PROJECTION POINTERS BY JOHN P. PYTLAK OF EASTMAN KODAK COMPANY.

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1. Shedding Light on Screen Luminance Meters

To Measure Light, You Need a Photometer

Standard ANSI/SMPTE 196M "Screen Luminance and Viewing Conditions" specifies the "Photometer type" as follows: "Screen luminance shall be measured with a spot photometer having the spectral luminance response of the standard observer (photopic vision) as defined in CIE S002. The acceptance angle of the photometer shall be 2° or less. The photometer response to the alternation of light and dark on the screen shall be to integrate over the range of 24 Hz to 72 Hz and display the arithmetic mean value."

Can You Please Translate That?

Simply put, the meter should "see" the light reflected by the screen as the human eye does. Some meters have photocells that are more sensitive to invisible infrared energy, and may give incorrect measurement of visible light. Meters designed specifically to measure screen luminance use special sensors and filters to have a "photopic" response just like the human eye. Second, the photometer used to measure screen luminance in a theatre should measure light reflected from a small area of the screen, no more that two degrees in viewing angle. For example, if you take measurements 60 feet from a screen 20 feet high, a meter with a two degree acceptance angle "sees" an area on the screen only about two feet in diameter. Having a relatively narrow viewing angle allows the user to measure luminance in various parts of the screen, to evaluate the uniformity of illumination across the screen. Since screen luminance is measured "open gate" with the projector running, the light on the screen is actually going off and on 48 or 72 times per second. At the normal 24 frames per second, a two- blade shutter gives 48 interruptions of light every second. A three-blade shutter gives 72 interruptions. A meter used for measuring screen luminance needs to be properly calibrated for the alternating light/dark cycle of a projector.

Professional Screen Luminance Photometers

Several photometers are designed and calibrated specifically for measuring screen luminance in theatres. They are available through theatre equipment suppliers, professional photography dealers, or from the manufacturers.

Minolta Model LS-100 Luminance Meter

This digital meter is available from Minolta is sensitive enough to measure luminance as low as 0.001 footlambert. It can be used to measure screen contrast ratio (black luminance) and stray light as well as screen luminance. Earlier models of Minolta screen luminance meters may also be available on the

used equipment market. Additional information is available at www.minoltausa.com. Click on the menu items for "Business," then go to "Color/Light Measurement," "Light Meters" and "LS-100."

SpectraCine CineSpot Model SC-600

The SpectraCine CineSpot One Degree Spotmeter Model SC-600 is popular with many theatre technicians. Complete product information is at: www.spectracine.com/Product_3.html

UltraStereo Labs PSA-200

Projection System Analyzer This unique technology for measuring screen luminance uses a CCD camera and laptop computer to display luminance measurements simultaneously for 45 areas on the screen. Other measurements and diagnostic graphs are also available. The PSA-200 is especially useful when aligning a lamphouse for uniform illumination, as the CCD camera can be set up in the theatre auditorium while the laptop computer display can be located next to the projector while the technician makes adjustments. Information can be found at the UltraStereo Labs website at: www.uslinc.com/products/features/psa200.htm.

For an article about the design and use of the Projection System Analyze, go to: www.uslinc.com/forum/smpte97.htm

Other Meters

Luminance meters (or spotmeters) designed for general photographic use can also be used to measure screen luminance. These meters may not have the specified spectral response, or may be "fooled" by the shutter interruptions, so they need to be calibrated against a known "standard" screen luminance meter. As long as the measuring conditions remain constant (same color of light, same type of projector shutter), the calibration should be valid. For example, the Sekonic L-508 Cine Zoom Master can be used as a screen luminance meter if properly calibrated. Information on this meter is at: www.sekonic.com/Products/L-508c.html Other photographic spotmeters made by Pentax, Minolta, or other manufacturers may also be suitable, as long as they are calibrated against a standard screen luminance meter for footlamberts or candelas/metre?

