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WHITE PAPER

LIGHTING FOR LIVE STREAMS

Good Lighting Makes Better Video...Better Video Connects the Viewer

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CONTENTS

INTRODUCTION

Video cameras are everywhere, including in our pockets. Due to the vast expansion of television as a communication tool from over-the-air and cable broadcasting to streaming, teleconferencing, archiving, or inside-the-venue image magnification (IMAG) on large screens — we have become accustomed to the almost casual omni-presence of cameras that beam an image to the room, down the street or around the world.

There was a time that a TV camera would be found only in the most elaborately planned and professional broadcast productions. The availability of consumer video cameras, with their greater light sensitivity, made everyone who could afford one their own producer. The phone camera took it a step further and made everyone a documentarian of everyday life or the director of their own show, via their own personal network. That phenomenon, alone, has immeasurably advanced the communications of marketing, entertainment, and the basic dissemination of infinite topics. Anyone can now add the advantages of the **visual** to the **audio** to heighten the effective delivery of the message. Just look at the popularity of cell phone and internet video chats. A mere phone call suddenly feels one step less personal.

Streaming video is often the very best solution to reach an audience — even a local one that is otherwise unable to congregate in person.

Note: This paper will use the terms television, TV, broadcast, streaming, webcast and video. Although each word has its own meaning and connotation, for the purposes of this document, they will refer to the art and craft of capturing live presentations on-camera for transmission to viewers on any of the many devices available, from the humble television set to the amazing screen on the modern mobile phone.

UNDERSTANDING THE CHALLENGES

The comparative affordability and ease with which we can now aim a camera at a corporate executive, a boardroom meeting, an inspirational speaker, or an orchestra, rock band or school recital, yields significant benefits. With this simplicity, though, has come a reduction in image quality due to underestimating what is necessary to create pleasing pictures. The video camera has inherent limitations compared to the eye — particularly concerning light and how the camera handles brightness and color. This is the scientific, mathematical aspect. There is another, less tangible piece of the puzzle: the aesthetic. It takes more than math to make a television picture appear pleasing to the viewer — whether consciously or subliminally.

BASIC PRINCIPLES OF LIGHTING FOR THE CAMERA

Intensity and Balance

There is no camera as good as the human eye. The eye has the ability to make subtle adjustments, in coordination with the brain, to smooth out differences in brightness levels from one object to another. And more importantly, the eye has a very broad span of bright-to-dark perception. This is referred to as dynamic range. For example, if there are two people in the eye's field of vision, one in direct, clear sunlight and the other in the shade, the eye is capable of registering both with a high-quality picture to the brain. Certainly, one appears brighter than the other, but, to a reasonable point, both are seen clearly and with visible detail.

Conversely, the camera is just a recording device that outputs a more literal rendition of what it sees. It has a comparatively limited dynamic range and cannot simultaneously process two objects of greatly varying brightness levels as adeptly as the eye. The camera, unlike the eye, is set by the operator or engineer to look best for only one specific brightness. A small range above or below that level will still retain image quality, but compromises become evident outside that range.

If the camera is set to make a bright object look good on the monitor, a dark object that is also in the same camera shot may fall off into a black shadow with no discernable detail. If the camera is adjusted for the dark object, the bright one may appear totally overexposed, or blown out as a super-white blob with a dramatic loss of detail. And if the camera is set in the middle between them, then both objects may look sub-standard.

Some cameras have a wider dynamic range than others, allowing for a greater spread between dark and light. However, the standard operating procedure for good broadcast lighting is to carefully adjust levels to maintain a more limited range between the brightest and darkest elements. The best lighting exhibits balance from person to person, and between foreground to background elements. How this is accomplished is the art of creating pleasing pictures that don't look flat and uninteresting, but still retain dimension and interest to the viewer. This makes all the difference to the resulting on-screen picture, whether the show is a sermon or a full concert.

Finally, onstage video screens, projections and video monitors must be carefully balanced to coexist visually with the stage lighting.

