The Hybrid Theatre

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ABSTRACT

Ever since the first movie picture house was opened, experiencing the unique cinematic experience has constantly evolved. Technological advances continually guarantee that more changes will happen to create the ultimate cinematic experience. Cinema has been reincarnated time after time, from the first hand cranked silent movie to the modern day Digital Cinema.

The technology used to depict the story changes; along with that change is the human thirst for a better transformation, for a more enjoyable, more encompassing, more believable, more immersive, yet simultaneously a more bewitching, entertainment experience. “In this volatile business of ours, we can ill afford to rest on our laurels, even to pause in retrospect. Times and conditions change so rapidly that we must keep our aim constantly focused on the future.” —Walt Disney. [1]

It has been said that “content is king”. By itself, that implies a disservice to the technology that supports it. Without the technology, the content could not exist. In today’s digital society; a movie can be downloaded to a handheld playback device the moment it is released. Offering these services at a cheap rate would enable studios to stay ahead of the curve, virtually eliminate video piracy and create the ability to deliver first class uncompromised content. It’s only a matter of time when new released movies would be distributed this way too and people are given the choice to view in the comfort of their own homes, hand held device or view at a local theatre.

Keywords: Digital Cinema, Walt Disney, Digital Cinema, Home Cinema, 3D stereoscopic, Hybrid Theatre,

1. INTRODUCTION

What is the future of local cinemas? The recent boom in "Home Cinema" and the current enthrallment with handheld electronic devices has made a serious dent in the box office of many productions. It would be naïve, however, to assume that this trend will not eventually reach a point of saturation just as it did when the advent of television spelled the, then predicted, demise of radio and even motion pictures themselves. All of these mediums have adapted to survive - radio will continue to be part of society; likewise the cinematic experience. As producers of both technology and content we have the opportunity, and the capability, to deliver first class content to the handheld device, IMAX theatres, and everything in between.

This is a unique opportunity; we are currently on the threshold of defining the future of cinema as we know it. Movies and images will always need to be projected or displayed somehow, either at home or in some other viewing environment. Ultimately the cinematic feel is totally different than watching the same movie at home. A giant 40 foot screen is more appealing than a fifty-two inch plasma television. Likewise surround sound from theatre speakers is much more alluring than the typical consumer speakers connected to your home system. Also 3D stereoscopic has returned on the scene with vengeance, not just for movies, but for an immersive gaming experience. However, a thought for consideration is that the technology needed to project Digital 3D does not come as a simple plug and play device; it has its share of obstacles and problems that we must overcome. From experience, there are specific integration issues to address. The merging of varying technologies seamlessly is challenging but doable using a Hybrid Theatre solution.

In order to consider a hybrid solution, it was important to research and collect all data relating to cinemas from the turn of the century to modern day.[2] Additional data was gathered through both personal experience and obtaining the wisdom and knowledge of those readily working in the production environment. When the peculiarities of a production environment are considered and the thirst for technological advancement is realized, the list of design requirements can

appear to be overwhelming. Taking a look at the process in phases can help manage the requirements. Once all of the relevant information has been gathered, a document of useable statistical data can be developed. That data is then transferred into a format that outlines the possible building requirements. This Hybrid Theatre information is then presented to potential users to insure that the final space will be suitable for their future needs.

The true Hybrid Theatre should support every form of viewing from approval sessions to screenings and studio presentations; but, the true Hybrid Theatre goes beyond the basics. Imagine taking part in a worldwide videoconference, attending a "tele-concert", or perhaps experiencing some significant, historical event in the highest definition quality available. Consider being immersed in a 3-D videogame with players from around the world, making the beginnings of the first "holodeck" a reality. While being mindful of how technology has grown, the Hybrid Theatre should routinely look at the direction in which technology is headed. Future-proofing is critical to the success of any Hybrid Theatre design.

Before going further, it's important to take a few moments to maintain perspective and reflect on the past. The motion picture industry is a little over one hundred years old. During this time, the way of viewing images has evolved from flicking through hand drawn images to the elaborate, multiplex theatres we know today. Throughout that evolution, viewers have witnessed multiple format changes, including the early magic lantern shows, spinning zoetropes, Kinetoscope parlors, celluloid strips, sprockets, CinemaScope, Vista Vision and so on. [3]

What became apparent was that both movie makers and the cinema owners found it expensive to re-tool for every new invention or format. In order to cope with changes, it became obvious that a move toward standardization would be required. The viewing systems therefore became refined and perfected into what we see today. The inventions of sound, radio and television were once seen as threats to the industry; but, each and every time, motion pictures have adapted and gained momentum. The single, most important factor for every new development in the cinematic field has been to successfully adapt existing equipment to cope with whatever change happens to come along. This keeps costs down for cinema owners and keeps filmmaker's images on the screen. Until recently, most cinematic advancements (anamorphic lenses, lens turrets, film platters, optical sound, digital sound, 3-D stereoscopic, etc.) have all found a way to fit onto or alongside existing equipment.