Unsuitable Meters

Incident light meters are NOT useful in measuring screen luminance, since they can only measure light falling on the screen (footcandles), and not the light reflected back to the audience. Incident light readings do not take screen gain or curvature into account, and are not a good indicator of screen luminance. Reflected light meters used for general photography usually measure a much broader area than two degrees, and often are not precise enough to measure slight changes in light level. For example, many photometers are only calibrated in Exposure Value (EV) increments equivalent to one full photographic stop, so they can barely discern the difference between eight and 16 footlamberts. Even a meter calibrated in 1/3 EV increments is not able to accurately measure the difference between 12 and 16 footlamberts. The meters built into cameras for exposure control are likewise not precise enough to sense small differences in screen luminance. In most cases, they also measure an area that is too large, and may not have the proper spectral sensitivity.

Need for Periodic Calibration

Regardless of the meter used, periodic calibration is necessary to ensure accurate measurements. Calibration services are usually available from the companies supplying the meter (e.g., www.spectracine.com/repair.html).

Obtaining Copies of SMPTE Standards

Copies of standard ANSI/SMPTE 196M "Screen Luminance and Viewing Conditions" are available from the SMPTE, 595 West Hartsdale Avenue, White Plains, NY 10607, Telephone: (914) 761-1100. Standards and test films can be ordered at the SMPTE website:
www.smpte.org/smpte_store/standards/

For more information, contact me at john.pytlak@kodak.com

2. Let There Be Light

Screen brightness is an objective measure of how much light is reflected from the screen to the audience. SMPTE Standard 1 96M specifies that it be measured with the projector in normal operation, but with no film in the aperture. Measurements are made using a spot photometer having the same spectral sensitivity as the human eye. Good meters meeting these requirements cost a few thousand dollars. Measurements should be made from several locations, since not everyone sits in the center seat. Although the standard specifies a screen luminance of 1G +/ 2 footlamberts (55 +/ 7 cd/m2) for review rooms (where the desired color and density of prints are decided by the director, cinematographer and film laboratory), it allows a range of 12 to 22 footlamberts (41 to 75 cd/m2) for theatres. Most people only remember the nominal aim of 16 fL. The image should be uniformly bright across the screen, without any "hot spots" or dark areas. The screen sides should be 75 to 90 percent of the screen center luminance, but not less than 10 fL (34 cd/m2).

Is Screen Luminance Level Important?

To understand why screen luminance is important, we need to understand human vision. During the daylight, our vision is fully functional so colors appear brighter, and we see with maximum sharpness. In dim light, colors appear desaturated, and we may have problems seeing detail. At intermediate levels of light, we may see color and detail, but not with the same vividness. Theatre screens fall into this intermediate level, where a small increase in luminance can make a big improvement in color perception and visual acuity.

Is Brighter Better?

To demonstrate the effect of screen luminance on image quality, we made two identical prints, color timed at the laboratory screening room standard of 16 fL. We included a variety of scenes having highlights, shadows, fleshtones, bright and pastel colors, and good sharpness. The matched prints were projected side-by-side on identical projectors, one at 12 footlamberts, and the other at 22 footlamberts.

The print projected at 22 fL had greater tonal range, sparkling highlights, more detail in the shadows, livelier and more natural flesh tones, brighter colors, and appeared sharper. There was slightly more shutter flicker in the very bright scenes, and underexposed scenes had lighter blacks. But almost all audience members preferred the brighter projector. In their minds, "brighter IS better." At higher screen luminance, most scenes will look better, but the colors may be brighter or the shadow detail more visible than when the director and cinematographer viewed it. But at lower screen luminance, the audience will always be shortchanged. Dim pictures look dull and lifeless, and never match what the director wanted.

