VIDEO & MULTIMEDIA PROJECTION

The science behind a professionally designed theater system.

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A common shared experience is going to the movies, it is easy to imagine that giant screen that, vibrant bright picture, that full rich sound. We like the experience so much many of us try to recreate the environment at home with large screen televisions and home theater sound systems. We have the same expectations of the experience in large and small venues, we even expect it in our home computer systems, large screens or now LCD screens and stereo speakers and high end audio cards. It is even possible to have a DVD player and surround sound. A 5 speaker system on a computer might not be that common, but, most home computers have stereo speakers and many add a subwoofer (3 speakers). When we see a projected image we have expectations about the quality of the experience. We expect the same vibrant bright picture we see on our televisions and in the movie theatre. When choosing to project an image for any contemporary audience we should try to meet those same expectations or we will face the disappointment and wandering attention of the viewers.

In movie theaters and many board rooms the room lighting is totally controlled:

- There are no windows
- In movie theaters the double sets of doors are usually separated by a hallway
- In movie theaters the walls are usually draped with a dark fabric
- The only uncontrolled light comes from the glow of the mandatory exit signs.

For the rest of the venues it is never that ideal. In most cases there is some uncontrollable ambient light, in many cases there is light shinning on the screen and sometimes, there is even (shudder) sunlight.

The source, the amount and the type of ambient light all have a direct relationship with the amount of lumens that is required from the projector.

- If the source of the ambient light is general illumination it is easier to over come than if it is focused light, especiallyif it spills on the screen.
- Since we visually define objects through the boundaries of light to dark or color to color contrast, the brighter the room the brighter the projector needs to be.
- The source type of light will also have a great affect on contrast, sunlight has a higher color temperature (5600 Kelvin) than incandescent room light (3200 Kelvin). Therefore it will require many more lumens to combat sunlight than room light.

All of these considerations will determine the size and therefore the cost of the projector. The more control over the room light, the darker the room, the less lumens required.

THE PROJECTOR

How do we know what type of system is required to recreate the experience and what are the considerations (budget aside)?

Several of the most important considerations are:

• The size of the venue (viewing distance and viewing angles)

• Placement of the screen

• The degree to which you can control the ambient light (how dark you can or want to make the room)

These factors will help determine what type of system is required.

The most common image creating technologies are:

LED (LIGHT EMITTING DIODE) is used for brightly lit spaces, such as very large or outdoor venues. LEDs are what is used in the animated signage on the Las Vegas Strip and are currently in the million dollar plus range to achieve VGA resolutions. Resolution measures the amount of detail that can be seen in an image. For computers, resolution is expressed in the number of pixels down and across the screen (VGA), and it's important that your projector be capable of matching the resolution of your computer system. VGA requires 640 x 480 resolution, S-VGA 800 x 600, X-VGA 1024 x 768 etc.. LEDs or LED clusters act in the same way the pixel does in the CRT (Cathode Ray Tube). The resolution is dependant on the number of LEDs or clusters.

• Very bright LEDs in 3 colors of red, green and blue, the primary colors of light, are mixed to create all colors. Light is the subtractive color system. When the primary colors are mixed with equal intensity, white light is created. So, white light is the presence of all color. Yellow is a primary pigment color. In the additive color system, when yellow, red and blue are mixed in equal intensity, black pigment is created. So, black pigment is the absence of all color. LEDs are better suited to very large screens (18 foot diagonal and larger) because the cluster of three LEDs are large (three quarters of an inch or so) and the screens need to be large in order to have 307,200 of them to produce a 640 X 480 VGA image.

• Very bright, color changing LEDs have the advantage of being one third the size of the clustered LEDs because the color is mixed in the single LED. Naturally they are more expensive and still require 307,200 LED's.

FILM PROJECTORS, as in the movies, are in the quarter million dollar range. They are:

• Very bright; the ultimate in resolution; and create intense color saturation. Film sets the standard for our expectations

• Film is expensive, time intensive and difficult to justify in this digital image age. The Star Wars Movie, "Attack Of The Clones" was filmed digitally and was shown in its digital version at many new digital theaters. It was only put on film in post production.

CRT, LCD AND DLP for projected multimedia (from several thousand to several hundred thousand dollars)

• **CRT (CATHODE RAY TUBE)** A vacuum tube used as a display screen in a video terminal or television. Three (red, green and blue) small image CRTs which are very bright are focused through lenses producing a bright image on the screen. The CRT has pretty much been replaced by the LCD or DLP in all but very large projectors.