With respect to film, however, we may be witnessing the end of an era. New technology is becoming available to present a motion picture – Digital Cinema. This format allows greater control and flexibility for studios, but at the same time, it is a huge expense for cinema owners to put aside their trusty 35mm projectors that have served well for innumerable years and replace them with a digital, electronic monstrosity that has yet to prove itself and will probably be outdated much sooner than later. What is the incentive for cinema owners? Recently, several studio-run initiatives were put in place to help theatre owners cover the costs of new equipment. Clearly, the transformation is important to the studios. But why is there such a push for change?

For studios, perhaps the biggest motivation is security. Digital Cinema allows production companies to keep tighter hold of their assets when a movie is released. Each cinema is equipped with a server that permits a production company to download their movie a secured server. The server then has a secured link to the projector and associated equipment using a digital key code that permits only that system to display the film. The key constantly checks the numerical identification numbers of the playback systems. If one component is changed, or the system senses a breech in security, the system will not work. Without the validation keys, the encrypted data file will not be viewable by any other device. On the subject of security, each cinema release holds unique digital fingerprinting, so unique that forensic examination will show the day, date, time and location from where a copy was obtained. That fingerprint will also be transferred to any recording device, including cameras aiming at a screen or audio recording devices.

Playback in the Digital Cinema is as easy to use as a consumer DVD player. If you think of it as a DVD with extra content you will be on the right track. Additional language tracks, alternate endings, and even edited-for-content versions are just a few of the perks. Production companies are to follow an electronic version of cinema standardization known as the Digital Cinema Initiative (DCI specification). This in effect means that the projected image will be the same in every viewing environment.

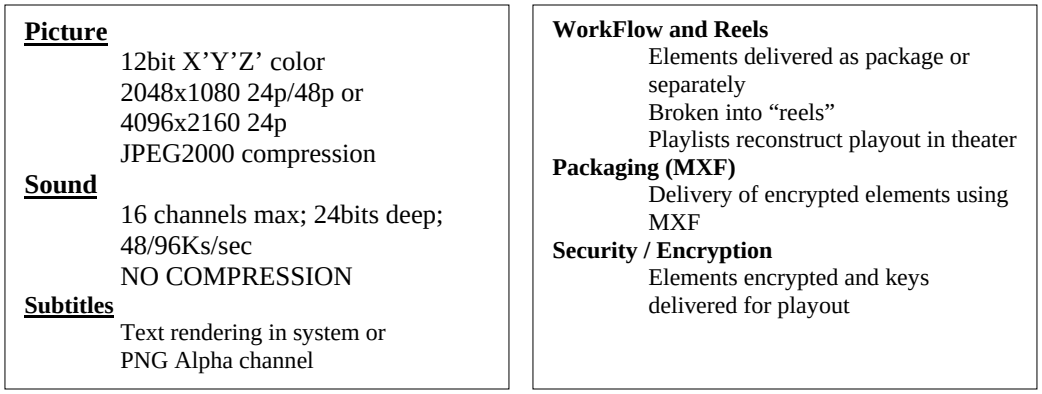

Fig. 1. The Digital Cinema Initiatives (DCI) specifications

Movie releases will be easy. A production company will create a Digital Cinema Package[4] which will hold previews of upcoming releases, advertisements, and differing content. This package will be automatically downloaded to theatre servers. Updating these packages will also be easy. For example, if someone forgot to hyphenate the lead actor's name - or worse, misspelled it – the Digital Cinema Package for that film could quickly and easily correct the error or even change a scene. But the advantages don't stop there. Let's say an unknown movie gains popularity overnight and reaches "blockbuster" status unexpectedly. Digital content allows distribution to any technologically-equipped theatre at any time without having to wait for expensive 35mm prints. The reality is that digital content and new mediums allow studios and content makers greater flexibility. At present, very little is set-in-stone, but there are many possibilities.

1.1 Home Theatre Revolution

There is a surge of High Definition equipment available on the market. "In the U.S., roughly a third of households without a high-definition television are interested in purchasing a new HDTV set in the next six months."--*The Diffusion Group*.[5] Electronics prices are continuing to fall and the consumer demand for large, flat-panel televisions is rising. For most people, the thought of regaining space in their home, getting rid of that large cumbersome box in the corner of the room, and replacing it with a sleek, wall-mounted piece of equipment is appealing and it is changing the home theatre market as we know it. The home theatre boom has exploded into a huge phenomenon that both content suppliers and equipment manufacturers are racing to take advantage of. Both groups strive to deliver the best content on the best devices available on the market, but this shift toward consumer electronics does not stop there. Mobile phones and handheld devices are no longer considered as just a phone; the new smart phones are designed to be used as a mini office, offering calendaring, email and internet browsing. But moreover, these devices are able to view high quality video content and play back digital music too. So what does this really mean for content producers and distribution companies?