Today's Situation

Recent surveys have shown that the vast majority of theatres are too low in screen luminance. Data reported by the Lucasfilm Theatre Alignment Program (TAP) showed the average screen luminance in first-run theatres to be about 11 fIL. A Kodak survey of theatres in one major city found first-run theatres with screen luminance as low as 7 fL in the center, and less than 5 at the edges. The Kodak survey also found multiple causes for the below-standard luminance, including inadequate lamp power, improper lamp alignment, dirty or improperly installed screens, etc. In most cases, theatres were unaware of how dim their pictures actually were, since they didn't have a spot meter, and had the luminance measured infrequently. Sometimes, the problem was misinformation. For example, many theatre managers believe you save money by running a xenon bulb below its rated

current. In reality, although this may save a little electricity, it may actually shorten the life of the very expensive bulb. If the quartz envelope of the bulb runs too cool, deposits will form, blackening the bulb. Some managers say, "My multiplex doesn't need a light meter to check screen luminance and light distribution—that's done once a year by our service engineer, and adjustments are made then to bring us back into specification." The reality is that screen luminance changes as bulbs age and screens get dirty and any time you change or rotate a bulb. The only way to be sure your screen luminance is correct is to measure it with a meter periodically, and whenever anything is changed. Although a proper screen luminance meter is expensive, it is a wise investment that can be prorated over multiple screens and many years of use.

The Future

Kodak is working on ways to help theatres improve screen luminance. Kodak print film is very resistant to heat damage and dye migration caused by excessive radiant energy, so that with proper alignment and heat filtration, even a 7000-watt bulb can be used. We continue to encourage the use of 70mm prints to fill the huge screens that can entertain over 500 people at a showing. Someday, it may be possible to consider a higher aim for screen luminance, and the quality improvement that it would bring. For now, we need to do all we can to have all theatres meet the existing SMPTE standard, so that dim pictures are a faded memory.

For more information, contact me at john.pytlak@kodak.com

3. Don't be in the Dark about Measuring Screen Luminance

What's Your Screen Luminance?

If you ask most projectionists or theatre managers whether their screens have the proper screen luminance, they'll reply that they are "on standard" or "it looks okay," and quickly try to change the subject. When you ask what "on standard" is, they usually answer with a question "Isn't the standard 16 foot - something's or other?" and sheepishly add "maybe we're a bit low on a few of the screens," as they furtively look to see if you have a meter to measure it. Boldly asking when the screens were last measured, the reply might be, "When the service technician was here last summer," or "When the theatre was built." Ask, "Do you own a meter to check screen luminance?" and the answer might be "Why do we need one, when the service tech checks it several times a year?"

Why Measuring Screen Luminance is Important

The above scenario plays out in too many theatres. All too many screens are poorly illuminated. The importance of proper screen luminance is not fully appreciated and the infrequent measurement is left to "the experts." Theatre personnel are familiar with some of the terminology, but often don't fully understand what it means or why it is so important. They rarely have access to an accurate

photometer for measuring screen luminance, which should be done routinely on a regular basis and especially after maintenance such as changing a xenon lamp or adjusting lamphouse alignment.

What is Screen Luminance?

Simply put, screen luminance is the amount of light reflected from the screen, as seen by the audience. Every theatre should have a copy of standard ANSI/SMPTE 196M, "Indoor Theatre and Review Room Projection – Screen Luminance and Viewing Conditions." It specifies the "screen luminance level, luminance distribution, and spectral distribution (color temperature) of the projection light . . . to achieve the tone scale, contrast, and pictorial quality of the projected print that will be of the quality intended during its production." Most people remember the figure of 16 footlamberts, which is the nominal aim screen luminance. But ANSI/SMPTE 196M specifies much more and describes the measurement procedure. First, the standard specifies the operating conditions for measuring screen luminance: the projector should be in normal operation with the shutter running, lens at normal focus position, and with no film in the gate. Measurements should be made for all formats (e.g., scope and flat). The standard specifies a spot photometer with an acceptance angle of two degrees or less, the spectral luminance response of the standard observer, a capacity for integrating over the shutter flicker. In other words, the meter should measure reflected light from a small portion of the screen as the human eye would, and not be fooled by the 48 or 72 cycle flicker of the shutter. The standard specifies that the primary screen luminance measurement should be taken from the center of the seating area at approximately the eye level of a seated person. Additional measurements should be taken from the center and from each end of the middle row in the theatre. For theatres with wide viewing angles or stadium seating, even more measurements are recommended. The nominal screen luminance at the center of the screen should ideally be 16 footlamberts (55 cd/m_). The standard allows a range of 12 to 22 footlamberts (41 to 75 cd/m_) for theatres. Luminance at the sides of the screen should be between 75 to 90 percent of the center luminance, and never less than 10 footlamberts (34 cd/m_).

