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PROJECTOR BUYING TIPS

By Don Hutcheson

As a frequent presenter of color-critical slide shows, I have worked with hundreds of different projectors in the last 30 years, but only a few were up to the quality I need. Hopefully these notes will help you choose the best projector or TV, both for professional color presentations and home-theater use.

WHAT WE ALL WANT

Today everyone has the right to expect bright, accurate, photo-realistic color on all our devices - phones, pads, laptops, home TVs, computer displays, etc. Unfortunately, not all digital projector manufacturers make photo-realistic picture quality a priority, even though they may claim some clever (but largely ineffective) 'special features'.

The good news is that a good projector doesn't cost a lot. (Spoiler alert - you can't go wrong with any Epson – especially the higher-priced models – and no, Epson doesn't pay me to say this).

The even better news is that today, your best option may be a large-screen TV rather than a projector. Most LCD / LED TVs offer higher resolution, longer effective life, higher brightness, better resistance to brightly-lit rooms, deeper blacks, richer color saturation, more evenness across the image, and relatively low prices, thanks to mass-production of home TVs.

TIP #1 - AVOID 'SINGLE-CHIP DLP' PROJECTORS

Most home or office projectors use a single 'DLP' behind a spinning filter wheel that changes rapidly between red, green and blue. These 'single-chip DLP' projectors claim very high brightness but actually produce disappointing color and should be avoided if you care about image quality.[1]

The problem with single-chip DLP projectors is that their filter wheel has not only red, green and blue filters but also a 'white filter'. By sending white parts of the image through the white filter (via a simple image processing circuit) the manufacturer can claim very high brightness numbers (e.g. '4000 ANSI lumens'), but this brightness is only in white areas. Meanwhile saturated colors appear dark and dirty by comparison *(see Figure 4).*

Sometimes the DLP filter wheel also has cyan, magenta and/or yellow filters, and the DLP projector manufacturer uses clever marketing phrases like 'Brilliant Color' to try and convince purchasers that the more color filters they use, the more colors you can display. But this is actually 'fake news' because it defies the fundamental rules of color vision and color photography.

BREAKING THE RULES OF COLOR

Color vision and color photography are both based on the simple fact that the human eye or color camera 'sees' with just three RGB channels, and a color TV or projector only needs three RGB channels to re-create virtually any color the eye can see. Adding extra channels (e.g. white, cyan,

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[1] NOTE: A '3-chip DLP' projector (if you can afford one) solves the problems of single-chip DLP, but is usually outside the price range of small business and home users.

magenta and/or yellow) actually makes color worse, not better, because it breaks the basic rules of how color photography and color vision work.

To make 'white', an RGB-based system (like the eye, a digital camera, projector or TV) simply uses the full amount of RGB. For example, in Photoshop, white is made with 255 R, 255 G, 255 B. But when a DLP projector displays white areas through a separate 'white' filter, those white areas appear roughly three times brighter than the brightest white (or red or green or blue) that could be made with just red, green and blue. As a result, saturated colors look dark and dirty alongside the 'fake white' areas.

Make no mistake, the so-called 'Brilliant Color' technology in most DLP projectors is just a crude way to try and restore some of the color that is actually lost when a white filter is added to the DLP filter wheel. DLP Projector manufacturers secretly know this, that's why they offer a special mode like 'cinema' or 'natural' or 'true color' (or similar) that switches off the white filter when you want more natural color, but then the projector drops to about 25-33% of its claimed brightness!

Unless you only show black-an-white images, buy a 3-chip LCD projector instead.

TIP #2 - 3-CHIP LCD PROJECTORS PRODUCE FAR SUPERIOR COLOR

Most better projectors use three chips (usually LCD - one each for red, green and blue) that produce much brighter, more saturated colors, even though their official 'brightness' in white areas may be slightly less than a similarly-priced DLP projector.

