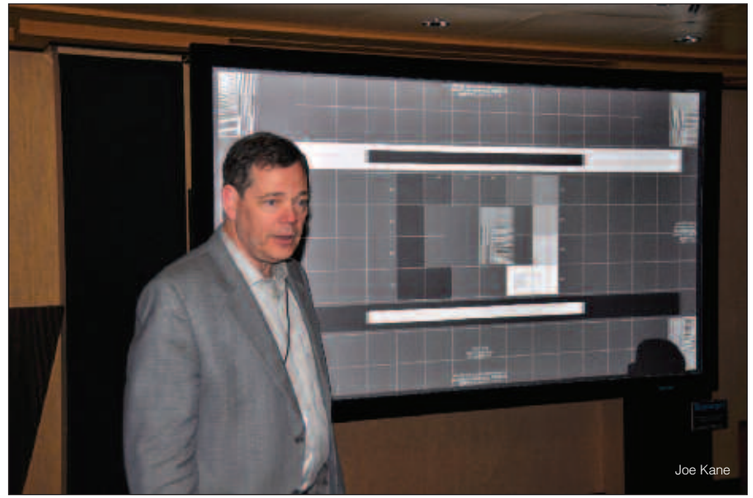
And because the food and amenities are all inclusive, there is no hassle or added expense associated with conducting business on the ship.

In addition to the wonderful entertainment, the amenities included 20 different dining options, an ice bar, nightclubs, a casino, a world-class health spa and fitness center, and Aqua Park. There was even a wonderful supervised kids' program on the ship.

All in all, this was an exceptional learning experience, with unique opportunities to network and engage in personal conversation with knowledgeable and experienced experts.

What follows is a condensation of the proceedings. In some cases, lengthy excerpts from the presentations are quoted.

The conference program started off with **Joe Kane**'s **"Getting Past The Wow Factor Of 3D"** presentation. Joe opened with the statement, "Among the issues that we have right now are the formats are coming at us faster than we are able to set standards."


Joe Kane

Joe explained the side-by-side and top-and-bottom 3-D formats, pointing out that the side-by-side format is a far better format when it comes to transmitting either interlaced or progressive. Both formats shrink the image, which results in half-resolution. Additionally, with an interlaced signal, half the resolution is lost on top of the side-by-side and top-and-bottom shrinkage because in interlaced only half the information is there at any given point. Joe reminded our group that there is not enough bandwidth in standard broadcast channels to do two completely independent channels of information. So what is being done is to simultaneously put the left and right image in the same image, thereby, theoretically, the 3-D signal can be compressed and carried across the bandwidth as is the case with a 2-D signal. So with a top-and-bottom interlaced signal, the vertical resolution is down one-quarter. And, as Joe pointed out, we have to remember if it's a true interlaced signal, we've already used up 30 percent of the signal—that being the difference between progressive and interlaced. "If you take a progressive signal and convert it to interlaced, you have to filter the top third—the high frequencies in the signal—otherwise, you'll get line twitter. You'll see really highly visible interlace artifacts. Interlace is already a 30 percent filter just to get from progressive to interlaced. Then we will be splitting it down to one quarter when we broadcast this."

Joe continued, "Now the interesting thing about the trials that have been done in 3D is that these images with one-quarter vertical resolution have been shown to consumer groups, and all the reports have said that nobody can tell the difference. Nobody can tell that three-quarters of the information is gone. Well, my first reaction to that is you did something wrong in the testing. Because if three-quarters of the vertical information is gone, and no one could tell the difference, somebody didn't do a good job of testing. And part of it, I believe, is the 'Wow' factor of 3D. There's no expectations for what you see in 3D. So I think part of the problem is when people look at 3D, there's the 'Wow' factor. 'Oh, my gosh, it's something completely different.' And they never take the time to notice that something's actually missing. They don't have any reference for what it should be."

Joe continued, "I think we are finding ourselves in the same position with 3D that we found ourselves back in the original days of LaserDisc. We have no expectation whatsoever of what should be. 'Wow' factor is the principal thing that happens when you see 3D that you have no expectations of what it's supposed to look like? Therefore, if it's just there, you can accept a picture with one-quarter vertical resolution and right now, you're saying 'Wow.' The whole case of my presentation is that if we really want good 3D, we've all gotta get over the 'Wow' factor and the faster we get over that 'Wow' factor, the better off that 3D is actually going to be. We need to start being objective about how we see 3D images. So when I say getting over the 'Wow' factor, among the things that I think are critical in 3D is getting to know 2D again. We've made some significant advances in two-dimensional images. And we need to be judging 3D by the best of what we know in 2D. 3D is a left image that is full resolution and it's a right image that is full resolution. What's happening in 3D is we're suddenly making a huge number of compromises in image quality. Now the compromises that we're making include the fact that 2D doesn't look good anymore, if some of the methods used for 3D are included. Early on, as an example, there have been advocates of a polarized system. Whether circularly polarized or linearly polarized, the glasses are passive and inexpensive. Now I'm going to use the example of horizontally and vertically polarized images so that you can get an idea of what I'm talking about instead of getting complicated in circularly polarized. But what happens is I have two images up on screen and when I have a projector I polarize one image horizontally so that all the light coming out of it is horizontal. Then I polarize the other image vertically so that all the light coming out of it is vertical. Then I wear polarized sunglasses, except for the fact that in one of the glasses, instead of having them both horizontally polarized, one of the eyes is vertically polarized. So theoretically, anything that's coming in horizontally polarized comes to this eye, anything that's coming in vertically polarized comes to this eye.

"The problem with that is that when there is image information on the diagonal it comes through both eyes. So you get ghosting in an image, you actually see part of what's in the left eye and part of what's in the right eye. You see it in both eyes. We get a 3-D image by displacing information between the left eye and right eye. As an example, the plane of the screen, we'll just call it a zero-plane for 3D. If I want to bring something out forward, what I do is I take what's on this side and I shift it over in that direction, and I take what's on this side and I shift it over in this direction. What happens, if you think about it, you have two eyes and you see forward. Your eyes converge on this point and this point becomes the plane. Then as you go through the plane, they diverge again. If I actually want to bring something in the picture forward, what I do is I cross it over because your eyes are seeing crossed. If you looked through the screen, then the left and right images go out that way. So if I wanted to make it go behind the screen, I push the left and right images in that direction. So it's actually really easy to create 3-D test patterns.

"The reason I want to create 3-D test patterns is I want a real reference for image quality. So I want to take my 2-D test patterns and I want to make them 3D and say, 'You know what these images look like in 2D. You have expectations of these images. Now let's put them in 3D and see what happens.' I'm just getting started. We've got a generator here from AVFoundry, and they actually allowed me to create test patterns and feed them into the generator. The patters will be made available on the generator. So, long before I get a 3-D Blu-ray Disc™ on the market, at least people who are out in the field calibrating and manufacturers are going to have instant access to 3-D test patterns and can actually, seriously, look at what's going on."

Joe then discussed display technologies suitable for 3D and commented: "So in choosing 3D, the kinds of technology that give

you instant images without any retention, without any leg of one image being up on screen staying up after another, are the only technologies that have a chance of doing really good at 3D. And plasma and DLP are the two technologies that can do that. In the initial stages, DLP and plasma are the two technologies that have the best chance of giving you really high-quality 3D. So if you want an opinion on where you start in this business, you just got it. That's the starting point. Now, the other technologies are going to take a lot longer to develop before they get 3D right."

Joe returned to a discussion of the passive systems. "Getting back to the passive method, in bringing 3D to the marketplace, it was critical that we get an inexpensive approach to bringing it into the theatres, and passive glasses were said to be the inexpensive approach because it was determined that the cost of glasses and maintenance, repair, cleaning, and all that sort of stuff was the biggest factor. Now there are two passive systems. There's the polarized system, which I just described, and there's also a color-filter system, which means that the glasses actually act like a comb filter. The visual spectrum is split up into three different groups, then overlapped. What happens is the glasses act like a comb filter. Therefore,


An Audience Ocularly Entranced

left-eye can be put in one set of three colors and right-eye in the other set of three colors. This is an overview of the system that Dolby® is using for their passive system. Passive is less expensive. The advantage of the Dolby system is there is no polarization that has to be maintained by the screen. If I use a polarized system, first of all, I explained that anything that's on the diagonal will get into both eyes because it will go through both sets of lenses. One of the first things that they're doing is—somebody got smart and said, "We can solve that problem. We'll just filter out the diagonals." Now if any of you remember cross-color in NTSC, where we combined color and black and white, anything on the diagonal would give you cross-color so that the black-and-white information would become color information. The color information would become black-and-white because the color and black-and-white information existed in the diagonal domain simultaneously, and in order to get a good picture, you had to do something about filtering them out. So we're right back to NTSC decoding. This is how far back we've stepped back to make a polarized system work. We're right back to the same tricks that we had to use in order to get NTSC to work. There's one more thing that's critical, and I'm going to demonstrate this in a minute. When you use a polarized system, the screen has to maintain that polarity. In other words, the light hitting the screen can't mess up the polarity. This has pushed us back to metalized screens. This has pushed us back nearly 100 years in technology. The first screens that ever came out in the motion picture industry were metalized. The whole concept of the metalized screen was to give you enough gain. Do you remember back when projectors didn't have enough horsepower? That screens had to help the projector out? Does anybody remember those bad old days of CRT projectors when we did some really obnoxious things in the screen? Well, that's precisely what we did 100 years ago when we had film projectors that didn't have enough light. The screen has often been made to compensate for something that the projector wouldn't do. We first had to metalize the screens so that we could push a lot of light back. Well, it turns out that those screens are ideal for maintaining polarity. So we're now coming back to putting screens in theatres that hotspot something fierce, color-shift something fierce, just to get 3D. Well, guess what that does to the 2-D image? If we're adding color-shift and hotspotting the image, we are severely compromising the 2-D image. But then if you look at 3D as just two 2-D images, we're severely compromising 3D as well. I actually got up at a SMPTE conference and made that point. I literally got booed. Like, 'Don't tell anybody! Don't tell anybody that we're literally destroying our images to get to 3D.' One of the things that's really bad in theatres is that they're actually converting over to metalized screens for 3D, which effectively means it's going to be another 20 or 30 years before we can get rid of them because we all know the budgets in the theatres. Once they go in, they're gonna stay.

"Actually the Dolby system can play off any existing screen. That is a distinct advantage to the comb-filter color system that Dolby is advocating. So all of this is about going back."

Following more discussion of metalized screens, Joe began to focus on good 2D. "The majority of the presentation that I'm going to be doing today is going back and looking at 2D and understanding what you should expect of 2D. Then I'm going to go forward with a couple of test patterns and show you what to look at in 3D so that you can get an idea of good 3D—we'll see how many of them we can make work. I'm going to show you what happens when you introduce 3D into the image, so that you can actually see where things can go downhill in a really big hurry."

Joe began to explore test patterns using a version of *Digital Video Essentials* that he created for the broadcast industry. "It turns out that the broadcast industry is faced with the same dilemma that I'm telling you that you are faced with. Whether you know it or not, you're all faced with the same dilemma. Nobody's doing a real proof of performance on the display devices. Nobody's actually saying, 'Well, let's test it out and let's find out exactly what it is doing.' So I created a separate version of this for the broadcast industry because we're now in a situation in the broadcast world where we're looking at 3-D displays. In fact, we're converting over—the broadcast CRT is gone. It's a dead device. It doesn't exist anymore. And quite frankly a lot of the post-production houses are being forced into the consumer market looking for high-definition displays because the professional market has been a bit slower about developing displays that can help them out. They started looking at consumer display devices about four years ago. But they weren't qualifying the devices. Of course, now that we're coming into 3D, qualifying the devices becomes even more critical in trying to decide what's an appropriate display to be

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using. ...Among the first things that you're supposed to be able to look at is the difference in level between the black background and 2 percent above black. In a CRT, which is what we're trying to emulate in any other kinds of display, there is a just-noticeable difference between black and 2 percent above black. So the first thing in qualifying a display is determining if you can set black properly."