One possible course of action would be to take pay-per-view to a new level by possibly releasing a new movie directly to a family's home theatre system or mobile device. Connection speeds, compression schemes, and data transfers have become fast enough (if a subscriber uses cable or some other high speed delivery service) that the content could be streamed rather than downloaded. The internet has become more than an "information" highway; it is becoming an "entertainment" highway as well. A person can now download television programs to an MP3 device within hours of its original air date. The possibilities in this market of delivery are unlimited.

This enhanced connectivity again asks the question: "Will these advancements be the decline of the movie industry or of theatres as we know them?" As stated earlier, cinemas have gone through many changes, many that were considered life threatening, but the dire need for people to get out of their houses and congregate in a public area has always been a key factor for the success of local cinemas. Our human nature craves for other human connections. We get this fix in many ways, from working with our colleagues to our home life where we take our families to restaurants, football matches and

so on. A cinema will always be a place for families to bond and congregate with other human beings. One possible future for existing theatre venues could be what is tantamount to the beginnings of a "holodeck". Immersive 3-D technology already enables viewers to watch concerts in 3-D which are being screened and tested with appealing results. Think of the possibilities for worldwide 3-D gaming conventions, concerts and so on.

1.2 3D Stereoscopic Reenergized

Right now 3D stereoscopic has been re-energized to a new level. Computer animation has broken through many levels which can make the process relatively simple to convert a 2D movie to 3D stereoscopic. Disney animators and technical crew are breaking new ground by utilizing the "stereoscopic window" to their best advantage. But, how do we view the content or how do we view what we have created.

When we approached the release of Chicken Little, our present 130 seat theatre was not equipped to display stereoscopic movies and the theatre had just gone through some major renovation without considering any stereoscopic factors. Adding the complexities of the digital transition to 3D viewing became on of my major headaches. I mean just what are we talking about here? Researching 3D Stereoscopic formats and viewing capabilities proved very illuminating, I did not realize so many systems existed.

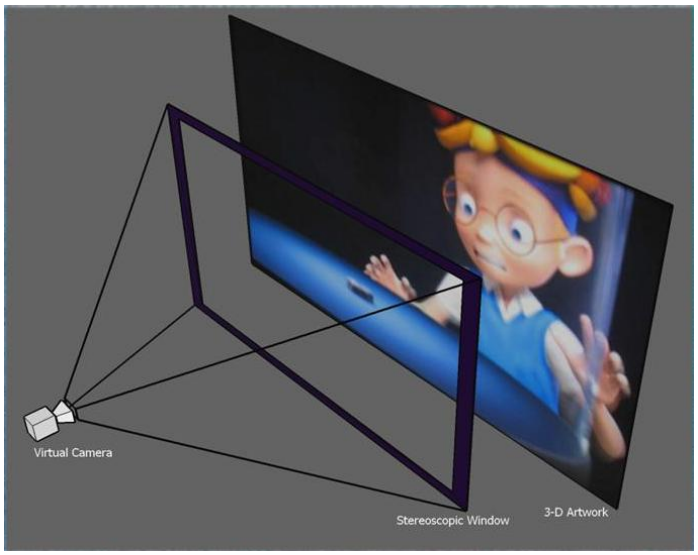

Fig. 2. Working with the stereoscopic window, Walt Disney Animation Studio's are working diligently to create a pleasant 3D stereoscopic cinematic experience, taking the stereoscopic viewing environment into the 21st century. © Disney Enterprises, Inc.

Any transition also needed to take into account the artistic need to view stereoscopic movies, old and new; you name it we had to find a way to do it. We installed a seamless roll down silvered screen along with a 2K digital projection system. The technology at that time was relatively new to us and no one knew what the playback device would be, or how or where we were going to store frames. To that matter, we also didn't know exactly how we were going to playback our media. We just knew we had to find a way to do it. We modified our production pipeline, installed a RealD system with our projector, and shortly after, held dailies and finally screened the finished movie. Our software group continues to write software enabling us to view and edit 3D stereoscopic Images.