LED screens and walls can be overly bright, requiring the stage lights to increase in intensity to match the screen so the camera shot appears balanced between screen and stage. LED screens also can be so bright as to add unwanted light and color to the stage, which the camera can pick up.

A **projection screen** may pose an opposite problem. In some cases, the projection appears under-powered compared to the stage lighting, which then must be dimmed to avoid overtaking the projection images.

A projection screen can also be affected by the stage light spilling onto the screen. Sometimes, just the ambient build-up of the bright stage lights is enough to compete with the projection, which may look washed out on-camera. Getting the lighting angles right is even more critical than usual when projection screens are present.

Monitors, based on model and type, can fall into either category of too bright or too dim, but also have an additional challenge to be aware of. Monitors often generate their picture at a refresh rate that is not matched to the frame rate of the camera. The monitor will then show lines or wavy, moving patterns when it is seen on-camera.

Screens and projectors can be adjusted in brightness, to a point. Regardless, this is a consideration that must be part of the overall planning in order to achieve the best-balanced picture.

Color and Color Temperature

One cannot discuss lighting for video without a rudimentary understanding of how the camera processes color.

The human eye perceives the colors in the visible spectrum, the brain processes them, and instinctively and continuously adapts to wide variations in hue.

The camera, in comparison, has a setting choice that regulates how it perceives color. This is referred to as the camera's "white balance", but it is based on a scientific concept called color temperature, which is a method of describing the appearance of a color in the visible light spectrum, measured by units on the Kelvin (K) scale. Contrary to standard logic, Kelvin temperatures are based on warmer looking colors being at the lower end of the scale (1000–4900K), and cooler colors at the higher temperature designations (5000–10,000K). A good image to visualize this is a metal rod heated in a fire. It goes from red hot when it begins to glow, all the way to blue-white hot at its maximum.

The principal use of color temperature is to establish white for the camera. White light can be quite warm and amber at one end of the scale (candle light, for instance) to very cool and blue at the other (cloudy sky). The two primary options for how a camera processes white are "tungsten" or "daylight" color temperatures, plus a few intermediate choices. An example of tungsten white is the common incandescent light bulb. Its source has a more amber looking white to it. Daylight, despite the impression that the sun produces yellowish light, actually refers to the bluer mid-day white such as a welding arc produces.

The color of the light must match the color temperature to which the camera is set. If it doesn't, the image, especially skin-tones, will look unnatural, which is distracting and unpleasant at the very least.

For example, if the camera is set to see colors in the tungsten range and the subject is being lit in daylight or with a daylight lighting source, the resulting image will look blue. If the camera is set for daylight and the subject is lit with a tungsten source, the picture will be extremely orange on-camera.

TUNGSTEN CAMERA SETTING WITH **DAYLIGHT** LIGHTING = OVERLY **BLUE** ON-CAMERA

DAYLIGHT CAMERA SETTING WITH **TUNGSTEN** LIGHTING = OVERLY **ORANGE** ON-CAMERA

The decision to set the camera to see light at a particular color temperature depends on many factors. Natural daylight conditions, whether outdoors or through windows, would make the decision obvious: use the daylight setting. However, there are other reasons that could influence the decision. Certain lighting fixtures output only the tungsten color range. Others produce only daylight colors. Some are in the middle. All can be adjusted, or color corrected, with **internal color-changing mechanisms** or **colored LEDs** to be fine-tuned so they precisely match the desired color temperature.

The most important fixtures to color-match to the camera's settings are those that light people's faces, or **key lights**. Some productions include audience lighting in the design, which might also require matching to the camera settings. Other lights, for scenery or architectural toning, may use more saturated colors for creative or artistic reasons. However, even those colors must be chosen and adjusted with finesse or they can get into problematic territory and appear distorted or unnatural on-camera.

Video screens and monitors also affect the color temperature decision. LED walls, projection screens and video monitors natively output colors that are in the daylight range. They can be adjusted, but they are always closer to daylight than to tungsten. If screens appear in the camera shot, there is a much more compelling reason to opt for a daylight camera setting, which then necessitates a daylight-colored lighting plan.