What makes 3-chip LCD quality so much better than single-chip DLP is a quality known as 'Color Brightness'. In a 3-chip LCD projector, white is made by switching all three chips to maximum brightness at the same time, which is the only scientifically 'correct' way to create white in a photographic system. High color brightness means that saturated colors look fully-saturated alongside white areas, which means you get truly 'photographic' images just as they appear in nature, without the need for misleading gimmicks.

Think of it this way, a 3-chip LCD projector works exactly the same as your home TV or computer monitor. TVs show great color with just RGB filters, so why should a projector need more?

TIP #3 - THE ONLY NUMBER TO LOOK FOR IS 'COLOR BRIGHTNESS'

'Color Brightness' is a new standardized metric created about ten years ago to help buyers compare projector quality. Color brightness measures the maximum lumens produced in a white image area with just three RGB filters, but no extra white, cyan magenta or yellow filters.

Not surprisingly, few DLP projector manufacturers dare publish their 'color brightness' numbers because they would reveal how dark the picture really is in 'true color' mode. But you can find a list of independently-tested color brightness numbers for a variety of projectors at web sites like ...

https://colorlightoutput.com/what-is-color-light-output.php

https://colorlightoutput.com/Color_Brightness_Buyers_Guide.pdf.

TIP #4 - CONSIDER A LARGE-SCREEN TV INSTEAD OF A PROJECTOR

Many businesses are replacing their projectors with large-screen HD TVs from 60 inch (152 cm) diagonal up to 80 in (203 cm), 100 in (254 cm) or larger. For a moderate-sized boardroom, 75 - 100 inch (190 - 254 cm) is often as large as a projector screen and makes a better picture.

TV VS. PROJECTOR PRICE (PROJECTOR WINS BUT ONLY SLIGHTLY)

4K TV prices in the USA (March 2019) start around $1,400 (75 in.) or around $1,800 (85 in.)

3000 lumen (color brightness) 1080p projectors from Epson range from about $670 to over $2,000 for higher-end models. All have excellent color quality.

TV VS. PROJECTOR IMAGE SIZE (PROJECTOR WINS IF YOU WANT REALLY BIG IMAGES)

The one clear advantage of a good projector is that it can theoretically cover a much larger image size than most affordable TVs. But remember, the larger the image, the more color lumens you will need, which raises the projector price into the range of a 100 inch TV. As most projector screens are 100 inches or less, a TV might still be a better investment, depending on your room size.

TV VS. PROJECTOR LIFE (TV WINS)

LED-illuminated TVs should last much longer than the average projector, considering cost of projector bulb replacement and the fact that projectors tend to lose quality due to dust in the optics, compared to LED / LCD TVs that tend to maintain the same picture quality much longer.

TV VS. PROJECTOR CROSS-SCREEN EVENNESS (TV USUALLY WINS)

One of the disadvantages of 3-chip LCD projectors is that they can develop uneven white balance (a.k.a. 'color balance') across the screen due to aging of the optical components, etc. (see '*THE ONE ADVANTAGE OF SINGLE-CHIP VS. 3-CHIP PROJECTORS*.)

Modern TVs tend to be better in this regard but can also suffer from some degree of unevenness. To test cross-screen evenness see *TIP #5 – TESTNG CROSS-SCREEN EVENNES.*

TV VS. PROJECTOR IMAGE QUALITY (TV WINS)

LCD/LED TVs are typically much brighter (2x - 8x) than a projected image, making them more suitable in normal ambient lighting.

LCD/LED TV contrast is typically much higher than a projected image, because ambient lighting does not wash-out shadow detail so much.

LCD/LED TV evenness across the screen remains more even for a much longer time. 3-LCD projectors tend to develop uneven color across the screen or 'hot spots' after some months.

NOTE: These notes apply mostly to LCD TVs with LED back-lighting. Plasma and OLED TVs may claim higher contrast and color saturation numbers, but suffer from long-term disadvantages like burn-in and cross-screen unevenness over time.