We learned a great deal over a short period of time. If we could go back, we would certainly do things very much differently. For instance, a silvered screen should really not be on a roll down mechanism; this is asking for trouble. We simply had to go with a roll down version because our facility had no fly space. Also the theatre had just been renovated and our primary white screen had just been installed. For us, a roll down became the only answer. But the simple acts of putting one screen in front of another created a multitude of different problems. How do we deal with the audio coming from behind the first screen and masking, also how to deal with the image reflecting through from the first screen into the second and subsequently been reflected back into the first screen? Our audio solution was to implement two audio equalizer settings – one for white screen viewing and the other for stereoscopic, our primary masking was also replaced with a system that would fully close behind the first screen to avoid light bleed through and reflection. We

installed a secondary masking system for the 3-D screen which soon proved to be awkward and unusable; it has since been discarded. The silver screen has also been replaced – three times to date – always at the most inopportune moments. It always serves as a reminder of what to do differently next time. Next, there is our overall theatre design which is "short and fat" as opposed to "long and thin". This created areas within the auditorium that were good for one type of viewing and unusable for Stereoscopic. Internally, these complexities were relatively easy to overcome considering our clients are the filmmakers themselves. But what if our clients were just regular people? How were they expected to know where to sit to view optimum results?

The stereoscopic release of Chicken Little brought to light many technical problems, each of which we eventually found a way to overcome. Currently, Walt Disney Studios only provides content for the following 3-D systems: RealD, Dolby, NuVision, and MasterImage. We do not provide anaglyph 3-D content due to its very poor quality. But with that said, we are expected to project and view anaglyph as an aid while a movie is being made, or to simply view nostalgic reels.
Below are Box office figures for our 3-D releases, as you can see there has been a steady increase in stereoscopic versions of our movies.

Chicken Little **Locations: 80** **Screens: 84** **Box Office: 7,462,383** **3D % of Total Gross: 5.5%** **3D % of screens: 2.1%**	**Nightmare Before Christmas (2006)** **Locations: 168** **Screens: 181** **Box Office: 8,700,869** **3D % of Total Gross: 100.0%**
Meet The Robinsons **Locations: 488** **Screens: 581** **Box Office: 30,443,678** **3D % of Total Gross: 31.6%** **3D % of screens: 14.0%**	**Nightmare Before Christmas (2007)** **Locations: 564** **Screens:** **Box Office: 14,486,897** **3D % of Total Gross: 100.0%**

* Fig 3 all numbers are domestic only

1.3 New Theatre Anyone?

A little over a year ago, we were asked to consider building three new theatres in a new Animation Building. Part of the consideration was to design one large five hundred seat multi format environment and two smaller one hundred seat digital theatres. At this point I needed a plan, I collected and assembled all of the relevant information and soon came to an overwhelming conclusion. Whatever we design, we would have to make sure it is some form of hybrid; in fact it would have to be a hybrid for Disney Animation simply because of the nature of our business, but what about the theatres out there in consumer land? At that point I began to put a theory together of a possible future Hybrid Theatre experience.

In reality, any new theatre design should take into account the many changing variables such as its primary and secondary use and the technology that supports it. For example, would the theatres primary use be that of a multipurpose venue or strictly as a viewing room. Most marketplace theatres cater to the masses and are somewhat generic with requirements. Our industry standards and requirements invariably change to suit the needs of both a production environment and the latest technological advancements.

During the design phase, it would be a strategic coup to consider 3-D stereoscopic compliance. Designing a theatre to meet these standards from the start should be a key integral design approach, the theory being that you can always convert a 3-D venue to project 2-D images, but the same paradigm cannot be used to convert 2-D environments to view 3-D stereoscopic. They are both equally important, but have entirely different technical requirements.

Therefore, taking into account the many different screening variables, it would be almost impossible to create the perfect screening room to cater for all events. The end result would most certainly serve as a hybrid, first-class exhibition theatre to serve many purposes:

a) Showcase latest movie releases and be fully compliant with the DCI (Digital Cinema Initiative) and SMPTE specifications.[6]
b) Showcase traditional 35mm print.
c) Showcase stereoscopic 3-D productions that would eventually be exhibited in existing conventional theaters.
d) Serve as a multi-media presentation environment for training and educational needs.
e) Meet current and future THX and Dolby surround sound audio specifications.[7]
f) Serve as a state-of-the-art facility that would showcase as an ultimate "best possible" screening facility.
g) Serve as a state -of- the-art facility to view and develop video games and other electronic media.

For the production design hybrid, further considerations must also take into account the limitations of existing marketplace multi-complexes and structures and provide a basis of a “real world” viewing environment. This allows production companies to see what their movies look like in a regular theatre environment. Further considerations for a production environment would be:

- Allow room for future growth in technological advancements.
- Take into consideration that the theatre will also be used for special interest groups such as press presentation, corporate sponsorship programs and celebrity pitches. Creating the right environment for these scenarios is extremely important.