Joe discussed gamma saying, "If the gamma is set right, there is actually very little difference in light level between the black and 2 percent above black." He then began a discussion about gray scale. "This is an 8-bit gray scale. If you know anything about television, you know that we sample each image. What that means is each pixel is sampled and there's 256 steps, 0 to 255, represented. Now it turns out that when we did our compression system, delivering information to consumers, the display devices that were used to look at those pictures were so bad that nobody could see that 8-bit didn't have enough resolution. So back in the late 90's when we—and I was a part of it—when we made decisions on what should be transmitted for DVD, high-definition, we all said "Nah, 8-bit is enough." I wasn't one of them. Anyway, what you can actually see is the steps in an 8-bit ramp. You're seeing the individual steps. So it turns out that 8-bits actually isn't enough resolution, but I'm pointing this out to you and having you look at this because a lot of displays out there claim to be 10-bit. Yet, when you put this up, you see block errors where instead of individually spaced steps, you see widely spaced steps, and you'll see noise in some of the steps. That actually means that the display is not even 8-bit. They'll claim 10-bit, 12-bit processing, and I'm sure you've all seen this in the advertising. They'll claim 8 or 10 or 12 bit processing and yet you put up an 8-bit ramp and it can't even show 8 bits. It can't even show 8 bits for what it's worth. A 10-bit ramp is much smoother. Now I happened to be among the people who objected to 8-bit because I understood something about the digital compression that the analog people didn't. It was analog people who made the decision. The idea 'if the numbers are lower, it must be easier to compress' so '8-bit must be easier to compress than 10-bit.' Well, it turns out—see all of those steps? They're actually harder to encode than if that was smooth. It turns out that if we had done 10-bit, we could have gotten an equal quality picture for 25 percent less in bitrate. We would have had a better picture at 25 percent less in bitrate. There are five companies that are approaching me now about a replacement for the Blu-ray Disc format. I've told all of them they have to go 10-bit and actually, they're thrilled, because it's a 25 percent savings in bitspace, and of course, all their proposals are Internet delivery or memory-stick delivery, or whatever, and they're saving 25 percent less. Or if they want to go 3D, the second channel can be thrown in for the current bitrate. And the quality will be better. So look for 10-bit in the future, and when you're buying displays look for real 10-bit capability. If you put up an 8-bit ramp and you have any steps in that ramp, or you have any discolorations in the ramp, or you have noise in the ramp, you know that the through-processing is not 8-bit. There's something wrong. It's not processing a full 8-bit resolution. Whatever the reason, it's not doing its job. If you look at a lot of LCD displays that claim 10-bit, they're not even 8-bit. So what you're going to do is you're going to get noise at some points, and they'll be very specific points in gray scale where you'll get noise introduced. And you'll get other specific points where instead of small steps, the steps will be large. That's going to introduce noise and contouring into your picture. So if you have a gradation in fleshtones, you'll actually get a stepping in the fleshtones instead of a smooth gradation. It'll introduce all sorts of contouring in the picture, so you won't have as good a picture. I'm emphasizing all of this because I want to create an expectation for 3D. You need to know what 2D should look like and you should have expectations of 2D. And there should be a compatibility between 2D and 3D. So we start here.

"The next thing that's really critical is flat-field uniformity. Flat-field uniformity is a parameter that has been ignored by a large number of manufacturers in creating display devices. Basically, if you put up a flat-field, it's going to be one color on this side [of the screen] and it's going to be another color on that side. Depending on where you're seated, it's going to be reversed so you will see one thing on that side and you will see something different on the other side. Now, the screen plays a part in that. I started working with the post-production industry in trying to put display devices in post-production. And they flat-out refused to use projectors. The reason they refused to use projectors is flat-field uniformity was terrible. They couldn't find a projector that had decent flat-field uniformity. And there was noise in the picture that they hadn't anticipated. So between color-shifts, luminance-shifts, and noise that was introduced in the picture they said it was impossible. They couldn't use a projector. Even as late as two weeks ago, there was a presentation done before SMPTE that effectively said projectors can't be used because of all these problems. The irony is the person who was giving the paper didn't know it was the screen that was at fault. It was the screen that was doing it. So that's one of the things. What I'm going to do is put up an example of a screen. This is typical of what we used to have in screen material. For those of you who are sitting close in front, you should be able to see the granularity in the screen.

"Well, it turns out that when detail crosses over that granularity, it actually looks like noise in the picture. It looks like active noise. So the screen is actually introducing noise into your picture. And the picture quality isn't anywhere near as good as you would like to have it. Now most screens are spray-coated. We start out with vinyl and we spray-coat the reflectivity characteristics we want. Even matte screens are spray-coated, or there is some sort of a coating on them. What happens is it has a granularity to it. The higher the gain, the higher the directivity. I really need to start using the word directivity instead of gain. The higher the directivity in the image, the more granular the surface is, so that a 1.5 gain screen would have a much higher granularity to it than a 1.1 gain screen. What would happen is the 1.5 gain screen would be far more noisy. It would add a lot more noise to the picture than a 1.1 gain screen.


An Epic Stateroom


The Onboard Spa

"As far as I'm concerned, it's something you need to look for in your home application too. You don't want a noisy picture any more than the post-production community wants a noisy picture. Now, going back to the granularity, I'm going to emulate you walking around the screen by turning the screen. Can everybody see the color-shift? [audience acknowledges] What you're seeing is a color-shift in the image. That's impossible in a good image. You can't have that in a good 2D or a good 3D image. The next thing that I'm going to do is go to the silver screen, which is what is used in the application of the polaroids. Now, can you see the severe hotspotting in this as I move this around? Can you see the noise that's in the picture? From where I am standing, there is actually a severe moiré pattern in this. Can anybody else see it from the audience? Not only are we adding noise, we're adding a huge amount of moiré to the picture, and we're effectively killing the picture by requiring a metalized screen. [audience acknowledges]

"Now how would you like to have a screen that does that to your picture? Do you see where my opposition to the early methods of 3D come in? Do you really want to add that to your picture? What I'm trying to say is that 3D is coming so fast and the 'Wow' factor is so significant that we're missing things like this happening in the picture. We're ignoring it because we're so enamored with the fact that, 'Oh my gosh, it's 3D!' We're ignoring these kinds of things. Part of what I want to do in the presentation today is to have you see some of the things that end up going into the image. Things that happen in these initial stages of getting to 3D as fast as we possibly can and ignoring the difficulties that are introduced in the process of getting them."

Joe demonstrates the problem with perforated screens. "There is a perfectly recognizable image that goes through the screen that never comes back. Any acoustically transparent screen—it doesn't matter what the fabric is, what the material is—a perfectly recognizable image is going to go through the screen and never come back. So when we're talking about 2D or 3D quality, a perforated screen is not in my bag of tricks."

Joe discussed the state of Blu-ray Disc players saying that "up until just recently, there was the Sony PS3 and the OPPO that could actually do a decent job of decoding from the component signal Y-Cr-Cb to RGB. Almost every single Blu-ray Disc player that I tried, when you demand an RGB out wouldn't decode it right. It wouldn't give you the right red, green, and blue. So among the things that you should look for on a display—that is a red-only, green-only, and blue-only mode in the projector. You know that I include filters with the program that I distribute. It turns out when we do matrix color correction, those filters don't work. What is matrix color correction? We start out with a color gamut that's much larger than what we need and then we get a red, as an example, by adding blue and green to it. So we pull it from way out here where it is. We pull it in by adding blue and green to it. It's called matrix color. If you hold up the filter, you filter out the blue and green that is being added to it, so you can't see what the real red looks like. So the projector or the display device itself has to have a red-only, green-only, blue-only mode in it, if you're going to detect what the rest of your system is doing. It turns out that a number of displays that are coming on the market now actually put it in the consumer menu system so that it's conveniently accessible. That's actually a tool that the installer needs in determining what components are right. As an example, I just mentioned that the majority of Blu-ray Disc players that are on the market get it wrong. That is just now changing, but I recently sampled Blu-ray Disc players, as of two or three weeks ago, and they're still getting it wrong. We're ten years into our high-definition system, and we still aren't building high-definition decoders that get it right. About three months ago, I got an LCD display and it didn't have a Rec.709 decoder in it—no high-definition decoding in the set anywhere. It had a red-only, blue-only, green-only mode in the set. They literally built in the ability of testing for it into the set and then never used it."

Joe then began a discussion on the subject of resolution. Resolution becomes really important to any pixilated display because what happens is if we don't have a pixel-for-pixel match 1080p to 1080p, as an example, we're going to lose a lot of resolution capability. Another thing that we're looking for here in this test pattern: these are single-pixel transitions, so we're looking for sharpness. If the sharpness is turned up too high, there will be extra edges here. This is the vertical direction and this is the horizontal direction, just in case they have independent adjustments for horizontal and vertical, you could set this up. This projector [reference to the Digital Projection Titan 3-D projector] doesn't have any problems in introducing sharpness. The next pattern is a pixel-phased test pattern. This allows me to see if I actually have a pixel-for-pixel match. I emphasize that this is all critical because you need to get 2D right before you can actually do 3D.

Joe returned to the subject of brightness. "You may know that through 3D there is a lot of light loss, especially in the polarized systems. But even in the shuttered glasses, we're losing 60 to 70 percent of the light in current shuttered glasses. So there's a huge light difference in doing 3D versus 2D. There's a temptation to once again make the screen compensate for the fact that there's such a light level difference. If you in any way allow the screen to compensate, you're going to be introducing hotspotting, color-shifts, and all sorts of really bad things into the image. Among the things that I hope some manufacturer explores for home use is a new white LED lamp that is 6,000 lumens. It's 100 watts and it's phosphor based so that it has a decent color spectrum. At 6,000 lumens in LED, you have a capability of controlling the light output so that when you do 3D you jump it up to the level you want. When you do 2D, you pull it back down. Incidentally, the retail cost on this bulb is $200. [Audience amazement] The half life specified for this bulb is 22,000 hours. I am not part of the inner workings of every projector company. The only company that has bought this light bulb are people like Mole-Richardson. They're a lighting company. They make lights for staging. They found this light to be a real advantage for 100 watts, for 6,000 lumens. It was specifically designed as a projection lamp. And of course, actually, that's what spotlights are; they're projectors. So companies like Mole-Richardson have started using it. To use in projection will require a new projector design because it's a group of LED lamps, and the group is much larger than the spot that you would get out of the Xenon or a UHP lamp, the whole optical path has to be completely redesigned to accept the lamp. But there are advantages for 3D—the advantage of being able to control the light in 3D—being able to go from 1,000 lumens, which would be

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appropriate for a 10-foot wide screen. Being able to switch to 6,000 lumens would mean that when you go into 3D it would be just changing the voltage on the lamp and you would be instantly there. What I'm trying to tell you—the future of 3D looks very bright. [Laughter] But we have to encourage people to do it right instead of fumbling on all the problems that they're now encountering to get there. In other words, everybody's trying to use existing technology to get to 3D as fast as they can, and in the process they're hurting 2D really badly. They're also not recognizing what needs to happen to make really good 3D.

"The cost-benefit is certainly down the road. In other words, right now the cost of revamping the optical path in a projector would seem to be expensive, but in the long run when you realize that it will make as good a 2-D image as you've ever seen and as good a 3-D image as you've ever seen—what it says is you convert everything over. It's getting a manufacturer to have the foresight to say, 'Look, in the future everything I'm going to sell is going to be 3-D compatible. Whether anybody uses it in 3D is another issue, but it's all going to be 3-D compatible and if I start now and redesign from scratch I can do a really good job of it, and I can get really high-quality 2D and equally high-quality 3D."

Joe then switched to a discussion of 3-D glasses. "Now we're going to get into glasses because I'm going to have you put them on and I'm going to put up some flat-fields and you're going to notice, as an example, some of the glasses that we've looked at, if you look at the top of the glasses you see one opacity, in other words, an ability to transmit light. If you look at the bottom of the glasses you'll see a different opacity. So there's a top-to-bottom difference. Now I've talked to the manufacturers that make those particular glasses and they told me they hadn't noticed it. [Laughter] And I said, well 'Gee, did you ever put up a flat-field?' 'Well, no. Why would we put up a flat-field?' And it's like 'It's so you can see what the glasses are doing!' [Laughter] Later on we're going to have a class on calibrating 3D. Among the things that you actually have to do is you actually have to shoot through the glasses because the glasses change the color as well as change the intensity. Incidentally, the color-shift is different when the glasses are on than when the glasses are off so that calibration has to be done with a 3-D source on the screen. The glasses actually have to be active in order to do the calibration. That was something else a lot of people didn't understand. So when we get into 3-D calibration, we've got to be conscious of the fact that we have to shoot through the glasses. If the glasses have one opacity at the bottom and a different opacity at the top, we're in a lot of trouble. Where do you shoot through the glasses and the fact that we have to shoot through a lot of the glasses?