TIP #5 – TESTNG CROSS-SCREEN EVENNES

To test for even white balance (a.k.a. 'color balance' or 'gray balance'), display a perfectly white or gray screen and look for unacceptable color variations across the screen. To display a white screen in PowerPoint press the 'W' key, or show plain white or gray images from Photoshop.

TIP #6 - PROJECTOR OR TV SET-UP FOR OPTIMUM COLOR QUALITY

Regardless of whether you buy a TV or a projector, you will need to explore the hardware settings menu to produce the best image. Most projectors and TVs offer a variety or 'modes', including 'Sport', 'Presentation', 'Cinema (or Film)', 'Dynamic', 'sRGB', 'User (or Custom)', etc.

Avoid modes like 'Sport', 'Dynamic' and 'Presentation'. These always increase contrast and color saturation and are nor suitable of watching movies or showing accurate PowerPoint color. Usually the best mode is 'Cinema' or 'User' (with appropriate tweaks). You can check which mode looks best and optimize the settings with the 'Voyager display check' target, described next.

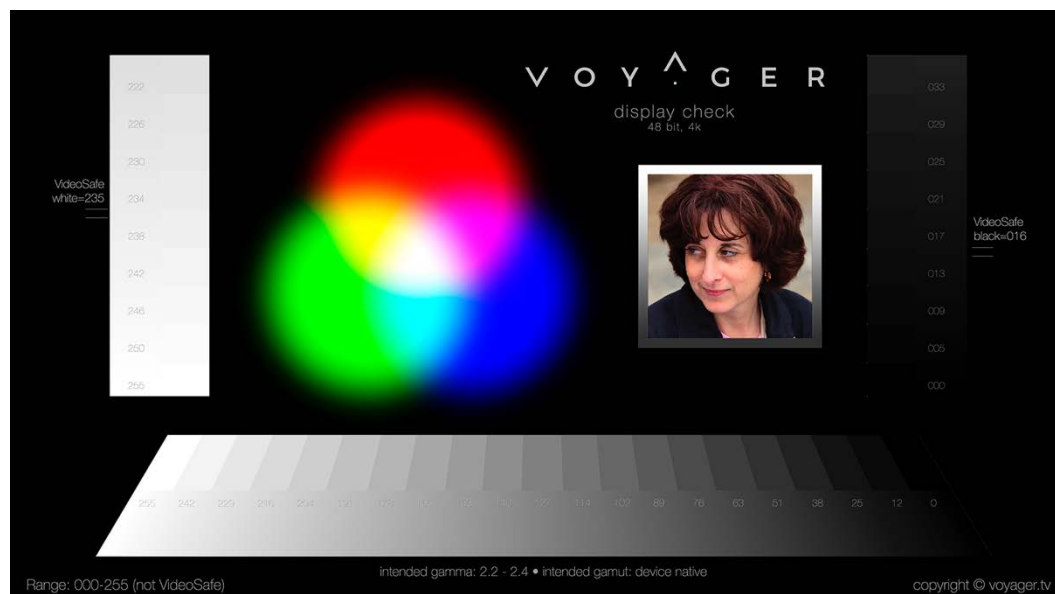## TIP #7 – USING THE VOYAGER TARGET TO EVALUATE COLOR QUALITY

Figure 1: The 'Voyager display check' target free at www.hutchcolor.com/Images_and_targets.html

The Voyager display check target[2] is used to visually-evaluate a projector, TV or computer monitor. It comes in 4K size (3840 x 2160 pixels) and 48 bit depth, but feel free to reduce its size to 1080 x 1920 and its bit-depth from 48 to 24 bits. Its usefulness will still be identical for most purposes.

There is no embedded ICC profile in the Voyager display check because it is designed to display the maximum native color space of your device. Feel free to assign sRGB or AdobeRGB if you want to, but remember that may reduce the usefulness of the three overlapping color circles.