Auditorium General

Traditional Viewing:
Traditionally, a long narrow theatre gives the best possible viewing angles, from the center of the screen, most seats are within a 19° viewing angle and few are more than 26°

a) By using a “gain” screen, few seats will have a significant loss of brightness.
b) Optimum subtended angle 45-50° with cinemascope picture.
c) A screen with a larger angle may reduce picture quality (grain, contrast loss, flicker)

Side walls:
Parallel side walls should be avoided, a projected image from the screen reflects light onto the walls, if the walls are parallel or have not been modified, the light reflect directly back to the screen. Likewise audio directed to an opposite side wall will reflect the sound back and create *reverberation. Typical auditoriums are funnel shaped with the viewing area located at the narrow part of the funnel and the projector at the wider part. The side walls are covered with molded sound dampening material and staggered to create a “saw tooth” type pattern. This shape reflects both sound and light away from the screen area.

Theatre Lighting:
Attention to theatre lighting should be acknowledged, exit signs should be at the rear of a room and aisle floor markings used as an aid to see during a screening should be on a pressure sensor. The illuminated arrows used in a floor to indicate exit direction should be electronically connected to the house lighting system to both turn off during a presentation and turn on after a presentation. If they are electronically connected to the house fire system, they would automatically turn on in the event of an emergency.

The light omitted from the aisle floor lamps if kept to a minimum would pose no problem, however the norm is to run a light bar the full length of an aisle which could raise the contrast level on the screen. Theatrical mood lighting will also be required, however we must pay particular attention if the theatre is to be used as a color critical area, and exit signs should be kept to the rear of the theatre and not in full view of the projected image.

Light block double entry door system,
Patrons entering the screening room should not be able to disrupt any viewing. Therefore a double door entry system that would block out external light should be designed into the plan. Modern designs have a hallway entry on the left and

right hand side, the hallway extends to the center of the auditorium to allow wheelchair entry directly into ADA compliant seating.

HVAC:
Airflow, particularly from HVAC should also be a high priority, noise levels omitted while in use could distract viewing, likewise air blowing or returns, located near the screen area could cause a distraction and equipment malfunction.

Rigging:
In the event of a theatre malfunction, or to simply try out new technology, a series of theatrical rigging should also be accommodated in and around the theatre and screen area. The rigging would also be used for light fixtures and spots for directional lighting.

Presentations:
Any audio system should include wireless microphones and an appropriate mixing station to control the microphones for multiple presenters. A lectern with an attached microphone is also helpful as is a table for notes, a laptop computer, or other presentation materials. The connectivity for these devices should be factored into the initial design of the space. Tie lines connecting the stage area to the audio console and projection booth should accommodate audio, high resolution video, network, as well as any proprietary or specialized needs (e.g fiber, serial control, etc.). Additional items that may be useful include RGB confidence monitors as well as speaker cueing and timing systems.

Rear CPU Area: (Production environments)
Rear center of the auditorium should have space allocated for necessary "production equipment" needed for viewing material such as digital review. Such equipment is normally CPU stations and alike. However light omissions from monitors and the cumbersome size of these machines proves to be one of the major obstacles to overcome. The ability to electrically or pneumatically lower and protect this area would be most beneficial. If designed correctly, lowering this equipment to ground level would create additional seating space or could also be used for ADA wheelchair compliance. If stadium seating were installed, this could prove to be a relative easy solution to do.

Stage Area:
Some occasions and presentations may require a stage area; this could prove to be a problem with acoustics and screen light reflection. The stage area could be achievable with either a pneumatic stage or acoustician design involvement. Again, if stadium seating were installed, the stage could easily be stored under the seating area and be motorized to extend when needed.

Removable Executive Console Area: (Production environments)
This is should be located in the prime viewing area and normally consists of a seat being replaced with a small console to allow talkback to the booth and touch panel operation of equipment. This area could also be used to connect a virtual mixer controller to enable an *audio mix to take place. The console is removable and would allow seat replacement to happen with short notice.

Under floor cable tray:
Audio and video cabling is usually extensive when building a theatre, access to a cable tray is equally important; the norm is to have a series of cable trays located under the auditorium seats with access via trap doors.

Hearing impaired
A closed loop RF system (preferred) or infared system should be set in place for the hearing impaired.

Seating:
Generally, the seating should be so configured that wherever you sit in the theatre, your eyesight lines up with the center of the screen. The best prime seating arrangement would be for the patron to be sitting directly in the middle of the screen and at the same level. Flip up arm rests with cup holders and possible back pockets for 3D glasses could be optional. There is talk in the industry for hybrid seating with a reverse rake in the front of the auditorium. This could be beneficial for any design to incorporate.