"Another problem with the active glasses is that they aren't all cross-compatible. Well, that's really a problem. If you own a 3-D system and you also want to invite your neighbors who also own a 3-D system, wouldn't that be nice to say, 'Hey, by the way, bring your glasses because I don't have enough for everybody.' But then they bring their glasses for system A and you're using system B and believe me there's C, D, E, F, G, H, I, J, K, all the way down the line. It's not an A and B issue. Incidentally, in triggering active glasses, there's not an agreement on how to trigger the active glasses. So glasses from person A may not work on system B, but even if they did work on system B there would be still be enough differences in triggering, there would be enough differences in color-shift in the glasses so that you might not be able to bring glasses from the neighbor's house to your house to watch 3D.

"Another part of the technology that isn't there yet is color fidelity. Some manufacturers—as an example, anybody working in plasma


Blue Man Group

and having shutter glasses for plasma, you're going to find that those glasses in particular are minus blue. What the plasmas do to get light output is they boost the blue and then they deliberately attenuate it in the glasses to come back to something that looks like a neutral color of gray. So the shading, the color of the glasses, becomes different, depending on what they're trying to do, which of course means that one set of glasses isn't going to be compatible in another system. In calibrating through the glasses, one of the things that several manufacturers are doing in their projectors is creating fixed offsets between what 2D looks like and what 3D looks like. What they've done is they've taken a single set of glasses, they've held them up and measured the difference between the two and said, 'Ok, this is the offset.' And they built the offset into all the projectors. So when it goes into 3D, it automatically throws in that offset that's supposed to calibrate for the glasses. The problem is I've sampled lots of glasses from the same manufacturer and it doesn't match. Would anybody in this room would have guessed that the glasses might not match? [Laughter]

"This whole seminar is about the 'Wow' factor and once you get over the 'Wow' factor what you can really expect? If somebody doesn't tell you what to expect, if somebody doesn't tell you to look for something, it's going to take you a long time to get over the 'Wow' factor. And you're going to be like *Consumer Reports* and you're going to be looking at this LCD set that they rated a close second. 'Well, you know the ghosting isn't all that bad.' The ghosting was horrendous. [Laughter] I don't know what they think they're doing but it has to be total inexperience for them to rate the ghosting on their second set as anything but horrendous. Now everything else might be a lot worse, I could probably give them that factor. But still, when you compare it to a 2-D image and then you start seeing severe ghosting that's a problem. It's going to take LCD technology a bit of time to overcome the ghosting. I think they can overcome the ghosting, but it's going to take time before that actually happens."

Joe commended progressive versus interlaced 3D. "One of the advantages that progressive has over interlaced, and it's the issue of the nth higher image, is there in a single pass—where, with interlaced, half the image is there at one point in time and then the second half of the image at the next point in time. That actually creates a problem in 3D, when you're dealing with two completely separate images. It now becomes really complex. Progressive imaging has a far better chance of producing 3D than interlaced imaging. It's no longer 1080 versus 720, it's progressive versus interlaced.

"Broadcasters have got a really difficult row to hoe in that the only way that we're really going to get good 3D in broadcasting is to switch away from MPEG. This over-under, side-by-side issue has got to go away because we lose resolution. We either lose vertical or horizontal resolution or the ultimate pixel. Somebody asked about the ultimate pixel system. We lose resolution there as well. The only way

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the broadcaster is going to be able to make it within the limited bandwidth of the 6MHz channel is to go to AVC, and boy, that's going to upset everything because now all the decoders that are out there have to be changed out. But we've got to go to a much better compression scheme. Now, early on I mentioned the fact that I'm working with five entities that want to replace Blu-ray. We've firmly established that by going to 10-bit for a given bitrate, we can reduce the bitrate


Digital Projection Titan 3D

by 25 percent and keep the same picture quality. Well that 25 percent is enough to take care of the augmentation channel. A left-channel, or a best-eye channel, which would be the primary channel and then an augmentation channel, which would get us to 3D. And it would get us to sequential 3D, full 1080p, out of both images, no filtering required. But again, it requires going to AVC, in order to do it and the only chance of really implementing that is some other system. Because changing the broadcast system over to AVC, as much as the FCC rules have allowed for that, changing over to it is really a logistic nightmare because of ten years of product that's already in place that I'm confident that not more than one percent of it can actually handle AVC. As an aside, that was something that I actually tried to change early on. You may or may not know that I was a consultant to Microsoft between 1994 and 1998. I actually tried to change VC-1 to 10-bit. Right out of the gate, I wanted it 10-bit because I knew of the reduction in bitrate. What I didn't know is that it could have done 3D. Nobody believed me. Nobody understood. Now it's necessary. Now they have to do it.

"Warner Bros is still staying with VC-1 and a lot of the things that are coming out of Fox are still VC-1. So VC-1 is still being used. The problem with VC-1 is the development team has gone away. It stopped. It came up to a capability and it stopped. The problem with AVC is there are five versions of AVC for Blu-ray, and they are different and you can see the difference in them. But a major problem with AVC is even to this day they're not using display devices good enough to see what they were doing. Microsoft from day one was using a display device that was good enough. The reason VC-1 was so good out of the box is because they could see what they were doing. VC-1 had very little capability relative to AVC. AVC is an infinitely more powerful compression scheme than VC-1 could ever hope to be. But VC-1 beat the pants off AVC in the beginning because the people who were developing VC-1 could see what they were doing.

The remainder of the seminar consisted of an extensive question-and-answer period, which you had to experience to fully appreciate.

Jim Grover, of **Stewart Filmscreen** followed Joe Kane with a presentation on "**Projection Screen Technology Applicable To 3D**." Jim explored how choosing the most appropriate projection screen for a particular application is critical to the success of the entire A/V system's design. Basic projection screen technology and how to integrate screens into the overall system design was explored with an emphasis on the application of 3-D projection. The different types of front projection screen materials and their most appropriate use was covered, including screen material suited for 3-D projection. Other topics discussed included screen gain, size, and aspect ratio. Jim stressed that screen choices were often dictated by the room conditions and that in most cases an optimum performance screen was not workable due to the room environment and room use, other than optimal projection. This was a very informative and thought-provoking seminar, which covered the basics to achieve absolute image fidelity from any video display, regardless of location or circumstance. Jim stressed that "I would rather you have a great experience that may have its flaws and compromises than explain to you how to do something that's either unachievable in your environment or not going to be something that financially you're ever going to be able to put together. ...There's a reason why there are 100 different projectors and there's a lot of different screen companies. And even at Stewart we make 60 different screen materials, a dozen of which I can make an argument are appropriate for home use. We have all these variables because generally we don't have a lot of flexibility in our room for one reason or another. It could be budgetary limitations, it could be the wife acceptance factor. In my house it's the HAF, it's the husband acceptance factor because I've got to tell you, I'm not painting any rooms black anytime soon. That's not my lifestyle. So you look at the dogma that's been forced upon people about projection systems—for the longest time it was light cannon, matte white screen, pitch black room. If you weren't going to do those three things, then just buy a television, don't worry about projection. And what I'd tell you is you're missing out on some fabulous experiences if you're thinking that way because there are a lot of solutions now that don't make you follow that kind of home theatre dogma."

Jim stressed that "what we know at Stewart is that the perfect screen is application based to the room and to the projector. It doesn't work the other way around." He referred to recent rave reviews of Stewart's StudioTek 100 screen reference material, which was the screen used for the Technology Conference presentations. "So as people were asking for StudioTek 100, we're like, well, wait a minute, StudioTek 100 is reference material if everything else in the system is reference. If I am going to black the walls out, if I am going to use a light cannon, if I am going to wear dark clothing when I watch television, and I'm not going to watch any comedies because if I smile, the reflection is going to show up on the screen, then that's the 100 percent right material for you to use. Now, on the other hand, if in your theatre, because it's your home, those aren't the conditions present, then I don't think that StudioTek 100 is the ideal material for you."

Jim discussed the development of gray screens. "GrayHawk was designed to tame the projector. Our GrayHawk material is oftentimes referred to as a negative gain screen because it's less than one. But that's not accurate. It actually is a gain screen. GrayHawk is starting at .5, halfway between white at 1 and black at 0. So it starts at .5 and we add a touch of optical coating to it to increase the gain up to .6.

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All things being equal, GrayHawk improves the black levels in your room. But there are tradeoffs for that too. That's going to adjust your color on the screen, it's going to have some effect, a minimal effect on what your white balance looks like, but at the end of the day, it's an intelligent compromise. In this environment it can make a huge difference. If I look at our FireHawk material next to our StudioTek 130—FireHawk is a 1.25 gain, StudioTek 130 is 1.3. So if I was getting say 23 footLamberts off of a 1.0 matte StudioTek 100 white screen, I would be getting 30 percent more than that 23 footLamberts off a StudioTek 130, and I would be getting 25 percent more than that off of FireHawk. Technically, StudioTek 130 has more gain than the FireHawk. But if I compare the two pieces of material side by side in an ambient light situation, FireHawk looks like it's a brighter, more poppy picture. The reason being is that my black levels have been lowered. Our perceived contrast in this image is that this is a much richer black [FireHawk], more vibrant picture than this [StudioTek 130]. Something funny also happens when you start playing around with perceived contrast. When you change contrast, perceived contrast will affect perceived resolution as well. High contrast equals high resolution. Low contrast is low resolution. If I have to make a compromise, if I can do some things to improve contrast, I'm also improving perceived resolution."

Jim talked about viewing angle when viewing 3D. "THX® has recommended in the past a 40 to 44 degree viewing angle for immersive video, to find yourself lost in what's happening on-screen. The first things I've heard about 3D is the recommendation of a 50 degree field of view to feel like you're immersed in 3D. That's big. That's wide. So if I'm trying to go anywhere between 40 and 50 degrees with a flat panel in my home, it's unlikely you're going to be able to re-create that experience. So when Joe talked about us being a little bit let down by 3D arriving at home, I'd say that the biggest letdown has nothing to do with the technology that's bringing it in the house. The biggest letdown is the experience is crappy. It's just that it's not what we remember when we saw *Avatar* at the theatre. ...My opinion is that 3D is not effective unless it fills your peripheral vision. If you're watching a flat panel from 15 to 20 feet away, it's like watching the world through a keyhole. It's the difference between sitting on your front porch and watching the world or sitting in your living room and watching the world through a window. So if I really wanted to make *Avatar* come home or bring the 3-D experience home, then—here's what I love about it as a screen manufacturer—that for the first time ever the flat panel guys, in my opinion, put their foot in it because they can't do it. I don't care what they do, it will never be an experience, it will be watching television. If I want this to be an experience, then size is going to matter to me... and I'm going to get my 40 degrees to 50 degrees of viewing angle. So I will tell you this, as 3D goes, whether you think I'm right or I'm wrong, this will be the biggest difference in your house. It's how large you can make that image and how immersive you can make that picture because the goal of a Hollywood movie, whether it's 2D or 3D, is to re-create a dynamic and immersive viewing experience. But not just for movies, for music, sports, and especially gaming."


Cirque du Soleil

Doug Blackburn, a reviewer for ***Widescreen Review***, covered his experience in reviewing 3-D flat panel displays, including the technologies and image quality differences in LCD, plasma, and DLP displays. His presentation was titled "**An Assessment Of 3-D HDTV Video Quality**." Doug discussed potential artifacts with respect to crosstalk, motion, flicker, and brightness, and glasses and IR emitters with respect to comfort, distortions, fit over eyeglasses, and performance. Also covered was 2-D performance of 3-D flat panel displays and what to expect in terms of 3-D factory settings on displays. Doug also shared his experience with 3-D display calibration through 3-D glasses. Doug's 3-D work can be seen in the most recent issues of *Widescreen Review*.

Rick Dean, Senior Vice President, **THX, Ltd.** and Chairman of the **3D@Home Consortium** presented the topic "**Keeping The Entertainment Experience In Home Theatre**." Rick painted a picture of a diverse content environment accessed through a diverse product mix, which on a product-to-product basis can actually affect picture and sound quality. The goal of THX is to optimize the playback experience of a diverse content environment in which content is authored and created in different types of environments. "It would be great if we all settled on the A standard and A environment to take and master all content in, but that simply doesn't take place. At prior home theatre cruise events we had some of the best people in the business up here saying that they all worked together to create that Grammy paper, and that Grammy paper said that there really was no agreement on any standard. Things evolve, even with music. Our devices in the home have to constantly get more sophisticated to address the differences in the content. And that's why we have so many options today. So even in our home, this is what we face. It used to be, in the good old NTSC world, we had the antenna hooked up to the TV, you turned it on, you got what you got. Maybe not the best, but it wasn't that complex. Today it is complex.