Obtaining Copies of SMPTE Standards

Copies of standards like ANSI/SMPTE 196M and test films can be ordered from the Society of Motion Picture and Television Engineers. The web site is www.smpte.org/smpte_store/standards/.

Screen Luminance Meters

In the next issue, we'll discuss the professional screen luminance meters that are available, including the Minolta Luminance Meter LS-100, the SpectraCine CineSpot Spotmeter Model SC-600, and the Ultra Stereo Labs PSA-200 Projection Screen Analyzer. We'll also look at how less expensive meters or even an adjustable camera can be used to check if screen luminance is correct.

For more information, contact me at john.pytlak@kodak.com

4. Electronic Cinema What Did YOU See?

Everyone seems to be talking about electronic cinema. After the ShoWest demonstrations comparing two prototype electronic cinema projectors with a conventionally projected film print, many felt that electronically projected images were finally approaching the quality of 35mm film projection. Sure, the film images seemed to have better color reproduction and flesh tones-and a bit more fine detail and sharpness. And there were questions regarding the cost and complexity of the digital equipment in the theatre-and the level of expertise required maintaining and operating it. But, ShoWest was a technical demonstration and so, to be fair, let's consider electronic projection and film projection from a technical point of view.

An Electronic Cinema SYSTEM?

With either technology, we need to talk about the images arriving on some type of medium. The images shown at ShoWest originated on film, but for electronic projection, they were painstakingly transferred to a digital (D5) tape. Actually, D5 tape is too expensive and fragile to consider as a large-scale distribution format. A practical electronic cinema system would likely use satellite, fiber optic cable, or optical disk storage to send movies to theatres. Today, all of these require considerable data compression to be practical. At ShoWest, the data was uncompressed. Compression entails 'throwing away' some image data. Most experts agree that current compression techniques (e.g., the type used for DVD) are not suitable for images intended for large screens. Development and standardization of an "open architecture" of compression adequate for large screen images must involve all segments of the industry and SMPTE, and may take years.

Security and Encryption

Electronic cinema proponents promise that electronic distribution and presentation of movies will nearly eliminate piracy by using sophisticated encryption technology. That implies that a film print is more easily pirated. In reality, making a high-quality pirated copy of a film requires the use of a 35mm telecine, and extensive access to the film. Aiming a camcorder at a theatre screen produces a poor quality, flickering image. Many film prints also have a unique identification coded into the image to allow tracing the source of any pirated copies (This CAP-Code was developed by Kodak in 1982). Most of the time, higher quality pirated tapes originate from video transfers made for legitimate purposes that fall into the wrong hands, and not from prints in theatres. Serious piracy today is often from an electronic format, not film. Encryption technology can deter electronic cinema piracy, but won't eliminate it. The most sophisticated encryption techniques can't be exported due to national security reasons. "Unbreakable" encryption codes for DVIX, DBS, PPV, cable television, etc. have already been cracked.

Maintenance

An electronic cinema system includes not only the projector, but many other components as well. Since the full system-in a commercially viable configuration-is not yet available, we can only speculate on what the final configuration and total cost will be. Satellite, fiber optic link, or "hard" media such as optical disks may be used to deliver data. Not all theatres will have "line-of-sight" to a satellite, or access to a fiber optic feed, so a variety of delivery methods may need to exist simultaneously, each with its own infrastructure. For satellite and fiber optic systems, "real time" delivery of compressed data is a goal. A two-hour movie will take at least two hours to download into local data storage at the theatre. This will likely be done "off-hours," when transmission rates are lowest, requiring pre-scheduling of the download. If the download is missed or fails, the data will need to be retransmitted or sent another way. "Hard" media such as optical disks are a possibility, but data requirements for a full-length feature film far exceed the capacity of current DVD technology, so new technology probably needs to be invented.