Stereoscopic Viewing:
Short, wide auditoriums are not good for viewing 3D stereoscopic content. The general rule of thumb is a long narrow auditorium with a smaller screen. This also eliminates ghosting and gives an all-around pleasant cinematic experience. The primary reason for the long and narrow 3D stereoscopic rule is to eliminate hot spotting. The polarized 3D screen is also a high gain of 2.4.

Stereoscopic Viewing Screen brightness:
The original specs were directed toward screen brightness, as for conventional flat (2-D) exhibition at 24 fps, and did not take into consideration the attenuation of the two sets of polarizing filters used for 3-D.
Digital projection also involves additional considerations, including the method used for measuring light. The problem is, that all systems in the original spec were measured at 24 fps (frames per second) with a two-bladed mechanical shutter, resulting in 48 interruptions per second. Any sensor lag in the measuring meter would, therefore, be a constant. With digital projection, different times may occur, such as when the "Z" screen is used, which effects 144 interruptions per second at 24fps. Since the sensor in a measuring meter may not be able to "recover" fast enough (this yet to be determined), this could conceivably yield a different "reading" for the same lumen output. Also, a standard has not been established as to differential readings at the corners as compared to the center of the screen, nor for the position(s) from which readings are to be taken. Even with 2-D film-based systems in the past, there was some contention that some readings were inflated by the readings being taken from the projection booth (near axial) as opposed to the much more realistic procedure of taking them from various positions in the auditorium at seating level.[8]

(Real D Stereoscopic requirements.) [9]

- Acceptable auditoriums will have a scope lens in the 35mm projector that has a focal length of 65mm or more, corresponding to a lens number of 1.4 or higher. The optimum lens #2 being the preferred.
- Throw = 2x the screen width. Eg. A 50ft screen would be a preferred 100ft throw with a #2 lens or a 70' minimum throw for a 50' width screen using a 1.4 lens.
- Real D Maximum screen specification width is 40'. (Using this spec, a minimal 56' throw or maximum 80' throw) This is because of a brightness issue, *(The projector, shooting through the Z screen on top of the audience wearing the 3D spectacles, measurements are ending up with only about 3. 5 ft. lamberts on the screen as opposed to SMPTE's recommended 14ft. lamberts We (Disney) are noticing anywhere between a 75% to 82% reduction.)*

Screen:
One of the potential problems of highly directional projection screens is that people who sit toward the sides in the front rows get an image that is both dim and distorted. Amongst which; ghosting images becomes a commonality when sitting in these positions. This may be alleviated by designing a colorized seating plan for stereoscopic viewing. (see below)

(Seating for stereoscopic viewing)
The seating configuration would be trapezoidal in shape with the narrowest rows in the front, and progressively wider rows toward the rear of the auditorium. A colored seating system would be unmistakable and easy to make a distinction between a 3D stereoscopic screening and a traditional 2D. Provided the right colors are chosen, the seating arrangement would be esthetically pleasing and artistic.

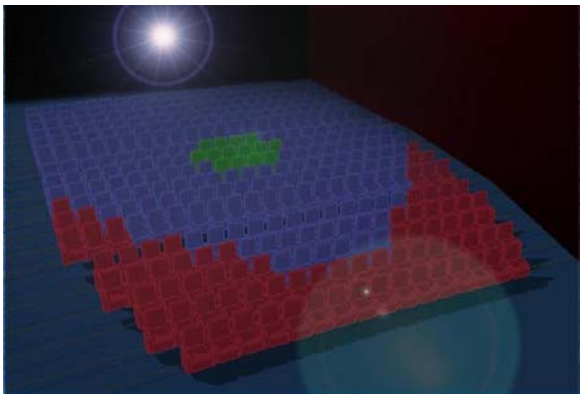

Fig. 4. Unique colored seating pattern for prime viewing of 3D Stereoscopic images.

Screen Gain:

Gain is an inappropriate word, as true gain is not possible, even with a near perfect reflector like a front surface mirror. It really should be stated as "relative loss". A screen "gain" of 1.0 is defined as the measured reflectance off of a chemically pure magnesium carbonate block, under certain specified conditions. Any other number indicates more or less "gain" than this reference standard.

Curved versus Flat screen:

A curved gain screen reflects more light back to the audience; however a curved screen would also be the least desirable in a multi-format theatre with little or no fly space for screen rotation.

Screen Rake:

With stadium or hybrid seating, raking the screen may prove to be beneficial. The seating should be "staggered" such that seats do not "line-up" with the row in front in terms of the screen center, but rather the seats in each row line up with the space between seats in the row immediately in front, so as to minimize "head interference". Bear in mind that each 1° rake gives a 2° improvement in reflected light angle; however a rake of more than 5° is not recommended. *Keystoning is also a huge issue with raked screens and should be avoided. Provided the design has height, stadium or hybrid seating is an option.