"What about color gamut? What about a proper white point? What about playing a game versus showing your photographs? What about the Blu-ray experience versus the over-the-air broadcast? These can be optimized experiences, but they take some method of consumer knowing what button to push on the products today to make that happen. So, here comes THX to the rescue—we call the solution "Media Director™," and what it is, it works as well in the 2-D world as it does in the 3-D world because of all of these variables. If we simply add a simple amount of metadata, which is data about the data, the data that describes pictures and sound, the product devices can go into their own individual optimized experience to render that content out. ...So we're turning the content into smart content. ...so that the descriptors—we describe the content with the metadata, delivering it with the content, and it lives all the way to the home so these end devices have something to read back. ...if you want something that's going to be rendered out closer to what the director intended, and I say closer because Media Director does not improve the picture, it makes sure the devices are doing their best

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job at rendering that picture out. So, therefore, as much as I'd like to say every time you see Media Director, you're going to get a perfect experience, it all depends on the technology displaying it. Artistic intent—we tried to work hard to make sure that content reflects the creative environment. We also respect the individual choices that a consumer might make for their own taste."

Switching to 3D Rick commented, "There's still bandwidth constraint markets out there. And frame-compatible 3D is a way to get that content delivered into more markets. So it's going to be out there. We can say that we don't want to think about it, but the reality is it'll be there. So let's optimize it, let's make sure there's a good experience that can be had with that.

Rick Dean of THX

"3D is not a fad. This is going to be part of our viewing experience. Is it going to be the dominant part of our viewing experience? No, because I don't believe for a second there's any reason to watch the evening news in 3D..."

Rick talked about 2D to 3D conversions. "I want to point out, there's two types of conversions. There's the conversion that represented *Alice In Wonderland*, which was digital effects, which are normally layered on top of each other. That represented the finished picture. But because you're layering those digital effects, you can at least plan them, at least somewhat well. You can also separate those back out to create the depth. Now this is a little bit different than doing something that's on film. Many of you probably heard, Lucasfilm announced a few weeks ago that the *Star Wars* series is going to be coming out in 3D. This will be converted, but there's going to be two different types of conversions used on that. There's going to be the fact that *Episode 1*, *2*, and *3* were actually digitally layered productions that they're going to take and separate out the bits again—actually they don't have to separate out, Lucasfilm is forward thinking enough that we keep everything individually on files. So we already have that, we can just simply re-render the movie in 3D. That can be done pretty well. But *4*, *5*, and *6*—I'm just using this as examples— are film based. *Episode 4*, 1977/78, is a flat image on a piece of film. There's no imagery that can be separated out except for the scenes that George changed out. There might be a few extra changes in these movies as well, but …Those types of 3-D conversions are going to be challenging, especially on the film side. And on any film side, it's going to be really tough. But on the digital, new digital processes, and the way that we make movies today, it's a little bit easier. Easier, but if you have the budget and the time. One of the things that I heard George Lucas say when we were on the press tour is that, somebody asked him, 'Because you can plainly see today that people can make movies in their garage, they can finish them out and they can publish them and all that, how does that challenge you to make better movies or different movies?' And for him, he said, 'Well, it doesn't challenge me at all. People, for many, many years have had typewriters, but very few of them actually wrote novels.' So there's an element of how well you can do something, not the fact that you can do it but how well it's done. I think this is going to be one of those things where that will be demonstrated as we see conversions happen in the future."

Rick stressed the importance of developing 3-D content beyond movies "Only one working is not going to move 3D forward. So, movies, great, but not enough. We have to have sports, we have to have user-generated content, we have to have games, we have to have the pictures that you guys shoot with your cameras on little Sally's birthday, and all that has to work on the same display in the same way, just as convenient as you do now—pictures of your favorite cat—and that all has to work into an environment, which is already complex. So we're adding another layer of complexity and user interaction to make 3D work. My biggest fear is, due to some of the things that we've kind of witnessed here, too, if getting into that proper 3-D mode is a hardship, you're going to go back to a 2-D program and simply watch the game. Us engineering folks, we love to take and work on the complex things, but we kind of lose sight sometimes that what we're doing is we're delivering an entertainment experience. At the end of the day, you just simply want to be entertained by this environment. So, therefore, THX believes, we need directors to know that an important component is to make everything work seamlessly together."

Rick commented on 3-D eyewear. "As of this year [2010], we've got over 14,000 3-D theatrical screens. Standards are coming about, but they're coming about slowly. They're not coming about as fast as I would want them to. The fact that glasses are still a discussion today, I think is a crime. So hats off to Monster and XpanD for actually coming up with universal glasses, which in addition to LG, Samsung, Panasonic, and the others, they're adding the fifth and sixth standard. So we still have to find a way to work together so that we can find true universal glasses. So let's not make any mistake that when you go into a 3-D mode on a flat panel display today, the picture brightens up and there's a color shift to accommodate for the glasses. Universal glasses will have to match those differences somehow, so it's not just a matter of turning off and on left eye or right eye, it's also matching the color, or else you're causing another shift in that artistic intent that's supposed to come through in the content."

In terms of home delivery, Rick commented, "We've got about 100 3DTV models available in various technologies and forms and such. Fifteen models of Blu-ray Disc players, and about 29 movies on Blu-ray, which will certainly help. Hats off to ESPN. They want to see 3D work. They've been one of many networks to get established. You've heard about Sony and IMAX getting together for a 3-D network. This is all great stuff. Two-hundred-plus live sporting events planned in the next 12 months. 60-million households in the U.S. could receive a 3-D program today. That's because of the HD infrastructure, it has nothing to do with 3D specifically. About a million have 3D-enabled equipment. I'm talking about the new products that are being sold in the market today. Worldwide numbers—we're still trying to gather that information because more and more great 2-D products are being 3D-enabled right now. And that's one of the issues of adoption rate, there's a lot of predictions out there. I break it down into a couple of classes. One is the person who wakes up on a Saturday morning and says, 'I'm going to go out and buy a 3DTV.' That's probably a very low number. The other guy who gets up and says, 'I'm going to replace my flat panel display or my projector and go out and look for a great product.' That person may very well come home with a 3D-enabled product, not necessarily going out intending to buy a 3-D display or technology. The third guy is the one that just stays home and says, 'I'm going to wait a year.' Therefore, the stats are really variable."

Rick showed projections based on what happens if content becomes more proliferate. "It's going to take a move up in the adoption curve, I think. Again, there's anybody's guess out there about the real numbers and the real projections and the real…who's going to be right about this? One of our members, Inside Media, also downgraded their projections about how many 3-D products will be sold. But as much as I see that, I see more and more of the product lines from various manufacturers enabling 3D in the top of their product list. Again, 3D may be enabled faster than we think, just by virtue of the fact that there's more 3-D product to choose from and you may want a great 2-D product that happens to have 3D in it.

"Why, you may ask, 'Why is THX up here telling me about 3D?' It's another expressive form in media. It can be done well, it can be done poorly, and we've seen plenty of examples of both. All the good reasons out there—well-done 3D is a great experience; poorly done 3D, not so good. All markets have to be enabled. Standards have to not leave out any market that we have for consumer enjoyment. The infrastructure barriers that we have right now are restrictive. Why do we have side-by-side or top and bottom? Because we can't evolve those markets until we swap out every set-top box that exists in your homes today. That's not going to happen overnight. The pipeline that serves those set-top boxes has to be improved, then the set-top box has to be upgraded. In the meantime, we need to work on how that experience that we can receive today and play on those products that you buy today, we have to see how good we can make it. No one's going to say that that's the best thing out there, but it's good enough—[for now]."

Rick commended Blu-ray. The Blu-ray spec had been released and it's out there. But how many of you know that that disc actually plays either 2D or 3D? Do you know that the actual video file on that disc is a left-eye only? Then there's a metadata file that represents the right eye. One of the key components of that Blu-ray Disc player is that it re-manufactures the right-eye image and then outputs it as left/right sequential. The difference between a run-of-the-mill Blu-ray Disc player and a well-done Blu-ray Disc player—keep in mind, you need to have a matched set of images, left-eye, right-eye for a picture to really be good and to give you that 3-D experience, which is not taxing to the brain. This is very, very important, so choose your devices wisely out there."


George Walter of Digital Projection

Rick discussed consumer comfort and safety. "One of the things that we have focused on a lot at THX is what makes people ill. The various forms of eye deficiencies and brain interaction and environmental things that actually help make a 3-D experience either good or bad. Consortiums from around the world—one of the things I was just at in Shanghai, we had the International 3D Fair. From the 3D@Home Consortium, the China 3D Consortium, the Korea 3D FIC, and the Japan 3D Consortium; we're all working very intently together right now to gather all of the studies. Jim Cameron even gave us a big dose of stuff when he made *Avatar*, on what to do and what not to do. We have universities from around the world getting us data, hooking people up to an abundance of machines to test the sweat on the palms, the pulsing of the eyes, the brain activity when viewing various forms of 3D, what makes people consistently uncomfortable, and what brings them enjoyment. Unfortunately, there's a ton of data that has to be turned into useful information, and that's what our consortium, our Steering Team 1 is actually working on right now."

Rick explained what the 3D@Home Consortium is. "We are a group of technology, studio, manufacturers—people all involved with trying to make sure 3D can happen. We are not a standards group. We help the standards community create the standards by providing good information. I told you about the competitiveness around the manufacturers, we have that as well, but we're not due process, which means anybody can stand up and say, "I don't like this," and the whole thing stops. We can break through a little bit and with that actually create the information in a little bit more collaborative way. Our governing boards have people from some of the best companies out there. John Shapiro of the 3ality Digital is leading our Steering Team 1. This is where we're focusing on content quality and how to take and make 3-D movies better, not ignoring the artisticness that also we have to respect. For the 3D Ecosystem, in total, many things have to be addressed. It's more than just a display, it's more than just a set-top box, it's more than just a camera shooting the content, it's how all these things work together to provide the entertainment experience. There's an incredible amount of work being done to fix all the things that we're complaining about right now that doesn't work with 3D well. Unfortunately, the technologies come out a little bit before maybe all this work is done, but believe me, there's an unprecedented amount of work being focused on to make it right."

For more information on the various 3D@Home Consortium Steering Committees visit www.3dathome.org.

Rick concluded with the comment that "Eyewear needs to be standardized. You have everybody building to the same spec. That price is going to come down dramatically. And ghosting issues and all that—I was just presented in Shanghai last week a company that is making a different substrate material, which is turning off the left eye/right eye. Evidently, there's quite a delay factor when you trigger to the actual response, and they make a substrate material, which is twice as fast, with claim that it takes care of a lot of the ghosting. The proof is in the pudding and let's see how that works. But, again, there are a lot of improvements coming around the corner. In terms of human factors, we have to understand more about how we can make more people comfortable watching 3D. The required HDMI cable type is important. The installation of batteries for glasses, these are all just things that need to be worked out over time. If you look at them, not overly challenging. But we can get there, it's just going to be a matter of why we need to do it and compelling the consumer to get excited about this, which is going to come from content and it's going to come from the price-points of the products, and it's going to be ease of use, and all that. 3D is one of those experiences that I believe is a very compelling thing once you've resolved all of these things."

Digital Projection's **George Walter** presented a seminar on "**3-D Projection Systems—What Are The Options**?" George discussed RealD's Z-screen technology. Z-screen employs two projectors—one projector is basically replicating what you see out of the right eye, the other what you see out of the left eye. You send completely different signals to both projectors, and the two images are literally converged on the screen. "Obviously the good news is you double the brightness and solve the problem of 3D eating light output. So that's the benefit. The downside is we're back to convergence. Some of you have been around for awhile and had CRT projectors and know a little bit about convergence and everything that comes with that but we've been spoiled for probably the last 10 to 15 years in the fact that we have display devices that don't require convergence. So to a large part, if you go with a two-projector solution, you're moving

backwards in time." The Z-screen approach uses circular polarization—clockwise and counterclockwise for the two different perspectives, so as you turn your head, you literally don't lose the 3D. The technology is said to deliver full 1080p resolution, while maintaining compatibility with 2-D imagery, along with a brighter picture than passive glasses systems. The same eyewear used in RealD-equipped commercial theatres can be used. The technology avoids the problems associated with synching active glasses to the display emitter, which reduces the viewing angle. "You're obviously doubling the cost because you're literally doubling the amount of display equipment. We talked about the two polarized filters. Each projector's working at 60Hz. That becomes significant because when you talk about a single-projector solution, we talk about it operating at a minimum of 120Hz, so literally twice as fast.