A light's output may look good to the eye, but may render skin tones or colors of wardrobe and scenery inaccurately on-camera. Manufacturers, in conjunction with lighting research laboratories, have developed ratings systems used to express a fixture's ability to faithfully reproduce colors. Common standards that measure lighting color fidelity are the Television Lighting Consistency Index (TLCI), and TM-30. Based on these indexes, manufacturers test and report the color accuracy of their equipment in their specification literature. The best lights provide a means to adjust the color output to achieve the most pleasing and accurate on-camera color.

Aesthetics

When the physical and electronic requirements have been met, the next step is to use them to make the most pleasing picture. Aesthetics are the professional nuances that make so many ordinary things in life extraordinary. A house can be four walls and a ceiling to qualify as a shelter from the elements. A shirt can be just fabric with buttons. It's the style — the subtle and indefinable — that draws us in or drives us away, inducing us to pay attention or tune out.

Humans respond to faces in a primal way. Each member of the streaming audience has the advantage of virtually sitting in the front row, or closer, to the person who is on-screen. From that vantage point, the view is quite a bit different — almost like using binoculars at the opera. Flaws in lighting a face that are not visible from twenty feet away become obvious, exaggerated and magnified when seen in a close-up shot. The objective is to connect the viewer to the speaker or performer, which the close-up accomplishes. Therefore, the quality of lighting for this shot becomes critical to its success.

Essential Elements of Lighting Aesthetics

- Angle
- Shadow
- Dimensionality

…combined with the best application of…

- Intensity
- Balance
- Color

When lighting is optimized for the camera by using these elements, a live presentation can still retain a sense of theatricality, and won't be transformed into a sterile and bland, washed-out look. Well-designed lighting for streaming strives to work for the camera and also for any live spectators present at the event. If done correctly, the ultimate objective is achieved: making the viewer watching on a screen or in the room as receptive as possible to the message or performance.

A professional appearance becomes psychologically associated with the high standards of the presenter. This can translate into a competitive edge, or a more solid bond to the ideas or entertainment being presented.

EQUIPMENT CHOICES

Lighting fixtures are the paintbrushes and paint we use to create the picture. Each one has its purpose and application, and there are many varieties of fixture types that are appropriate to use.

Demystifying Hard Edge VS Soft Light

There is a common misconception that the only suitable lighting fixtures to be used for a broadcast or streamed webcast are the stereotypical large floodlights on stands or low-hanging pipes that are seen in depictions of movie shoots and news or interview programs. Not so! There are reasons those lights are commonly used on movie sets, but for a production that has a live entertainment or presentation aspect, it is certainly impractical and less effective to use those fixtures.

"Soft lights" are a type of fixture that spreads the illumination broadly and evenly. They are commonly used for photo shoots and filming where it is possible to position them close to the camera, just a few feet away from the subject. However, they create a lot of spill which must be controlled by a variety of methods. For the capture and streaming of a live event, they are generally not the ideal tool.

In comparison to these studio lights, well-engineered theatrical fixtures offer effective advantages. Many are compact in size, weigh less, have longer lamp life, and require less power — especially the advanced LED-based fixtures available today. The ability to throw their beam of light over longer distances keeps them overhead and out of sight. They also have the capability to easily control their spill and brightness. The quality of their light on talent is excellent and when properly angled and combined with other lights that enhance the subject's on-camera appearance, yield beautiful results.

LED Technology

We know LEDs are everywhere these days, in the home and in industry, and are now considered the standard for new fixture design. However, all LEDs and LED fixtures are not the same, and it is vitally important to know what to look for, especially regarding **color production, color matching,** and **flicker** problems.

LEDs are available for so many different products, from car interiors to factory lighting to theatrical fixtures. Each use puts different demands on the quality control of the LEDs themselves. The lighting of a factory space can allow for differences in color and intensity that are almost imperceptible to the eye. That translates into the use of less costly, but potentially unmatched, LEDs.