• **LCD (LIQUID CRYSTAL DISPLAY)** A display technology that uses rod-shaped molecules (liquid crystals) that flow like liquid and bend light. Unenergized, the crystals direct light through two polarizing filters, allowing a natural background color to show. When energized, they redirect the light to be absorbed in one of the polarizers, causing the dark appearance of crossed polarizers to show. The more the molecules are twisted, the better the contrast and viewing angle.

• **DLP (DIGITAL LIGHT PROCESSING)** A data projection technology from Texas Instruments that produces clear, readable images on screens in lit rooms.

DLP is suitable for all ends of the projection spectrum, from units that weigh under 10 pounds to electronic cinema projectors that are expected to replace large-screen movie projectors some day. The technology uses a Digital Micromirror Device (DMD), a chip with from 400,000 to more than two million light switches that cancel or reflect light. Microelectromechanical mirrors, each 16 micrometers square, are built on top of a CMOS memory chip. Bright but tends to be high in contrast.

CRT VS. LCD PROJECTORS

LCD projectors are more popular in general because LCD units offer major advantages in cost, size, weight, serviceability and brightness, while still providing very good images. However, CRT projectors can provide better results if you project video, because they offer better color and grayscale accuracy. CRTs offer a much better range of brightness from highlights to shadows. This is the reason they appear to be brighter than their specifications suggest.

Most installations today are LCD or DLP projectors which are in the under $20,000 range and their prices are dropping with each new model year.

DLP VS. LCD PROJECTORS

LCD projectors have better color dynamics and produce a much better gray scale (low contrast) You can figure that an LCD projector will have a comparable image to a DLP with about 20% more ANSI lumens. However, except in a side by side comparison, you are not likely to notice a difference of only 20% in brightness so both images will appear similar, except generally the DLP will have higher contrast.

• ANSI, (American National Standards Institute) in New York, is a membership organization founded in 1918 that coordinates the development of U.S. voluntary national standards in both the private and public sectors.

• Lumen is a unit of measurement of the flow (rate of emission) of light. A wax candle generates about 13 lumens; a 100 watt bulb generates 1,200 lumens.

The primary method of measuring the light output (ANSI lumens) of projectors is to take an average of several measurements taken across the face of the light source.

The size of the image, the program material and the amount of ambient light greatly affect how many ANSI Lumens are required to achieve the expected experience. If the program material is mostly multimedia (Powerpoint etc.) with some video, a rule of thumb would be:

• Under 1,000 lumens can do a decent job on a small screen (up to 84" diagonal) in a moderately lit boardroom.

• 1,000 to 2,000 lumens will handle a large screen (100" to 200"diagonal) in a dimly lit under 600 seat auditorium.

• 2,000 to 3,000 lumens can do a good job on almost any small screen and can handle that auditorium with low lighting (able to read a newspaper).

• 3,000 to 4,000 lumens is over kill on a small screen and can handle almost anything short of sunlight on a moderate screen and can do justice to a large size screen (180" diagonal screen) under moderate lighting (read a paperback) in up to a 1,000 seat auditorium.

However, showing videos, where there may be dark scenes and low contrast, you will need up to 4 times the lumens. That is why movie theaters are almost pitch dark and have dark walls and big bright projectors.

Another factor in choosing a projector is contrast ratio, which measures the difference between the brightest white and darkest black your projector can produce (expressed as 100:1 or 300:1, etc.). This ratio is only relevant to multimedia program material displaying high contrast images. Video and low contrast program material will require the grays in between and this is not expressed in the ratio. Here is a simple way to visualize these issues. Turn on your television and turn the contrast all the way up, then turn the brightness up (more lumens) and down (less lumens):

• observe how much detail you see.

• note that turning the brightness up does not improve the detail. So, as you can see, brightness (number of lumens) is not the only important issue when selecting a projector.

Beside contrast and brightness, some of the other important issues are:

• **COLOR ACCURACY**. Besides the number of colors, how well does the unit handle subtle color renditions, such as flesh tones?

• **SHARPNESS**. How clean and sharp are photos or videos, how crisp are the images?

• **EVEN ILLUMINATION**. Does the image have hot spots or a clean, even brightness from corner to corner? Is the focus consistent from center to corner?