Storage

Once the image data is in hand, it must be stored. Mass storage devices capable of storing TERABYTES (1000 times more data than a giga-byte) of data for each movie will likely be required in each theatre. And, when you add a system to 'back up' the data, you've got the storage capacity equivalent to several hundred home computers. A powerful server (don't forget a backup here too) will control the distribution of all this data within the theatre, feeding each projector through a fiber optic network. All this sophisticated computer equipment will likely require a surgeprotected regulated power supply, emergency backup power supply, special air conditioning, and HEPA air filtration system. Electronic

projectors are sophisticated opto-electronic devices. The current Texas Instruments DLP™ technology uses three proprietary SXGA DMD™ chips to modulate the red, green and blue light, each containing 1,310,720 microscopic moving mirrors, for a total of almost four million moving parts. Failure of even one mirror in a million will result in four"dead pixels" permanently imaged on the screen. The DLP chips and optical prism assembly must be kept cool using a water recirculator. Accidental "hot spotting" of the xenon lamp or failure of the cooling system could "fry" the heart of a $75,000 projector. The current Hughes - JVC ILA, projector technology uses three analog highvoltage cathode ray tubes (CRTs) to excite proprietary liquid crystal modulators for each color, illuminated by a large xenon lamp and dichroic separation filters. Proper cooling is essential, and cooling air must be filtered with a HEPA filter to avoid dust buildup on the highly charged CRTs and optical components. The ILA-12K projector is very large, weighs over 1600 pounds, and requires 60-ampere, 208-volt, 3- phase electrical service. Considerable maintenance time and costs should be part of the equation for anyone planning to pioneer the use of this technology. Networking terabyte-sized image files to dozens of screens and maintaining sophisticated computer and electronic equipment will require professionals with specialized background and training. If a mass memory device or file server goes down, all of your screens could go dark. If a projector is damaged, the repair bill could cost thousands of dollars.

Did You See Film At Its Best?

The format of the film print at ShoWest was 1.85:1 "flat." This was dictated by the need to match the "native" 16:9 format of current HD technology. Every good projectionist knows that 2.39:1 "scope" is a more efficient format than "flat" because of the larger image area on the film, giving a bigger, brighter and sharper image on the screen. About 30 percent of films are made in "scope," but they account for well over half of the boxoffice dollars each year. Electronic cinema projectors can show 2.39:1 aspect ratio movies, but at reduced light levels and with poorer sharpness when compared to their native 16:9 aspect ratio. In other words, the demos shown at ShoWest showed film in its least efficient format, so it could match electronic cinema in its native format. Film shown in 2.39 "scope" would have been even better, and the premier 70mm format would have been unexcelled.

So What Did YOU See?

So what did you see? I saw that electronic projection has come a long way in the last 10 years. I saw electronically projected images that were bright and sharp on moderately sized screens. But I also saw lots of work before we have an electronic projection SYSTEM that can compare technically - and in so many other ways - to what we have with a film projection SYSTEM today.

For more information, contact me at john.pytlak@kodak.com

5. SMPTE - Setting the Standards

Questions and Answers

What size is the image on a 35mm "scope" print? How bright should my screen be? How should a gain screen be installed? What can I use to help train new projectionists? Where can I get test films to align my projectors? What is the future of Digital Cinema, and will my concerns be heard? Theatre owners and projectionists are faced with many questions regarding the technology of motion-picture presentation. For over 85 years, The Society of Motion Picture Engineers (SMPE) has helped answer these questions. The SMPTE was founded in 1916 to foster and standardize advances in motion picture technology. Television added a "T" to SMPE in 1950. Today, the Society of Motion Picture and Television Engineers develops and publishes the Standards, Recommended Practices, and Engineering Guidelines that guide almost all motion picture and television technology. Its engineering committees provide an open forum for suppliers and users of the technology to discuss options, concerns and future direction. The monthly SMPTE Journal has documented almost a century of technology, and SMPTE publications have helped enlighten and train users of that technology. SMPTE test materials are widely used to set up and evaluate picture and sound presentation.