Vertical Direction:

Another related consideration is in the screen's vertical direction. In most cases, depending on the theatre design, the Projectors are located higher than the audience sight lines. As such, a perfectly vertical screen will result in much of the light being wasted, since it is reflected back to the projector rather than to the audience. An improved procedure is to tilt the screen slightly forward. The optimum angle may be determined either mathematically (angle of incidence equals angle of reflectance), or empirically. The latter is the most accurate, as it takes into consideration light fall-off with distance. The procedure is to project raw (white light) onto the screen, and from the position of the screen, observe the reflection of this onto the auditorium seats. The screen frame is then tilted until the "hot spot" is centered near the center of the seating pattern. Again *Keystoning is also a huge issue with raked screens and should be avoided.

Fig. 5. Above diagram shows both correct and incorrect projector placement. Incorrect placement causes distortion (*Keystoning) within the projected image.

Screen and Sound.

Traditional 2D images are projected on a white screen with appropriate gain. These screens are used extensively throughout the industry; however stereoscopic images are projected on a silver screen. The silvered screen is used so as to preserve the angle of polarization. In this way, the image from the right picture is blocked out from the left eye but allowed to pass to the right and vice versa. Most stereoscopic projection does not work using a standard white screen although there is new technology on the horizon that boasts this capability but is somewhat expensive for theatre operators to consider without incentives.

You can view 2D content on a silver screen, but there is a color shift, in order for a viewing environment to display images the way a production designed them to be seen, the theatre would have to install two screens and ensuring suitable fly space to allow screen changes, one silver screen and the other white. The failure to provide fly space would most certainly mean the need for a permanently fixed silver screen with a roll down white screen which will add complexity and limitations to screenings.

The silver screen texture is extremely fragile which does not allow it to be folded or stored incorrectly. Even adding an electric roll down screen would create problems, not only with screen tension, but the constant rolling in and out would inevitably damage the sensitive screen surface. Therefore fly space for both screens would be a necessity to allow multi format projection use. With that statement goes along with the fact that simply rolling one screen over the other does not solve the problem; it in fact it creates many others.

Screen Perforations and Digital Projection

Screen perforations are another consideration to be aware of. There are several perforation types available, the most common being “micro-perf”. Screens are perforated to let the audio from the theatre speaker system through from behind the screen, but as you can imagine, anything that is perforated also lets light through. To merely put one screen behind another would cause light to reflect through the first screen, bounce from the second, back onto the first. Likewise audio would have to travel through two screens, which may cause screen vibration due to audio diffusion.

With analog film projection, the continuously changing grain pattern and movement of film through a projection gate is such that these perforations are not normally noticed, and in terms of stereoscopic images, they tend to be sufficiently random so as not to be a problem. With digital projection, however, there is no film grain or movement through a film gate; just a nice steady image. Therefore each pixel always lands at the same point on the screen producing a crisp clean image. This is not a problem with 2-D projection, but it’s a totally different story with 3-D, due to parallax differentiation, one pixel may land on a perforation, and not be seen, while the corresponding homologous stereoscopic pixel (representing the same point, or part of the stereo image in the other eye-view) may land in between. The result is a form of retinal rivalry that appears as a *moiré-like pattern. It is not a true moiré, but rather is simply differentiation between each eye-view that appears to be a "speckle" that moves as the image moves or the parallax changes. The brighter the image, the more noticeable this is.

Micro perforated screens reduce the effect, but do not entirely eliminate it.
There are some possible solutions which include using an un-perforated screen and sourcing the sound differently. However this may possibly result in audio mismatching, equalization problems and possible THX non compliance.

Screen Replacement:

Easy access to change out the screen. (For example A 50’ screen will be delivered in a 52’ box, on a 54” roll. The diameter of the roll will be approximately 24”) Allowing access to change out a screen is a much needed commodity and is often disregarded at the design phase. A simple (lockable) external access panel should be installed, but should also not interfere with the audio characteristics of the theatre.

Masking:

In the event of a two screen scenario, the masking would have to be extended to cover both screens, which would create shadowing problems; alternatively a separate masking system would have to be used. In addition, a separate mask would have to sandwich between the two screens to eliminate rear screen projection reflection. Audio equalization would also need two settings, as the audio would have to travel through two sets of screens if one were to merely cover the other.