• **RESOLUTION**. How big the images appear in relation to the size of the screen. The desired resolution is dependant on how far the furthest viewer is from the screen. The higher the resolution, the smaller the image on the screen. For most large venues, 800 x 600 resolution will probably be the highest resolution that will produce an image that is readable from the back of the auditorium.

• **RELIABILITY**. Will the projector work through a critical presentation? Does its manufacturer have a good reputation? Does it use a long-life lamp? What's the warranty? Is it UL listed?

• **SERVICEABILITY**. How long will you have to do without your projector if it breaks? Will your dealer stand behind you if you need it for a critical meeting?

• **FEATURES.** What are the important features? That will depend on how you use the projector. Some of the more useful features are:

• **A direct digital video input** (when used with a computer with a digital video output), will increase the quality of your projected image by eliminating the need to convert a digital RGB signal to the analog RGB, accepted by most projectors and monitors.

• **A zoom lens** is useful if you can't control the exact placement of the projector or if it will be moved from one venue to another.

• **Keystone correction** or lens shift corrects rectangular distortion caused positioning the projector away from the center axis of the screen. Adjustable keystone correction is a real plus, though nearly all projectors have at least a fixed correction factor which allows you to position it below the center of the screen.

• **Inverted or rear projection** is determined by placement and orientation of the projector. If the projector will be hung upside down, then you will need to invert the image. Similarly, to project from the rear, you will have to flip or reverse the image.

• **Mouse control** operates your computer mouse through the projector. If this is not available on the projector, a remote mouse for the computer is an inexpensive solution to the problem.

• **Multiple inputs** allow you to switch between more than one computer and video source.

THE SCREEN

Fixed or retractable screens front or rear projection what are the trade offs?

• **Retractable screens** are convenient and they are less obvious and intrusive when retracted, but, there are several caveats which must be noted. Air movement will cause a hanging screen to flutter and or wave and this will subtly distort the image. Something moving in and out of focus (even subtly) can have the same effect as motion sickness. Tensioned retractable screens greatly reduce the flutter but are very expensive and the waving might still be a problem depending on how strong the air movement is.

• **Fixed screens** are usually mounted on the wall which makes them immobile and stable, and they are also much less expensive.

• **Front projection** is by far the most common mode, but, the projector must be mounted in front, in view of the audience. The projector may be able to be mounted in the back of the audience, but that will require a long throw lens which is expensive and wastes a lot of lumens.

• **Rear projection** usually requires space behind the screen, 15 to 25 feet depending on screen size and projector lens type. A front surface mirror can shorten that distance to 8 to 15 feet if necessary, but that will add to the cost. There should not be any ambient light behind the screen to compete with the projector and the projector must be able to rear project. However, rear projection will maximize the projector output as it is more impervious to ambient light issues and is less obvious to the audience.

WHAT KIND OF SURFACE?

Modern screens come in a plethora of surfaces. The usual trade off is viewing angle for gain:

• **Viewing angle** is the degrees from the center of the axis of the screen that the projected image is brightest to the audience. Viewing angles generally range from 25 to 50 degrees from center.

• **Gain** indicates Goniophotometer reflectance readings. The higher the number, the more lumens reflected to the audience. Typical gain readings are from .08 to 2.8.

In other words, the narrower the viewing angle, the brighter the image. So it is important to know what the viewing angle is for the outside seats in the venue in order to maximize the light from the projector that reaches the audience.

Other considerations are: Can the screen surface be cleaned; is it flame retardant; and, is it mildew resistant?

BEYOND THE SPECIFICATIONS:

There are some comparisons that are very difficult to make from a spec sheet (and, at times, the measurements or the methods on which the specifications are based, aren't accurate). All of the above variables and considerations can be quite confusing which is why most professional venues seek the advise of a consultant. In some cases, you might even want to have the projector demonstrated to make a decision.

To achieve the total experience and deliver your message, your audience must be able to see, hear and understand. The environment must be conducive for them to pay attention and focus, therefore, they must not be distracted by competing noises, inadequate sound or inadequate lighting.

RICK SHAW, CSI MULTIMEDIA

Founded in 1986, Campbell - Shaw, Inc. (CSI) is a California corporation and CSI Multimedia (CSI MM) is its division of Multimedia (sound, video, lighting and projection) Consultants, Designers, Dealers and Integrators. CSI MM specializes in consulting to churches and schools regarding the unique challenges associated with lighting, sound and projection systems in sanctuaries, gymnasiums and on athletic fields. Our specialty is taming difficult environments.