SMPTE Today

There are more than 10,000 SMPTE members spread throughout 85 countries, making it a truly worldwide organization. There are 27 local "sections" worldwide, with student chapters at many universities. The SMPTE can be contacted at:

Society of Motion Picture and Television Engineers
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website: www.smpte.org

Let's discuss some of the programs and services of the SMPTE, especially those useful to theatre owners and projectionists. Details are provided on the SMPTE website, so specific links are provided.

Standards, Recommended Practicesand Engineering Guidelines

The SMPTE develops standards that enable the worldwide use and optimum presentation of film and television images. For theatres, these important documents specify everything from the size of the film, to the brightness of the screen, to the frequency response of the sound. They also outline recommended practices and provide guidelines for theatre design, presentation quality, etc. These documents are listed on the SMPTE website and can be purchased individually at: www.smpte.org/smpte_store/standards/ Many theatre engineers and technicians find the CD-ROM containing all of the motion-picture standards a useful tool. Licenses are available to share Adobe Acrobat .pdf copies of ALL the motion-picture standards among multiple users for only a few hundred dollars. It's very handy to have all the needed documentation with you during a service call or when a technical question arises.

SMPTE Test Materials

The SMPTE also provides test materials for setting up and evaluating projection and sound equipment. Perhaps the most familiar test film is the 35- PA Projector Alignment Film (sometimes known as RP 40) which is used to evaluate image area, focus, field flatness, steadiness, travel ghost, etc. in 35mm projectors. Test materials are available for other film formats, and for aligning optical and magnetic sound. Test materials can be ordered by calling or writing the SMPTE at: www.smpte.org/smpte_store/

SMPTE Publications

The SMPTE sells a variety of publications covering all aspect of motion imaging and sound, from production to presentation. Of special interest to theatre personnel is the new Projection Manual, published in collaboration with ITEA and BKSTS. This manual, comprised of two main sections, includes a BKSTS projectionist manual, featuring a comprehensive tutorial guide providing a stepby-step training program for the new projectionist. The second half consists of a series of articles authored by U.S. experts in cinema technology. This manual is an excellent resource for newcomers to the projection room, and can be ordered on the SMPTE website at: www.smpte.org/smpte_store/books/

SMPTE Engineering Committees

SMPTE Engineering Committees are the "heart" of new technical developments in the industry. Engineers and experts meet on a regular basis to discuss the details of technology, and the path forward to implementing and standardizing that technology. These open meetings serve as a forum

and sounding board in the standards development process, with formal balloting procedures to approve the standards that specify the technology used in every theatre. Information about SMPTE Engineering Committees can be found on the SMPTE website at. Of particular interest to theatres are the Committee on Theatrical Projection Technology (P3), Committee on Audio Recording and Reproduction Technology (A12), and Committee on Digital Cinema Technology (DC28). Anyone with a vested interest in standards development and a willingness to actively serve can join a committee by completing a "Statement of Participation" at the SMPTE website. Note that you do NOT have to be a member of the SMPTE to participate in an engineering committee. You only need to have a vested interest in the work of the committee, and be willing to work on committee activities.

SMPTE Membership

Membership in SMPTE has many advantages. In addition to receiving the monthly SMPTE Journal, members receive discounts on SMPTE merchandise and registration at SMPTE conferences and events. "Networking" with other members of the industry is invaluable, and the SMPTE Membership Directory provides a valuable and complete listing of industry contacts. The SMPTE now offers a wide variety of "on-line" services, including access to the searchable SMPTE Library of technical presentations, past journals, and indices. You can join the SMPTE by simply filling out an on-line membership application at: www.smpte.org/membership/individual/ When you attend your first SMPTE engineering committee meeting or technical conference and look around the room, you may see a few familiar faces. Some of your friends from Kodak are likely to be there too, working together with you to help define the future of the movie industry.

For more information, contact me at john.pytlak@kodak.com