You can display the target directly as a single image in Photoshop, as a single frame in DaVinci or Premiere Pro, or add it to a PowerPoint (or Keynote) presentation. Remember the application may be affecting color, so be sure you understand and its Color Settings or color preferences.[3]

BANDING OR 'QUANTIZATION'

The bottom gray scale should not have any 'color banding' or sudden tone breaks.

Figure 2: Color and tone banding (a.k.a. quantization).

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[2] Courtesy of www.voyager.tv

[3] PowerPoint automatically recognizes an embedded profile in the file, or else uses the system profile.

WHITE CLIPPING OR BLACK PLUGGING

If the left or right two or three patches of the lower gray scale are hard to distinguish (too light or too dark) adjust the TV or projector's 'Contrast' or 'Brightness' settings.[4] After adjustment, all patch boundaries should have equal contrast and you should be able to *just* distinguish the lower two patches on the left-hand vertical 'white scale' and the right-hand vertical 'black scale'.
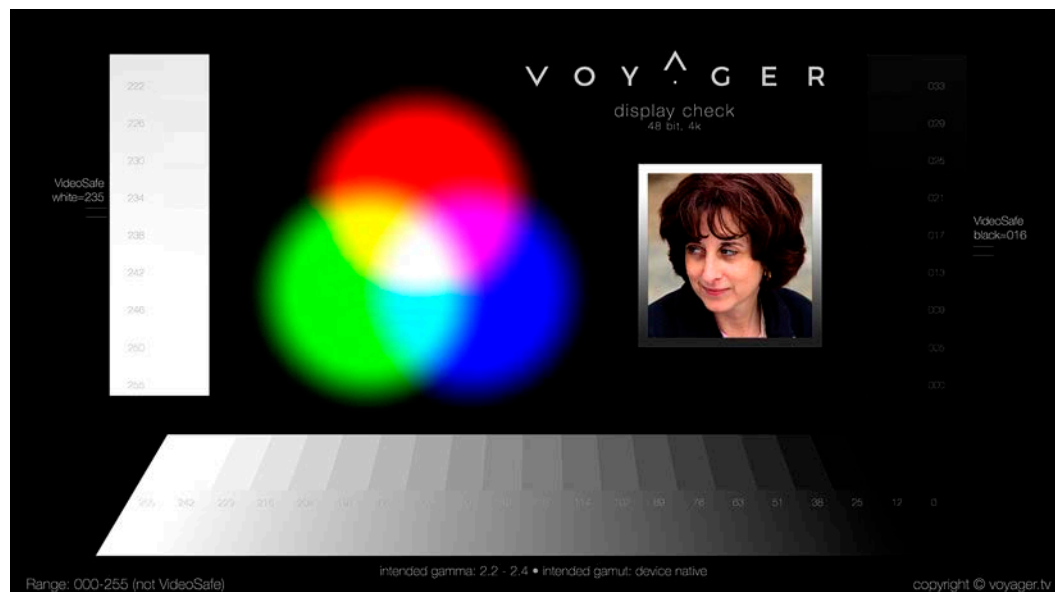

Figure 3: White clipping and black plugging (compare ends of the gray scale to figure 1)