Theatrical fixture manufacturers are free to use the same LEDs in their lights as a manufacturer of overhead factory floodlights might use. But the camera can see those inconsistencies from fixture to fixture in a pronounced and bothersome way. The best LED-based theatrical fixtures are built with painstakingly matched LEDs to assure uniformity from one unit to another. This is especially important for fixtures that emit only one color, because the difference from one light to the next becomes obvious to the camera.

Many theatrical LED fixtures are capable of outputting a wide variety of colors from the same light. Depending on its intended use, a fixture might have LED arrays of three, four, five, or up to eight different base colors, that can be combined to achieve a complete range of different hues. The advantage gained by having a greater selection of base colors to work with is the ability to produce more fine-tuned colors, and the decision whether to use a three-, four-, five-, or eight-color fixture can then be determined by the specific job the light will do.

Aside from matching color from one fixture to another, there is the concern, discussed above, of accuracy in rendering colors on-camera so the actual color of an object reads correctly on the screen. This is a major concern when using LEDs, due to the science of how colors are mixed inside the fixture to create a variety of hues. A fixture with superior color manipulation and high-quality LEDs is more likely to assure faithful color rendering.

Finally, there is the very important issue of **flicker**. Cameras and LED fixtures often operate at different frame and refresh rates. These variances can result in an unwanted on-camera flicker. Many LED fixtures will appear to flicker quite visibly on-camera even though the issue is not at all detectable to the naked eye. This means that not only does the light source itself appear to flicker if seen on-camera, but also whatever surface is being lit. The best lights are engineered to avoid flicker or include refresh rate adjustments to eliminate the flicker.

Fixtures

The lighting industry has been busy incorporating advances in technology, and cultural taste, to create a cornucopia of fixtures that solve an assortment of lighting challenges. Below is a breakdown of the most common fixture types and features available.

Types

- "Profile", or sharp-edge beam, with the ability to adjust to soften the appearance of the edge.
- "Wash light", with a soft-edge beam. This beam edge cannot sharpen.
- "Striplight" or "batten" fixture. Linear form-factor for scenic toning and effects.
- "Eye candy" fixtures, whose sources are directed at the viewer for an overall enhanced visual effect or as a scenic element.
- Creative LED elements. Fixtures that add dynamic and innovative backgrounds, primarily driven by video.

Features

- Stationary: fixed focus, non-moving
- Single color: with the option to use gel to alter or adjust the color
- Multiple color output: changes color with internal glass filters or multiple, colored LEDs
- Zoom: from wide beam to narrow beam
- Moving lights that remotely:
    - Pan and tilt to refocus
    - Shape the beam with straight edge shutters or round irises, or both
    - Change color
    - Zoom
- Add effects, such as patterns, to the beam of light

CONTROL

Every location will have unique lighting requirements to complement the size and complexity of its events and presentations. The type of lighting control equipment needed should, therefore, match the technology of the fixtures.

Lights that have multiple functions— brightness (intensity), color, zoom, and movement — will require a more full-featured controller. At the other end of the spectrum are smaller installations using fixtures that have adjustment controls on the light, itself. Once those are set, the fixture can be powered on and returned to those presets by a wall switch or circuit breaker.

THE APPROACH TO MAKING IT WORK

Each production has different goals and circumstances. Good lighting makes better video, and better video connects the viewer. Requirements and solutions should, ideally, be customized for specific needs, determined by the physical parameters of the venue, the types of events or presentations taking place, and of course, the budget.

Evaluation Checklist

A venue owner or manager might use the following breakdown as an initial guide in developing an action plan to update or upgrade the existing lighting package. This represents a preliminary analysis that can be expanded upon to formulate next steps. The advice of a consultant who specializes in lighting design for streamed events would be a worthwhile investment to work hand-in-hand with the equipment sales representative.