"There's a two-projector solution, where you use color filters on projector A and a different set of color filters on projector B and then wear glasses that kind of correct for that so that each eye gets its own dedicated information. Or in the cinema side—and Barco right now is the only projector company that's actually doing this—they had a spinning wheel inside the projector. So you're using a single projector that's operating at 120 Hz the same way our Titan projector is. But the wheel spins so that left eye-right eye information, again with colored filters, is displayed on the screen sequentially. The pros, of course, is that you can do passive 3D with a white screen. No need for silver screens. And because you're using different portions of the color spectrum, again with a single projector, you're not getting a color shift and the glasses themselves tend to be a little bit more efficient, passing a little bit more light. The cons—for really good notch filters that would go in the glasses are not inexpensive. They make an inexpensive version, which gets you down to $50 or less but they tend not to be as good. So if you really want to see high performance, much like anything else, the better quality optics and the better

Cozumel, Mexico

filters provide better performance. The feedback from some customers, because these again are color filters, the back elements tend to be very shiny so you have to be in a very dark room. If you get light from behind you, they tend to reflect on the inside of the glasses. And general feedback—and this will be shared by anybody who uses the Infitec technology—is that viewers can start to see a reflection of their own face and their own eyes, and it's very distracting.

"Calibration can be very challenging, particularly with a two-projector solution. Because in a two-projector solution you're going to have completely different color points. If you look at the triangle you're going to have different red, green, and blue points for each projector. Exactly. So for home solutions it can be very challenging. But for professional solutions, particularly in the cinema, the way they've worked it out, it's actually a pretty decent solution and a chunk of high end cinemas, not so much in North America, but in Europe, are using the Infitec solution with the Barco projector.

"A single projector with a RealD modulator, used typically in the U.S. operates at 120 Hz, or 144 Hz. Typically when you see them in the theatre they're operating at 144 Hz. The reason for that? We're back to 24p, which is the actual framerate that the content resides in, and 144 Hz is what we refer to as triple-flash. So you're seeing the left eye triple-flash, so 24 times 3 equals 72, plus the right eye triple-flash, 24 times 3 equals 72, so combine 72 left eye and 72 right eye, the projector operates at 144 Hz. A modulator that sits in front of the projector—and it's actually operating synchronized with that so it's switching polarization realtime—so that you're seeing left and right eye information sequentially. And it allows you to use passive glasses, but it does require a silver screen. The general feedback from most users is that they find passive glasses the most comfortable, because they're lighter and they physically don't switch. There's no power to them. You don't have to worry about 'are the glasses on?' There's no emitters. There's no challenges like that. In a professional, non-consumer world, medical imaging technicians will only use passive glasses. Primarily because when they're doing research-oriented work, they find that they are actually over a period of time sensitive to the switching of the glasses, where with passive they don't see that.

"The advantage of a single projector that can operate at 144 Hz, basically, is that you can do any of those technologies. We could do passive, we could do active, or we could do passive/active. That's all a function of how you build a system around it. There are a few different companies that are starting to come out of the woodwork. RealD is part of one of the companies that they're rolled up in, kinda had a stranglehold on this active modulator. But now there's another company called DepthCube. And there's at least two different companies, one in Japan and one in Australia, that have recently released product or product technologies to do this LCD modulation.

"Digital cinema projectors can easily be retrofitted by adding the RealD Z-Screen in front. A theatre cannot purchase a Z-Screen from RealD. They have to lease it. It's all part of a program, and they get part of the revenue. Which is part of the reason why if you go to see a 3-D movie, you typically pay a premium. Somebody's paying a premium for that because the money goes back to RealD.

George went on to provide background on Digital Projection. "Not to get too far off tangent, but for many years Digital Projection was one of the pioneers and the leaders in DLP cinema. We were one of the first license holders, but part of the reason that we got out of that and left it to the other three companies is that, literally, the model from a technology point of view worked but from a financial point of view it didn't work because there was nobody that was going to pay for that. And only within the past few years, based on a variety of things finally coming together—in fact one of those things that came together was the projectors were being sold at high volumes but incredibly low margins just to get this initiative started. Which incidentally and probably shouldn't surprise anybody, but the company that's selling more of those projectors than anybody else in the United States is owned by a lamp manufacturer.

"So active is kind of what we see now as the definitive technology, or a derivative of that, in the flat screens. This would be a single

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projector or single display that is operating at twice the frame rate. So in other words, instead of 1920 x 1080 @ 60 Hz, it's 1920 x 1080 @ 120 Hz. So in the same interval of time we're displaying left and right on the input and we're doing it sequentially. Again, 144 Hz. Today, if you've got a Blu-ray Disc player, most of them, when operating in 3-D mode at full resolution, it outputs 24p. Effectively, in that timeframe you're getting left-eye information and right-eye in a shorter time interval—effectively 48 Hz. So left-eye and right-eye combined at 24p. We triple-flash that so the projector's actually operating at 144 Hz. Why? Because if we only double-flash, 48 and 48, you get 96, you literally start to see flicker. Again, you get down to the dynamics of the human eye. Fifty percent of people at 96 Hz wouldn't see flicker. Fifty percent would see flicker. When you up it to 120 Hz, basically nobody sees it. At 144 Hz, for sure, nobody sees it. But if we stayed at 120 Hz, you'd have to basically get back to some derivative of 3-2 pulldown. If you go 144 Hz, it's natural—triple-flash. And the beauty of active is that we use exactly the same screen for 2D as 3D. So there's no need to change the screen.

"Again, getting back to the very beginning, where are we today? Regardless, your display should be the best possible 2-D display that it can be…that now does 3D. Because 90 percent of your viewing or more, is still going to be in 2D. And you don't want any compromises there. You want 3D to be an added feature. Something that when the right content comes along, whether it be movie content, sports content, gaming content, it adds to the experience. Not something that's going to compromise your 2D and distract from the experience.

"So to quickly look at the formats, which have been discussed, there are four basic formats defined in HDMI 1.4a. Top-bottom, which is now 1920 x 540 @ 60Hz or 120Hz, and basically you take the same 1920 x 1080 and you display left and right eye just squeezed. The Comcast content is top-bottom. Side-by-side, the Panasonic Blu-ray player has a side-by-side option. DirecTV is outputting ESPN in side-by-side. You're basically taking the horizontal resolution and cutting it in half and squeezing two images there. Before we change from this, we've been having quite a bit of conversation with RealD, and we'll be having some announcements within the next 30 days of some cooperative efforts between Digital Projection and RealD on 3-D technology. One of the ideas that they have for the future is to get more resolution and more content to the projector and still be able to fit it basically within the existing broadcast bandwidth limitations. If you look at these two images, obviously, the majority of the content is exactly the same in both images. If we pass this to the projector the way that it is, the first thing that it would do would split these apart. It would take the left-eye information, reformat it or resize it to fill the full 1920 x 1080, take the right-eye information and do the same thing. And then when it's displayed on the screen, they're literally interwoven so they're displayed sequentially. But you're starting out with half-resolution. So what RealD actually has a patent on now, and they're finalizing the development work on it, would basically be side-by-side information, that's the way that you have to transfer it, to run it through a specialized high-pass filter to first look and say what is the difference between left and right eye? Because that's all we really care about. All the content, which is exactly the same, we can basically stream in a different direction so that we're not compressing, losing as much information. The problem with that, of course, is that you actually have to have the same multiplexer and demultiplexer to get full resolution. But that's one of the things that you can expect to see in the future: better resolution without expanding the amount of bandwidth required."

When I brought up the SENSIO approach, which appears similar, George commented, "I'm familiar with SENSIO but exactly how they're doing that…I know they don't have a patent on it because RealD was just granted the patent for that about a month ago.

"With interlaced we're going back to the old days again, where basically you reduce the information and display half in the odd lines and the other half in the even lines. The really sad thing is that in DirecTV right now you're getting interlaced AND side-by-side, which now you're down to roughly quarter resolution. And unfortunately—I say it's unfortunate—we discussed earlier in the week how this is a step back but in an effort to get 3D content to viewers, which was really what the drive was, they sacrificed all this resolution, they got the information to viewers, they put the glasses on, they said 'Wow, it's 3D!' And they were so enthralled by the fact that it was 3D that nobody looked close enough to realize that they were basically back—at best—to NTSC resolution. But it has 3D. This is what's known as the checkerboard pattern—odd pixels and even pixels. Viewed through separate lenses in the glasses, you see left and right eye sequentially. That, of course, is the reason why early Samsung and Mitsubishi DLP rear-projection consumer sets sold five years ago can now do 3D, with the addition of a simple external box. It's not a


Fat Cats

technology that you'll see going into the future, but it took advantage of something that was already in existence, and there were literally tens of thousands of sets sold that are instantly 3D-compatible.

The active formats are referred to as flip-frame, or sequential, and that's when the actual display is putting full resolution in the same time interval twice as many frames displayed one after another after another. Ultimately, what you view on the screen is that sequential, not side-by-side, top-bottom, or whatever. We all have to go through some type of a format conversion and operate at a minimum of 120 Hz to 144 Hz.

"The last thing I will mention here is dual-pipe, which was initially used in some gaming displays where you literally vent two channels of information from the graphic's card to the display. A discrete left-eye and a discrete right-eye at full resolution at 60 Hz. Incidentally, the Titan Reference projector has that capability. If you want the highest level of performance, you can feed it separate, dual-pipe, separate streams for left-eye and right-eye at full 1920 x 1080 @ 60 Hz."

George summarized the advantages of an active system. "The advantages of active have been discussed quite a bit. Single projector, no special screen, very easy transition from 2D to 3D. The display does most of the work. The content, the sources, whether they be

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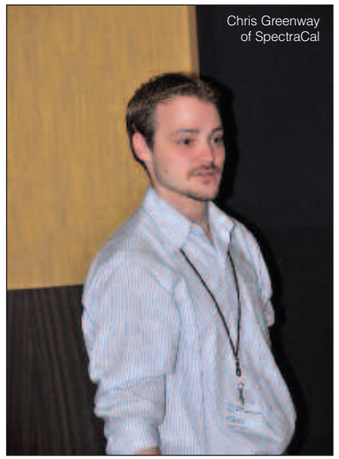
Blu-ray or whatnot actually require very, very minimal changes. There's more, such as the way the content's burned on the Blu-ray Disc because they're relying on the display to do most of the work. The advantages of passive, overall as a system, less light loss. I didn't specifically mention this, but in general, in a 3-D system, expect the amount of light actually to be seen through the glasses to be about 30 percent of the amount of light that you would see in a 2-D system. As a reference to that, we probably have all heard, I think it's probably safe to say everybody's heard that 14 to 16 footLamberts is the cinema spec for 2-D viewing. Does anybody know what the cinema spec, through the glasses, is for 3D viewing? It is 4 to 6 footLamerts. So, substantially less. So the passive, compared to active for a handful of reasons, there is a little bit less light loss. Certainly with the Infitec solution—less-expensive glasses."

An audience member raised the question, "Is there a perceptual issue, when you're talking about light through the glasses? Let's say the glasses happen to be clear by some miracle and you're looking at left-eye, right eye images, your left-eye and your right-eye would still be seeing 14 to 16 or 12 to 16 footLamberts for each eye? You just wouldn't perceive it as often. Would you perceive that as being a dimmer image?"

George responded, "You would perceive it as dimmer information because your left-eye is capturing information, then it's turning dark, then your right-eye is capturing information, then it's turning dark."