THX Dolby Surround and Acoustics:

The acoustical characteristics of any theatre are particularly important considerations, including audience-absorption. Speaker placement, rear fill in speakers etc must be addressed during the design phase. An acoustician would take into account the sound heard in a completely filled auditorium versus the sound heard in a nearly empty auditorium, they both have dramatically different sounds. An empty theatre normally produces a very live and reflective sound, whereas a full theatre produces a muffled and diffused type of sound.
Filling an auditorium with people can reduce reverberance considerably. Choice of seating upholstery as well as wall-ceiling-floor treatment can reduce this difference considerably.

Surround sound during a 3D stereoscopic presentation is far more dramatic than sound in a 2D screening. Having sound follow a 3D object brings theatre audio into a new realm. For instance, if the image of an object appearing to come off of the screen is followed in a silent film, or unrelated sound film, there will be a point at which the eyes will no longer "track" and the images will appear to "split apart". If, however, a sound track is designed to "move the apparent sound

source" from the screen position to the rear of the theater in sync with the picture, the eyes will accommodate a much wider parallax, and the object may appear to come much closer before the images seem to split.

Balcony seating:
Balcony seating also creates many audio problems such as echoing, along with projection angle and light problems. Rarely are balconies installed in modern day theatres and possibly balcony seating should be avoided altogether.

Uni-Booth:
Any new facility that will house three theatres or more should incorporate a uni-booth structure, along with a projector rail system. This is a strong recommendation for many reasons.

1. Shared “minimal” equipment between three theatres.
2. Shared equipment redundancy in case one breaks down.
3. Single person operation.
4. Easy to run 3 theatres with the same image on the screen.
5. Cheaper to construct, less fibre and network connectivity needed.
6. Cheaper to operate with resources, HVAC and so on.
7. One elevator both ADA and service needs could serve 3 booths. This would be a huge cost saving.

Theatre booth minimal requirements
Power – 208 V 3-phase 40 amps

1. HVAC
2. Digital Projectors
    a) 2k and/or 4k
3. REAL D Z screen
    a) 75” from wall to rear of projector
    a) REAL D Z screen and Controller – Z screen mounts on front of projector, the controller mounts in 1 rack unit in the base of the projector.
4. 2 x 35mm projectors
    a) Interlocked and a rail system to allow use between theatres.
    b) Minimum 12 inches from front of lens to port glass (15 inches preferred)
5. View Port and Projection Port.
    a) Single large projection and view Port. This must be designed correctly; a single long piece of glass has issues too. The normal thing to do is to have a small port glass with a viewing window next to it.
    b) The sole reason being to eliminate booth light from escaping into the auditorium. A large single wall of glass would not give you that option, therefore low lighting booth configuration and design should be thought of sooner rather than later.
6. Port Glass
    a) Water clear glass
    b) 97% transmission across the spectrum, from 425 to 650
    c) Reflection off either surface of no more than 2% at any single frequency in that same range.
    d) 6 mm thickness
    e) Tempered glass or polarized glass is not acceptable. Abrisa is the preferred glass
7. Exhaust
    a) Minimal 600cfm with 8” duct
8. Entrance
    a) Under no circumstances should the entrance to the booth be located in the auditorium. The Projectionist must be able to gain access unobtrusively at all times.
9. Server
10. Latest SMPTE DV 28:40 spec; DCI compliant.

Other
Safety equipment and design considerations
    a) OSHA compliance regulations

b) Local codes and authorities compliance
c) ADA compliance

3D Viewing Glasses

a) Cleaning & sterilizing or disposal
b) Dispensing and collection container system
c) Clip-on type for prescription eyeglass wearing patrons.

Additional conduit runs to future proof the facility.

CONCLUSION

Motion pictures are a unique part history and our way of life. They can be very emotional, make us laugh, make us cry, we can cheer for the underdog and sneer at the adversary. They can be about the past, present, future or fantasy; there are no limits or exceptions when portraying a story. There is no other form of media that can grab the attention of millions the way the cinematic experience is able to do. Yet the motion picture industry is a story in itself that continues to improve with age. However in order for studios to continue creating first class entertainment, it's imperative that we learn from the past and explore new technologies to ultimately improve the cinematic experience. In order to do that, we must think ahead, explore both new and old avenues, embrace technology and be prepared to accept challenges and overcome failures.

ACKNOWLEDGMENTS

I would like to thank the following people for their helpful informative input and communications. Without such, my research would have taken innumerable man hours.
John A. Rupkalvis, StereoScope International.
Captain 3D, Phil McNally
Dennis Pacelli: Harkness Screens. D.Pacelli@harkness-screens.com
Howard Lukk. Walt Disney, New Technology.

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[9] Rod Archer: RealD. Cinema Installation Requirements. 5335 Sterling Drive, Suite B, Boulder, CO 80301.