Streaming Evaluation Checklist

Venue description

- Type of building or space
  - Theater, nightclub, house of worship, conference room, etc.
- Dimensions
  - Overall length and width
  - Ceiling height above main floor
  - Stage or presentation area
    - Length, width, height above main floor
- Existing overhead lighting positions
  - Pipes, truss, Unistrut channel, etc.
- Power
  - Adequate for existing setup
  - Sufficient for additional equipment
  - Existing circuits and/or cable for running power and control signal to lights
- Ceiling
  - Open beam
  - Drop ceiling
  - Riggable points
- Lighting equipment currently in use or in storage
  - Fixtures, follow spots
  - Video products onstage
    - LED screens
    - Projection screens
    - TV monitors
  - Control
    - Console/lighting board
    - Architectural wall panel
    - Switches or circuit breakers
  - Video cameras currently in use or planned for future

Presentations/events

- Type, genre, style
- Number of people onstage or on-camera
- Background elements: scenery, backdrops, audience
- Need to alter lighting setup or focus for different events

Goals and expectations

- What "works" now? What doesn't?
- What is the ultimate objective to be accomplished, if known?

LAST THOUGHTS...

Why does lighting that is enhanced for the camera matter?

Advances in video technology and transmission have expanded the reach of entertainment, worship and business communications to make streaming a relatively easy option. Viewer numbers increase and previously inaccessible customers become accessible.

The difference between well-crafted lighting for the video camera and "as is" stage or room lighting may not be understood on a conscious level by viewers, but their intuitive response can be sharpened, or blurred, by the power of pleasing visuals that enhance the message.

We have entered an age where a presentation is preserved for some version of eternity, to be paused, replayed, and shared. This raises the stakes and makes an improved lighting approach more compelling than ever.

And it's attainable.

Attention to the basics — heightened aesthetics, a well-designed lighting plan, and quality equipment — help the message reach its target…with impact.

ABOUT THE AUTHORS

Jeff Ravitz specializes in live entertainment and events being captured for broadcast and streaming. Well-known for years as Bruce Springsteen's lighting designer, Jeff has enjoyed a career full of variety and challenging projects of all sizes, budgets, celebrity, and sectors of lighting design, including live, televised and webcast concerts, stand-up comedy specials, Olympic ceremonies, Super Bowl halftimes, game shows, talk shows, and specialty scenes in feature films, as well as the design of permanent lighting system installations.

Jeff was named the Parnelli "Lighting Designer of the Year" and was honored with the Primetime Emmy® Award for lighting design. He is a founding partner of design firm Intensity Advisors, LLC.

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ORCID

Mike Baldassari is a Tony® and Emmy® nominated Lighting Designer whose work has been seen live in 25+ countries. In addition to designing a number of Broadway musicals and plays, such as *Cabaret* and *Children of a Lesser God*, he has bridged theatrical lighting into films such as *Ghostbusters*, *Nine*, *Rock of Ages*, *Joyful Noise*, and *Neil Young Trunk Show*, among others.

His television designs range from *Saturday Night Live* parodies and episodes of *Documentary Now!* to David Letterman's *My Next Guest Needs No Introduction* as well as many stand-up specials for Netflix and Comedy Central. Concert tours have included artists as diverse as Neil Young and Alice in Chains and some of his televised concerts include Mary J. Blige, Tim McGraw and Garth Brooks.

mike-o-matic.com

Greg Scott's love of lighting has driven his multi-faceted career of 30+ years in concert touring, theater, corporate, television, architainment, and countless unique projects. His work for camera includes televised events for the NFL, MTV, VH1, Discovery Channel, feature film projects and music videos. Greg has supported corporate as well as gaming events both live and streamed worldwide. His clients include Microsoft, Starbucks, Novartis, EA Sports, Amazon, Nintendo, and Xbox. Greg is a member of the IES and an Affiliate of the IALD.

He has enjoyed a variety of projects throughout his career but remains passionate about working with musical artists which have included BB King, Soundgarden, Bon Jovi, Yes, Van Halen, Queensryche and The Who.

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ABOUT MARTIN BY HARMAN

As a world leader in the creation of dynamic lighting solutions for the entertainment, architectural, and commercial sectors, Martin lighting and video systems are renowned the world over. Martin also offers a complete line of smoke machines as a complement to intelligent lighting. Martin operates the industry's most complete and capable distributor network with local partners in nearly 100 countries. Founded in 1987 in Aarhus, Denmark, Martin is the lighting division of HARMAN International Industries.

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