George touched on the HDMI 1.4 connectivity standard. "The current consumer format is HDMI 1.4— side-by-side, top-bottom, frame-packed and sequential. Incidentally, frame-packed and sequential could be perceived as very, very similar. The advantage of going frame-packed as opposed to sequential is the frame-packed image—first of all, as I said the sequential is 1920 x 1080 @ 48Hz left-eye and 48Hz right-eye. So in 24 Hz, you'd get both of them—frame packed is a single frame at 24 Hz, but it's 1920 x 2250. So it's got basically left and right jammed into the same frame. The advantage of that is you always know that the left-eye is on top and the right-eye is below it, so there's virtually no chance of left- and right-eye becoming interchanged. What does the system look like? It starts with the source. We're seeing more and more 3-D sources starting to come out now. Whether they be media servers, which many people would argue is the killer source of the future because you can run all your content through there, you can stream video from the Web, you can drop a Blu-ray Disc into it, you can do whatever you want. There is Blu-ray Disc, which is the most affordable; cable-boxes, which are the lowest resolution; and video games, where PlayStation®3 has gone 3D, Xbox has gone 3D, and virtually anything that you want to play off of a computer can be converted to 3D with a variety of different graphics cards and formats. Distribution is probably the biggest challenge that all of us face. Incidentally, we've had this discussion quite effectively, where you've got multiple devices in your stream, from the source to the display. Well, we go to HDMI 1.4—as you start to add components, any piece in that chain that doesn't transfer all the data, and by data I mean, not just the video resolution but metadata, and HDMI handshake anywhere in the system, effectively the system won't work. That will be one of the challenges as we creep forward in 3D. Dual-link DVI, I only mention that because in the media server side high-end NVIDIA graphics cards use that as the transmission device, and it literally has the capability of displaying separate left- and right-eye information at full 1920 x 1080 @ 60Hz. But they're very expensive cables and very expensive distribution pieces. Converter boxes, when I say converter boxes, I will also include in that video processors. I know of at least two companies that are working on 3-D video processors. It's not a simple thing. It's a very complex thing because what they will have to do, if you've got side-by-side or top-bottom, is they'll strip those two images left and right. Then they will run parallel video processing to correct for color, to do resizing, to do all the things that we rely on video processors to do and then in the end, they're going to have to weave that back together or send them out in some kind of a dual-pipe, depending upon what the display's capabilities are. So it's a substantial increase and amount of work. There are a lot of patents in existence, and in some cases, these patents are eight to nine years old. The companies that have been doing this work have been slowed down. Passive or active? A lot of different possibilities for converter boxes there if you want to do two-projector work. Today I don't know of anybody that makes a box—there are a lot of boxes that can take a variety of 3-D formats and convert them into separate left- and right-eyes. You can feed them to two projectors. But I don't know any of them that are HDMI 1.4-compliant. In other words, they'll do HDCP. One of the really popular high-end companies, who makes media servers for digital cinema, make a killer formatter box. When I saw it, I went out and bought one right away. We tried to test a Blu-ray Disc player with it and it didn't work. So I contacted them and I said 'you've got HDMI inputs. Why is it not working?' They said, 'Oh, it's HDCP.' I said, 'It doesn't do HDCP?' They said, 'No.' Ok, so that pretty much renders it useless, I thought 'So when do you expect to have HDCP in there?' They said, 'Never.' I know that there are some people that have that on their wish list, but right now it's really one of the weak links in our overall system. I talked about the emitter capabilities with DLP-Link. The key element is you have to have a display that operates at a minimum of 120 Hz. And by that, it's not like some of the existing flat panels, where they're literally just refreshing the LCD panels at a higher rate, but literally capable of accepting content that's streaming at 120 Hz, which there really is a difference. And then, of course, the glasses. So the Titan Reference 3D Projector is in many ways very, very future proof, and it does have the capabilities of being easily upgraded as the existing standards start to unravel. We have adjustable dark-time, we have a lot of adjustments inside the projector, so that as different glasses or different content may evolve, the settings could be tweaked so that the projector can still display excellent 3-D images.


Chris Greenway of SpectraCal

"The key thing about dark-time—and I don't have a slide to demonstrate that but it's worth a two-minute conversation—if you were to envision the video to have a left-eye content and a right-eye content and it's flashed, basically, this is blocked when I'm seeing the right-eye and this is blocked when I'm seeing the left-eye, ghosting, which is one of the things that people initially looked for—they say 'Hey, is there any ghosting in the 3D image?'—that's when a little bit of the right-eye information is being displayed, when I'm in a left-eye mode. So I see a little bit of the shading, that's the ghosting. So what we do is we interject a dark-time. We literally put a dark interval in between, which kind of erases that content and then displays the other eye's information. If the dark-time gets too big, first of all, you're losing light. Second thing, you could start to clip on the colors, which may be what we're experiencing here with the new XpanD glasses. If the dark-time gets too narrow, then of course, you're going to start to see ghosting because you'll see some overlapping, so this interval here is adjustable, based upon content and what it's all about, but when it's right, you'll minimize ghosting. One of the parts of the initiatives for defining the 3-D standards would be fixed dark-time so that the content and the displays are all exactly the same and matched with the glasses."

George made some points as to where we were with the state of 3D. "In my opinion, we're at such the early stages of 3D that it's going to get substantially better in a variety of different ways. The resolution will get substantially better. Obviously, we know what we expect and right now we're coming very, very short on that. The noise and the ghosting can all be improved. Special algorithms in the 3-D multiplexing and demultiplexing are needed. And the glasses, which has been the largest challenge, need improvement and cost reduction. Literally, two years ago, the XpanD glasses were $400. And they were sold in extremely low volumes. And everybody knew that for this to become really a consumer device that the prices were going to have to be at least less than $150 and more targeted at roughly $50. So the first drive was to just get cost down. Once the cost was down and we got a critical mass, the next thing that can happen is you can literally start spending some money on technology that make the glasses good, to make the switching times faster, to make the transparency better, lighter, better battery, all of those things. And what I predict is in the next 12 months the biggest advance that you're going to see in 3-D technology is better glasses. And that's for all solutions, active and passive. Don't expect 3D without glasses. That's a long way away. There's some really, really large challenges for us to see that. You will see some 3D displays without glasses for flat panels. Particularly for digital signage. Basically they're using a lenticular filter, which sits in front of the flat panel. The pros and cons of that are when you see a demonstration, they will typically say 'you need to stand RIGHT HERE.' And when you stand there, the way this filter is designed is, I view that display from here, my right/left eye are capturing slightly different content. But as I drift to the right, the 3D goes away. As that's become more evolved and the lenticular filters have become finer, I do hit secondary and third-tier spots where 'here' my 3D is in again, and 'here' it's in again, but in between it drops. For digital signage, that's awesome. Because when I'm walking in the mall and I hit 'right here' and I see the 3-D thing and it tells me to buy jeans I'm like, 'Wow, that's really cool.' And I remember to buy jeans. But it's not something that you'd actually watch in the field."


Roatan, Honduras

George briefly commented on calibration. "Certainly calibration for 3D is a big challenge over calibration for 2D. And most importantly, your display would have to have the capability of storing two completely separate calibration formats, one for 2D and one for 3D."

Chris Greenway, Director of Calibration at **SpectraCal** presented the topic "**How In The World Do You Calibrate 3-D Video?**" Chris pointed out that while manufacturers are scurrying to adopt one or another of the incompatible and widely varying 3-D technologies, the key to getting a good 3-D picture was calibration. Chris said that current 3D calibration solutions are still lacking. Chris addressed how you set up a 3-D display so that its output represents the director's intent. During the seminar he explored how to measure the display's gamma, gray scale, and color; how to test its 3D-ness; how to measure ghosting; and how to determine how much color shift 3-D glasses introduce. Much of the talk focused on what tools are required for accurate 3-D display metrology. With a focus on 3-D patterns and their importance in accurately showing 3-D output and meter selection, Chris talked about some of the pitfalls and ways to avoid them. Secondary to this was discussion on simply measuring the characteristics of a 3-D display that the home user has little control over, including measuring 3Dness and checking for ghosting present. This is a difficult subject to cover and Chris did not claim to have definitive answers to any of these questions, but he has spent as much time as anyone else studying exactly what we can expect from the current generation of 3-D displays and what tools we will need to get the most out of new 3-D displays. In conclusion, Chris shared with us what is known today and where things are headed tomorrow.

Craig Eggers, Director Consumer Channel Marketing at **Dolby Laboratories** talked about "**Dolby's Role In Next-Generation Entertainment Media Acquisition And Delivery**." Craig focused on a discussion of Dolby TrueHD 7.1 and 9.1 Dolby ProLogic IIz enhancements, how entertainment media acquisition is changing, and the role that Dolby Digital Plus will play in next-generation entertainment delivery.

Craig traced the history of Dolby back to the earliest days when Ray Dolby developed a solution to analog tape noise reduction and the continuous improvements over the years reflected in the Dolby SR process. Throughout Craig's presentation was the sense of pride and shared passion amongst the Dolby people in delivering highest-quality experiences regardless of platform. He related a story about how Ray Dolby came to work one day and saw people taking the "Laboratories" sign down and said, "No, we are still an engineering and technology company." All the "Laboratories" signs went back up the next day.

Craig provided an overview of Dolby Laboratories: "We work very much with the industry, have brought a lot of innovation to the industry. I think our competitors will agree, even they look to us to bring a lot of innovation in this industry. We are 45 years old as a company and have done a lot to really influence and impact the entertainment experience. Right now we've got about 1,200 employees. We're in 13 different countries. We have research facilities in Sweden, Germany, the U.S., Australia, Japan, and Hong Kong, and I think one of the things that really makes us different from a lot of companies out there in the marketplace is something we call Ecosystem. We're great at listening to audio, but we're also great at listening to partners. We work with content creators, to providers, and ultimately the hardware manufacturers."

Craig then discussed the development of the Dolby Digital Plus codec. "When we designed Dolby Digital Plus we designed it with that aspect of, hey, more bits, more channels, higher quality. But we also built in new coding efficiencies that allowed Dolby Digital Plus to be an excellent solution for next-generation broadcast and streamed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video and audio allocations. Vudu has been delivering high-definition movies, with over 4,000 movies encoded in Dolby Digital Plus. A month ago Netflix announced that they would adopt Dolby Digital Plus to deliver high-quality surround sound in a streamed media environment. The first player to support that is the PS3. There will be more player introductions at the CES. But up until last month, the only audio you would get from new streamed media from Netflix was two-channel WMA or AVC. Now we're helping Netflix. Dolby Digital Plus can also support 7.1 content. Dolby Digital Plus is very, very important for where we are going as an industry, and the fact that it's scalable, the fact that we can get a better-than-DVD-quality audio experience. It's scalable as bandwidth increases, the picture quality is going to get even better, and the audio quality is going to be even better. We're going to have more channel capability."

Craig then shifted to a discussion of Dolby ProLogic IIz. "Pro Logic IIz started out with an internal conversation. When Blu-ray came out, we had two additional channels to play with. What were we going to do with those two additional channels? Well, some of our research showed us that 7.1 was becoming defacto in a lot of receivers out there in the marketplace. In fact, for $349 and up today you can buy a 7.1 A/V receiver. We were doing some sonic testing inside our labs, and here's what we discovered. If you take loudspeakers and put them behind you, and elevate them behind you, I can take that loudspeaker and move it 10 degrees, 15 degrees, and you can't even tell that we moved it because genetically we're programmed to hear sound in front of us. I could take that same loudspeaker that's above you and move it 2 degrees in either direction, and you will notice the fact that we had moved that soundpoint. So we became very, very excited with this idea of, hey, let's take Channel 7 and 8 and let's go to the content community and show them the things that we're hearing with some of the things that we encountered.

"We worked with Mark Waldrep [at AIX Media Group] and some other producers to actually create discrete 7.1 sources utilizing the two front channels as discrete sources. Well, we met with Hollywood studios, and Brant Biles [Mi Casa Multimedia] was one of the people we actually met with, and we said we've got this idea that maybe we should use Channel 7 and 8 to bring front height, to add a new dimension, to bring discrete front height to the home theatre. Brant didn't like the idea because when he's working with his stems it's not easy to pull out specific height elements and place them up here. It requires a heck of a lot of work, it requires going back beyond the stems to grab those specific height elements because the last thing you want is a dog walking across the ground and its Foley sound coming from up here. But with Dolby ProLogic IIx and the Lexicon solution that gave us 7.1, we kind of almost created a defacto standard in the industry.

"So Hollywood basically said, you guys created a defacto standard, we're going to go with 7.1 on the ground, and that's what they've done. But we are still excited and we're still excited about this idea of height speakers and front height loudspeakers. Now Dolby ProLogic IIz is integrated with the marketplace, it gives you two options. It can't do 7.1 in the back, but now you have the possibility to do 7.1 utilizing two front-height loudspeakers.

"What we do with Dolby ProLogic IIz is we identify what we call non-directional de-correlated elements that are part of the surround mix. These are elements that occur naturally within the surround signal. These could be wind whispering through the hills. It could be musical swells without phased de-correlated elements in it. It could be rain. If you've got Dolby ProLogic IIz in your home, get the first one minute of *Ratatouille* and put it up, where the rain is coming down. It's phenomenal. The result is to add more dimension and more depth to the listening experience. We're taking that information, from extracting from the rear channels, processing it, identifying it, and that's what goes up into your two front-height channels. Nothing is added and nothing is removed from the original signature. We honor the original mix.