SMOOTH COLOR SATURATION

The three over-lapping color circles should show full color saturation and perfectly smooth transitions, without any hard edges. A pronounced white triangle in the middle surrounded by dirty colors indicates a DLP projector set to the wrong color mode.
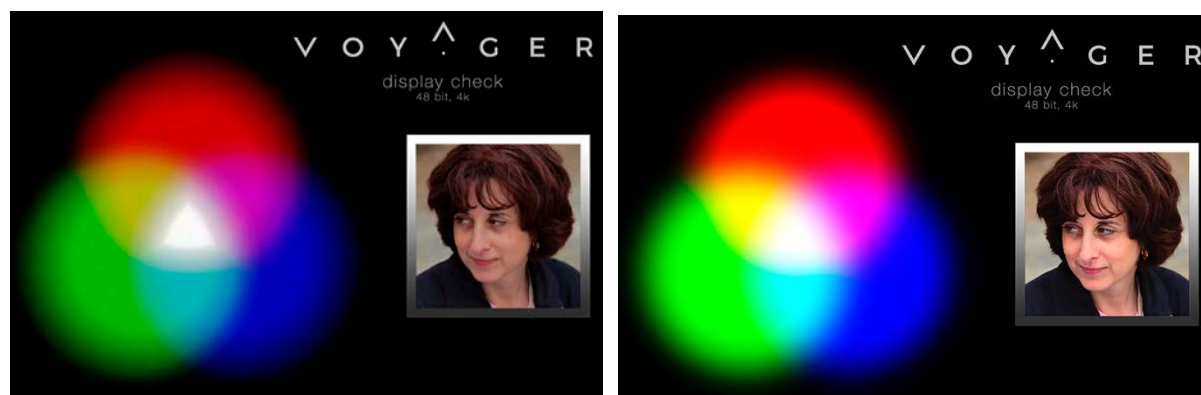

Figure 4: The negative effects of a DLP projector's infamous 'white filter'(left) vs normal (right)

PLEASING FACE TONES

The woman's face should look 'pleasing' and natural, especially with the sRGB color space assigned to the image. (Pleasing is a subjective term – there is no exact 'right' or 'wrong'.)

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[4] Note: Some systems reverse the 'Brightness' and 'Contrast' functions - you may need to experiment.

TIP #8 – RESIST MAKING A CUSTOM ICC PROJECTOR PROFILE

So long as the Voyager display check target looks good, you probably do NOT need to create a custom ICC profile for your projector.

Most users (including me, with over 50 years in photography and printing) will be perfectly happy with the 'pleasing color' produced in the system's native state, plus any adjustments made under tip # 6, so long as this is a good projector (e.g. 3-LCD).

For absolute color geeks (that's describes me too, but I know when to stop fussing) you can make a custom ICC profile if you have the equipment and software, but be prepared for possibly disappointing results unless you REALLY know what you are doing.

LIMITATIONS OF CUSTOM DISPLAY PROFILES

Any screen flicker or change in ambient lighting while profiling can introduce serious errors in the profile, like non-linear tone ramps.

Custom projector profiles made with some ICC profiling software can actually reduce smoothness in gray ramps.

BEST ICC DISPLAY PROFILING SOFTWARE

At the time of writing, the best display profiling software (by far) in my experience is basICColor display 6 from www.basICColor.de, but it's really only for absolute color geeks.

THE ONE ADVANTAGE OF SINGLE-CHIP VS. 3-CHIP PROJECTORS

The one theoretical advantage of a single-chip DLP (OR LCD) projector over any 3-chip projector (LCD or DLP) is that they typically have very even color balance or 'white balance' across the whole image, because any fading or aging of the chip, or unevenness in the light path due to miss-aligned optical components, is equal for all color channels.

FREE TIP FOR PROJECTOR MAKERS (YOU KNOW WHO YOU ARE)

Regardless of whether you use DLP or LCD chips, try building a projector with the benefits of both 3-chip LCD and single-chip DLP designs, as follows;

ELIMINATING THE POOR COLOR OF A SINGLE-CHIP DESIGN

Use only one image chip (to avoid cross-image color variation) and a spinning filter wheel (or other color modulation system) with ONLY red, green and blue filters or LED lasers, etc. If the image is too dark, raise the lamp brightness.

ELIMINATING CROSS-IMAGE COLOR BALANCE ERRORS IN A 3-CHIP DESIGN

Use only three RGB LCD chips or three RGB single-DLP filters (no extras please!) and add a way for professional users to compensate for cross-image color variations due to manufacturing, filter or chip fading, lamp miss-alignment or other optical issues. (This may already be in high-end 3-chip DLP projectors. Feel free to donate one to me if it is.)

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