"The experience is content-dependent. If you've got Woody Allen talking to you in an anechoic chamber, nothing is going to come out of those loudspeakers up there. But if you've got something like *The Hobbit* with wind whistling through the leaves, or you have something like *I Am Legend*, the first five minutes where you're in this giant canyon that's called New York City and you have all these ambient sounds, just like some of the ambient sounds that Brant added to the mix that we heard the other day, it's those kinds of elements that are going to be identified by ProLogic IIz, and those kinds of elements are going to go up here and are going to enhance our experience.

"There is an encode/decode capability with Dolby ProLogic IIz. Brant could actually encode height information if he wanted to. This is probably going to come first from the gaming community. In fact, I can tell you, there are video games coming to the market that will be encoded with Dolby ProLogic IIz, front-height sound effects, so you literally will have helicopters that go up in front of you, near discrete elements in the effects.

"In our research we were discovering that a lot of people have 7.1 receivers who are listening in 5.1, or have a second room application. They're doing that because of spouse acceptance factors or because of room factors, they couldn't put loudspeakers behind them. So ProLogic IIz is an alternative for the consumer who can't put loudspeakers behind them. Christophe Chabanne, who actually designed Pro Logic IIz, actually prefers listening to 7.1 front rather than 7.1 back.

Craig talked about loudspeaker placement and advised that the height loudspeakers be positioned at least a meter above the left and right mains, at 90 degrees relative to the sweet spot. Thus, if your main loudspeakers are positioned at a 60-degree included angle, then the height loudspeakers would be out another 15 degrees from each main. "So 7.1 and 9.1 configurations are content dependent. And just as you set up your surround sound system and choose the gains that you want for your rear surround loudspeakers, most A/V processors have that capability for the height loudspeakers. Some people, if they have height loudspeakers, they want a lot of sound

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Q & A Session

coming out, other people just want it to be very, very subtle. But I will tell you, it is a very immersive and dimensional effect that you get from ProLogic IIz, and it's honest to the original creation."

When asked by an audience member why Dolby choose the same plane as the left and right mains, rather than go overhead over the sweet spot and more into the room, Craig responded, "First of all, because we're taking and de-correlating information that's part of that surround mix. Second of all, right now that's impractical for a lot of people. Third of all, from a hearing perspective, we hear from in front of us, not necessarily above us. We hear more from in front of us than above us."

Craig discussed Dolby Volume. "There's some misconceptions about what Dolby Volume does and doesn't do. With TV broadcasts we've all had the situation where you go to a commercial and the levels are all over the place. When there's local insertion of commercials, you can have as much as 30 dB in difference between content. The U.S. Congress recently passed a bill, one of the few things they could all agree on, to mandate a solution for this issue. But that, unfortunately, doesn't solve the problem. Congress only dealt with broadcast. Think about it. What's coming into your product today? Maybe you've got a satellite receiver. Obviously, you've got a cable box. You're doing multi-downloads from Netflix and Vudu. You've got Internet radio coming into your receiver. You've got YouTube coming into your television set or your receiver. Has anyone played YouTube through a television set or A/V receiver? The gain levels are all over the place. Satellite radio. Five disc CD changer. When you've got Metallica, there's no dynamic range in Metallica, right? You could have a Metallica tune and a Fleetwood Mac tune and it would be like, 'wow, turn that stuff down.' So, it's a growing problem because we've got so many digital sources coming into our home today. There's another problem—I heard those rear surround effects in the cinema, but when I get home at night and the wife's upstairs or the significant other's upstairs and the kids are upstairs and everybody's asleep and I want to watch a movie and I turn the volume down, what happens? We lose all of our ability to hear bass. We lose all of our ability to hear treble. And the surrounds just totally disappear. That's no way to listen to a movie, is it? As humans, we're genetically programmed to hear mid-range. As I said, we lose our ability to hear high frequencies and low frequencies at those lower volumes. Back in the '30s, a gentleman by the name of Fletcher and another gentleman by the name of Munsen created a contour curve that kind of describes what happens. They modeled how we hear. And you can see the significant drop off in low frequency and you have significant drop off in high frequency. So what makes Dolby Volume different in the marketplace? Well, you've probably heard of frequency domain and time domain as ways of doing signal processing. We actually came up with an entirely new way of doing signal processing. It's called loudness domain signal processing. And it is the foundation for which we will do all of our DSP in the future. It's based upon the science of psychoacoustics—understanding how we humans hear. The important thing about it is it does maintain the spectral spatial balance when it adjusts the volume. Most importantly, that touchpoint that everybody connects to—it enables high-quality leveling: the ability to create a level signal. You choose the listening level that you want your content to be. And it can vary as much as 30 dB. Dolby Volume will give you a consistent level listening experience. All of that's because of domain signal processing. There's also system intelligence built into it called Auditory Scene Analysis that understands that the last piano chord is supposed to gradually, gradually, decline and roll off and isn't introducing pumping or breathing to raise and lower that as other sounds might come into the spectrum. The other thing that's very, very different about Dolby Volume—we analyze individual frequency bands of information within each channel. That is processor and signal intensive. But we had to do that to get to the solution that we wanted to have in the marketplace. There are two elements of Dolby Volume. This is the element that everybody relates to. 'Ah, I want a consistent level listening experience.' Dolby Volume Leveler is a compression technology. Dolby Volume Modeler, which is always on during the Leveler, is that technology that enables us to turn our system down and have all of our system dynamics still present, even at lower gain levels. ...I've been in demonstrations and we've done demonstrations for the high-end community where we'll play a musical source and we'll start to bring the gain levels down, and you lose the bass and you lose the high frequency. Then you'll turn on the Modeler and it's all there again. All this is united by something called Loudness Domain Signal Processing. That new architecture for understanding how we hear and applying those elements to our processing going forward. Here's an example: you're watching a television channel and it's very, very loud. Next channel, it's very, very soft. And then you change channels back to your original source and it's loud again. On an existing leveler that's out there, because they're less sophisticated and they don't have Auditory Scene Analysis, they don't know what's happening. They'll basically just clamp down and gradually increase the gain levels. But Dolby Volume, because we have Auditory Scene Analysis, because you're doing Loudness Domain Signal Processing, this signal now becomes the same gain as this signal here, which is the source level that you want all your content to be. That's where you set your gain levels. ...The amount of modeling and leveling that is applied is tied to the volume controls."

Craig concluded with a discussion of cinema sound. "I want to talk about something that we've had some conversations about earlier today and yesterday. This is our 40th anniversary of innovation in cinema. There is a gentleman at Dolby whose name is Ioan Allen. Ioan has been with Dolby since 1969, and he's still with the company and very much involved in the AES. Ioan is a legend in the industry. Ioan is one of those passionate people that cared about movies and movie quality. Ioan was the person who introduced Noise Reduction in movies back in the 1970s. And Ioan was the person who worked with Francis Ford Coppola to master and create the 5.1 discrete soundtrack for *Apocalypse Now*. In fact, in the special features of *Apocalypse Now* you'll find references to Ioan Allen. This guy is a legend in the industry, and we owe so much to him in terms of what

we hear in the cinema. But when you do have 40 years of audio innovation that started with Ioan, it started with Noise Reduction. But Ioan also introduced Dolby Stereo. Some people call this Dolby Surround. Dolby Stereo in the cinema was released with *Star Wars* in 1977. There were actually only 26 screens, and actually *Star Wars* was not the first Dolby Stereo release. Does anybody know what the first Dolby Stereo released was? *A Star Is Born*. That was the very first Dolby Stereo release. With Dolby Stereo, you had a decoder that was giving you left, center, and right in front. This is what a cinema looks like. We've got point-source loudspeakers in our home theatres. In the cinema, you've got banks of loudspeakers. And your surround information for Dolby Stereo, was mono at the time. Then we went to Dolby Digital, which gave us right surround and left surround capability. But again, your right surround and left surround consisted of these banks of loudspeakers. We got a lot better. Then we worked with the folks at THX and developed Dolby Surround EX for the cinema. This was released in *Star Wars Episode 1* back in 1999. Through matrix encode-decode, we actually introduced the idea of rear-surround loudspeakers through a single channel in the back—right surround-left surround-single channel mono in the back. A couple of months ago, we introduced Dolby Surround 7.1. It came out of a collaboration with Pixar. When they were introducing *Toy Story 3*, they were looking to take 3D and tell a better story and create a more compelling experience. Those 3-D images prompted them and us to look at the cinema and see how we could push the sound in cinema to the next level. So the actual mix itself happened over at Skywalker. What we discovered was that 7.1 gives us the capability for better ambient sound. It gives us the ability to have better directionality of hard effects. It gave us more accurate dialogue panning. It gave us more accurate side-panning. It gave us discrete surround and rear-channel effects and all the things that you could do with discrete surround and discrete rear-channel. So it really enhanced the experience. Dolby Surround 7.1 is the cheapest innovation available to the cinema. If you've got an EX theatre these days, for less than $400 you can have Dolby Surround 7.1. If you're not wired for EX yet, $1,000 more is all you spend as a cinema owner to have 7.1

Jim Chase of HDMI

surround sound. So the cost is an additional amplifier if you don't have the EX-wired theatre. Sound pressure levels that we recommend are 85 dB in the front, 82 dB in the sides, and 82 dB in the back. It literally is the lowest cost of ownership for a new format in the cinema. The ecosystem starts with the surrounds being wired and powered for 7.1 in the cinema—those levels that I talked about. The server itself can actually support up to 16 channels in the future. Obviously, the cinema processor needs to be updated for playback. We have three different cinema processors we're bringing to the market: CP-650, CP-750, and our digital server systems. All these now are available to be upgraded. And our new server system actually comes with the upgrade already built into it. So we've been thinking ahead, and we've been thinking backwards. The one thing about Dolby, when we introduce technologies, we don't leave you stranded. When we introduce new technologies, we're always looking at how this technology impacts what is already in the marketplace. You want to enhance the experience that you have if you have some of our older technologies. We don't want to leave you high and dry. That is an overriding element when we go to market. Studios releasing content: a number of them. Specific titles? *Tangled*, *Tron Legacy*, *Gnomeo & Juliet*. These are specific titles coming in the near future. Here's where we are worldwide: we've already got 350 screens in the Americas. Look at Asia-Pacific. And in Europe, 133 screens already wired and ready for Dolby Surround 7.1. What does it mean for the home? Well, we had a big, big session a couple of days ago about 7.1. This is going to complement that work. In fact, it's going to make more content become available in the future on Blu-ray Disc, streaming media, and other applications. It gives the mixing professional a wider palette on which to express their art going forward. So it's nothing but positive for what we're trying to do with Blu-ray and the performance and the experience that we're trying to bring to Blu-ray. So that's Dolby Surround 7.1 for the cinema."

Following Craig's presentation a session of questions and answers followed.

Jim Chase of **HDMI Licensing, LLC** presented the topic "**HDMI Specification 1.4a: Enabling The Next Generation Home Theater**." While 3DTV is the latest technology offering from CE device makers geared toward enhancing the home theatre experience, it is only part of an ever-changing ecosystem that increasingly allows consumers to enjoy high-definition content anytime, anywhere. Jim discussed how the HDMI Consortium has helped the industry by simplifying CE products, enhancing the viewing experience, and enabling new usage models through the release of the HDMI 1.4a Specification, with an eye toward next-generation home theatre applications.

Jim prefaced his remarks with "We realize that the custom install community and the home theatre enthusiast community are not our number one fans. They're a very vocal subset of the larger A/V ecosystem. We have made a concerted effort to reach out to this community to both educate and learn. So I'm here in both capacities. I'm really impressed. I've been sitting through all the sessions. When you're in the mass market consumer electronics space, it's easy to forget how important little things are. HDMI has evolved over the last eight years. It's not done evolving. Over the last 15 months or so we've had two versions of HDMI come out. ...HDMI was founded on three basic principals: simplicity, high-speed digital connectivity, and HD performance. And while I understand that there are detractors from that, if you think about the average Joe consumer and his ability to go buy an A/V receiver, a Blu-ray Disc player, or a DirecTV or Comcast set-top box in an HDTV, take them home, hook them up with a minimal number of cables, that experience for the average consumer is much easier than it was eight years ago.

"Basically from 1.0 to 1.2, all of the features that were added to HDMI, like DVD-Audio, SA-CD, and video resolutions, were mandatory. Everything from 1.2a on is optional. It's really important to understand

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that because one of the big questions that we see is, 'Will a 1.4x product work with a 1.3y product?' And I'm hoping that when I'm done here that I help educate you to help spread the word that calling things by version number doesn't make any sense. It makes no more sense for HDMI than it does to say you're going go buy a Cadillac CTS 3.1 that had a GPS and heated seats versus a 3.3 that has a sunroof and tinted windows. You don't buy cars that way. You shouldn't be buying A/V equipment that way. It's important to you as audiophiles/videophiles to understand what the features of the product are, do the research, and particularly for the installers, to understand what features work together. I'm not going to dwell on it too much but I want to make sure that you understand that you choose products based on features."


Dennis Erskine of Erskine & Associates

An audience member questioned that with 3D if you're not 1.4-compliant you're not 100 percent sure that it will work for 3D, so you need to know the version. Jim responded with "No, what you need to know is that it says HDMI with 3D support. That's how we're mandating our adopters to market the product. If the packaging says HDMI 1.4, and that's it, or it says HDMI and 3D somewhere else, then we have to go after them for trademark and logo usage. That's part of my team's job. We have to teach them and correct them. Or it may be a counterfeit product. We try to do a good job in reviewing packaging, but obviously with 1,000 adopters shipping billions of products we can't catch everything. We could use your help. If you find things that are unclear, don't make sense, let us know about it. You can either email me directly at jchase@hdmi.org or at admin@hdmi.org. We'll get it to the right person."

Jim discussed the evolution from Version 1.4 to 1.4a. "Three big megatrends have prompted those changes. Improved viewing quality, portability of content, and the merging of content sources are what have driven HDMI's 1.4 and 1.4a's evolution. ...We developed a technology actually called the HDMI Ethernet channel. So we actually have the ability to send Ethernet data between devices in the A/V cluster. Devices like Internet-connected TVs, Apple TV, Roku boxes, even your legacy satellite cable boxes. All of their Internet connections being able to get content between them in an easy way. ...It doesn't cost much for TV manufacturers to add Ethernet connectivity into the TVs these days—a little bit more than it did 3D. That's one of the reasons 3D was so successful. The change in the processor was very small for a chip to give you 3D, since it is frame-compatible. With a couple of wire changes, a little different memory structure, HDTVs are now selling at a higher dollar rate. Manufacturers are getting higher margin, even though they're not selling as many as they like, at virtually no added cost. As for the Ethernet channel, we've added the ability to send 100 megabits bi-directionally across the cable. We converted a standard 100 base-T Ethernet to an HDMI Ethernet twisted pair, so the chip itself has the ability to receive input in standard Ethernet format through a switch and then convert it into high speed muxed over Ethernet. We take it in pins 14 and 19 and turn those, so one was a spare channel and the other was the DVC line. So we multiplex, we multi-use the DVC line, and take the spare unused line, shield that with another ground, and create basically a fourth twisted pair. We have three TDMS twisted pairs inside the HDMI cable, so this now adds a fourth. So it is physically different in construction. It will work in non-ethernet applications. But the other way around will not happen in legacy devices. The bottom line from a connector point of view is there's one cable you should be looking for. You should be looking for High Speed with Ethernet. If you're buying that you'll have no issues. It can support every feature in all versions of the HDMI spec. A device that has multiple HDMI inputs will serve as an Ethernet switch. On the back, where the HDMI ports are, there will be an indication called HEC or HEAC. That indicates that that particular port can support Ethernet. Some devices, again, product manufacturers make the decision, may have four HDMI inputs but only have one of them that supports high-speed Ethernet. Or in the case of a receiver, more than likely, if it supports it on one input it will support all of them. It's at the device-manufacturers discretion of how many ports and if they'll they support the feature. Even if the power is off in the device, the device still has to be able to pass through and act as a switch. That's part of the spec."

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Another audience member questioned, "How do you address the issue of somebody who just bought a $6,000 receiver two years ago that doesn't do 3D and now it won't pass Ethernet, which is the biggest, coolest thing that's happening right now in all of entertainment?" Jim responded that at least there is an alternate solution. "Buy a switch with Ethernet pass through. Another solution is to buy a Blu-ray Disc player, such as the OPPO with dual HDMI 1.4 outputs. One connects to the HDTV and the other to the legacy HDMI 1.3 receiver. If everything's in spec, with regards to A/V sync and delay, then it should be fine. That might be the workaround for a high-end installation."

Jim talked about other applications for HDMI. "We now have a cabling system with relays so that HDMI-enabled devices can be

Norwegian Epic

used in the automotive entertainment systems. It's a hardened connector. It meets all the temperature, vibration, spec-issues for the automotive industry and automotive temperature range. Here's a minivan example, where you have internal harnessing connecting the displays to an in-mount Blu-ray Disc player and in addition to that you have a receptacle that will allow you to bring an actual camera or smartphone or potentially a game system if you wanted to take it on the go. The very first product is now on the market. The 2011 Odyssey is available in the U.S. and has HDMI porting. That's another new area where we've tried to work with the industry to figure out what their unique needs are. We're looking at things like digital signage and commercial aircraft. Looking at other markets where there's enough devices in play now where they want to figure out how they interoperate with those devices."

Jim described the audio return channel. "The ARC basically allows—something that people have complained about—you to send audio back to the receiver so if you've got other sources, whether it's a built-in antenna or other source connected directly to your display—you don't need to run a separate S/PDIF cable to get audio bumped back through your surround system. Audio goes straight through the HDMI cable. It's not a physical change to the cable at all. It's just a change to the actual chip hardware and the registers and the protocol allows back channel communication."

Another question from the audience. "There is a certain brand of cable on the market that is labeling cables HDMI 1.4, and customers are being told that now that they bought this 3DTV they had to have this HDMI 1.4 cable, and the only one on the market costs $125."

Jim answered. "There are two people on our staff full time for compliance. We try to hunt that down. Again, with the number of devices, we try to go after the low-hanging fruit. The cables are the biggest problem. To be honest with you—how do I say this in an elegant way—the retailers have no problem with them marketing in such a way that allows them to upsell. So they kind of have some passive encouragement by the retailers to violate our trademark and logo usage. If you see those, please let me know. Those I want to know about immediately because those are the ones that create a lot of problems and really hurt the end-users because they're spending money they don't need to spend. I'll say this, when we get to cables: There is value in a $40 cable over a $4 cable at Fry's. What that value is, I can't quantify, alright? But as a custom installer, shame on you if you try to go in there cheap to put a few more bucks in your pocket and you buy some cheap cable and it doesn't work and you end up rolling the truck back out to fix the problems rather than testing things in your shop up front and making sure the cables that you've got are satisfactory for your application."

Another question pertaining to speed. "Going back to your statement about, 'don't buy the version, buy the feature,' if somebody buys a cable knowing that someday they're going to have 4K projector, you've already got standard-speed HDMI cables and high-speed HDMI cables. What do they buy now?"

Jim: "If you buy high-speed cable or high-speed Ethernet, it will cover all this up to 4K resolution, even if they are HDMI version 1.3. They were already capable of handling 4K by 2K @ 30Hz. It's 340 Mhz per TMDS channel, which gives you, all three channels together, 10.2 Gigabits per second of data. Those cables could support that speed. There are not chips out yet that can run at 340 Mhz per TMDS. Right now, the fastest on the market are about 225 Mhz, which is like 8 Gigabits per second, and there's a new one coming out that's going to be around 300 Mhz. So the silicon technology is trying to catch up to the spec we're required for higher speed."

Jim spoke about cable compliance. "What I can tell you is cablemakers have to test the longest length of the product that they're submitting for certification. So if you buy a 25-foot long piece—that product was to have been certified. The burden of compliance falls on the adopters. They have to send a representative sample for testing and have that certified, and it's fully tested. They're supposed to retest whenever they change anything in the manufacturing technique. That's the agreement. We had ten CBP (Customs Border Patrol) seizures this year of counterfeit cable. Huge dollar amounts, huge quantities, container-loads of cables. So we try to track it down aggressively. If you run across problems, we want to know about it because we'll go track them down and make sure 1) that they're an adopter and 2) that they've got compliance in that configuration and 3) if they've got other issues, then I've got to research it further. Then I've got to get the tech team to start doing interoperability checks on it and figure out the problem. I'm dealing with a cable issue right now that is in spec, but I'm running into some issues.

"The counterfeit could be that they never paid for HDMI licensing. Or counterfeit in the fact that it's labeled a known-name brand but it's not. Of course I do care about the labeling. Anybody that can go build and bundle and sheath wire can potentially get into the counterfeit HDMI business in a lot of different ways. And it's low hanging fruit. A lot of these guys are in South China where it's very tough to track them down.

"We have a pretty rigorous compliance testing program right now. Our requirements are very specific in what you must test, how often

you have to test it, and what you can test yourself, versus submit to one of our test centers. So there's a fairly ridged set of guidelines. It's important for interoperability. We don't test for interoperability but we test for compliance. The thought is that the better job we do at testing compliance, the more likely we are to have fewer interoperability problems. ...The PTS (Performance Test Spec) is 850 pages of test procedures and guidelines and recommended test equipment and specific tests that each adopter has to agree to follow. You can test at one of our test centers or self-test if you're big enough and you have the ability to do this stuff. It's not cheap. Textronics, Adulant, and then the smaller guys like Quantum Data make very sophisticated test equipment, so this is not for the faint of heart if you're going to get into self testing. But there is a very rigorous set of requirements. We have ten test centers around the world and our founder companies Silicon Image, Sony, and Panasonic own most of them. Our adopters have the ability to go use those test centers. Those test centers are specifically in the business of serving the adopter base."

Jim discussed HDMI cable labeling. "On the sheath itself it should say 'HDMI High-speed' or 'HDMI High-Speed with Ethernet.' On receivers they can say HDMI 1.4a as long as they describe the specific features that they support."

Jim mentioned possible future versions of HDMI. "HDMI has always maintained backward compatibility. New features don't work with old things but old features will continue to work. The new devices will continue to support the older features. If there is an HDMI 1.5, I would assume it's going to continue to evolve just like versions 1.3 and 1.4 have. Would there be an HDMI 2.0 that is completely different? If we're going to do something like locking connectors, probably because it's going to have to be a different connector, so there's where you're going to get away from it. And the devices are going to have to have both 1.3 and 1.4, and 1.0 and a 2.0 compatibility. But I'm not speculating because I don't own the spec, I enforce the spec. There are seven founders that will meet and talk about if and when they add new capabilities and how that's brought out."

Dennis Erskine of **Erskine & Associates** presented an interactive "**Room Design Practicum**." In this practical four-hour course, participants were given a real room, real customer requirements, and the real constraints often found when you want to tackle designing your own home theatre. During the session, a set of documents and information provided by the client was presented and some of the various approaches were discussed, Several breakout sessions allowed teams to design their own solutions, step by step. At the end of the session each team presented their room design for group discussion. At the conclusion of the course, participants were shown the actual solution implemented and photos of the actual completed room. This was a challenging, thought-provoking exercise that turned out to be a fun and enlightening experience.

DTS, Inc. sponsored **Brant Biles**, President and Chief Engineer at **Mi Casa Multimedia**. Brant's three hour presentation was a tutorial on "**3-D Audio For 3-D Video**." This live mixing presentation and discussion covered "How To Invent A Soundtrack For A True 7.1-Channel Experience," with examples from the re-mastering of *The Sound Of Music* and *Toy Story 2*. Emphasis was placed on 3-D audio for 3-D video—spatializing audio to match 3-D picture—in which the added two channels at 90-degrees included angles relative to the "sweet spot" adhered to the preferred optimum 7.1 loudspeaker channel layout recommended by DTS and Dolby. This was an extremely enlightening presentation, which covered the optimal spatial relationships involved in creating 7.1-channel soundtracks and the use of sound elements to achieve a more spatially immersive and real soundfield experience matched to the on-screen imagery.

The Home Theater Cruise Technology Conference At Sea concluded with an in-depth Q&A session on 3D and the implications for the future, which involved all the presenters. That evening we held the Thank You Party and Segs4Vets Auction. The Thank You Party


Brant Biles of
Mi Casa Multimedia

was not only our way to thank our group for attending the 9th annual cruise, but also a way to help our disabled veterans. We hosted an auction for Segs4Vets, where our group bid on items donated by industry sponsors. We raised nearly $24,000!

David Bott and I, aka known as The Cruise Brothers, thank you for your participation and support and look forward to our next Home Theater Cruise event. **WSR**