

DLP vs DV-LED Displays in the Control Room

ACTIVU THOUGHT LEADERSHIP BY **PAUL NOBLE**

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Overview

This whitepaper examines indoor, high pixel density, direct view LED (DV-LED) and its potential impact on the US control room display market, where LED-illuminated DLP projection cubes are the incumbent display technology.

Up to this point very few direct view DV-LED walls have been installed in American or European control rooms due to the enormous cost premium over DLP, especially for the higher pixel density DV-LED required for closer viewing distances. To date, DV-LED has seen more control room adoption in the domestic Chinese market where virtually all DV-LED product is currently manufactured. But this will surely begin to change over the next 1-2 years as prices continue to drop, the technology evolves, and awareness of its advantages for certain applications permeates the market.

Today the vast majority of new larger control room installations continue to use DLP cubes while many smaller control rooms use LCD panels due to their lower cost and shallow form factor. But whereas LCD has some technical disadvantages over DLP such as thicker mullions, shorter life and image retention risks, with DV-LED the only real downsides are the currently much higher price and lower pixel density. Please note that DV-LED is categorized by its pixel pitch and all measurements, including cost, are typically expressed on a per square meter basis while DLP is measured on a per cube basis. In order to make comparison meaningful, I have normalized all cube measurements to match the per square meter metrics used with DV-LED.*

Also, by convention DV-LED brightness has historically been measured in nits, DLP cubes in candela per square meter. Different terms, same measurement.

Please note that, as an emerging technology, DV-LED innovation is fast paced with frequent new model introductions, and beyond declining cost, we are seeing small improvements in weight and power efficiency and a focus on design refinements that improve ease (and cost) of installation, cabling and servicing.

Technical comparisons between DLP and DV-LED

Brightness & Contrast

(Peak) brightness of DV-LED, typically over 800 nit, exceeds control room requirements which are typically in the 250-500 nit range: ideally matching the brightness of operators' desktop displays to avoid eye fatigue. DLP brightness varies greatly depending on the light engine, brightness setting and screen formulation, but on-axis brightness will generally match or exceed control room requirements at one or other brightness setting.

DV-LED contrast significantly exceeds DLP (and LCD) since in both rear projection and LCD the light source is always at full intensity and 'black', for example, is achieved by fully masking the light, which is an imperfect process. By comparison, with DV-LED a 'black' pixel is simply 'off'.

Simply said, content looks sharper on DV-LED when viewed from an appropriate distance, especially high contrast graphical content such as SCADAs and one-lines. Also, DV-LED is more resistant to glare and reflection from ambient lighting compared with DLP screens (and LCD glass for that matter).

One of the limitations of rear screen projection is the trade-off between on-axis and off-axis brightness. Depending on the screen formulation, fall-off can be moderate at the expense of on-axis brightness or alternatively off-axis brightness can be compromised to maximize on-axis brightness, especially vertically. This is not an issue when the wall and viewer are in the same plane, but can be more challenging when, for example, some viewers will view the display at an acute vertical angle.

With DV-LED there is essentially no noticeable fall-off of brightness (or color variation) off-axis up to and beyond any practical viewing angle. In addition, there is no visible variation in brightness or color across a wall.

With DV-LED, brightness will look uniform over the entire wall and from virtually all viewing location and angles of view. This is a real weakness with rear screen projection and a huge practical plus for DV-LED. A typical DV-LED product specification is > 97% uniformity and an effective 160 degree viewing cone, with horizontal brightness > 90% at 70 degrees off-axis, vertical brightness > 75% at 70 degrees off-axis. A typical DLP specification is: horizontal brightness 50% at 35 degrees off-axis, 10% at 57 degrees off-axis; vertical brightness 50% at 10 degrees off-axis vertically, 10% at 28 degrees.

An advantage of DV-LED's brightness uniformity is that very wide video walls would not need to be curved as much, with the attendant structural complexity, as is common with very wide DLP walls.

Mullions

There are no visible mullions or "lines" across the video wall with DV-LED, and alignment is perfect. The total lack of visible mullions is a particularly noticeable improvement when watching full motion video and graphics. It is less important when operators are further away from the video wall, and/or when displaying a SCADA or one-line with a black background.

Minimum Viewing Distance

Optimal minimum viewing distance (OMVD) is a function of pixel pitch. OMVD is the distance at which the display pixel pitch essentially matches the perceptual pixel pitch of the human eye with 20/20 vision. (It is derived from a trigonometric function and can be calculated for any display by dividing the pixel pitch by 0.000291). This is the same calculation Apple uses to define retina screen resolution in its products. In simple terms it is the distance at which individual pixels cease to be visible and a fully coherent image is formed and is related to the density of cones in the Foveal region of the human eye. It is more critical when viewing static graphics than full motion video.

For any two displays with the same pixel pitch, OMVD should be similar regardless of display technology, e.g. whether DV-LED or DLP. That said, there are subtle perceptual differences, especially near and just beyond the OMVD limit, based on how individual pixels are created.

With DV-LED, each pixel is essentially an individual point of light on a black background. It has a relatively low pixel to background ratio or 'fill factor'. In fact, if you examine DV-LED up close you will see that each point of light is actually comprised of separate red, green and blue sub-pixels, which merge visually at even a foot away though the individual pixel groupings only visually merge at the OMVD.

By comparison, DLP, comprises 'full sized' (i.e. very high fill factor), full color pixels, using a spinning color wheel or other means to sequentially deliver the red, green and blue color information to the eye at a high enough rate for the component color information to merge, psycho-visually.

When DV-LED is viewed at closer than the OMVD, whether because staff are seated too close or because the operating model calls for people to move back and forth in the room, the individual pixels become very visible, due to the lower 'fill factor' of DV-LED and the information is harder to decode and uncomfortably pixelated, whereas DLP just looks softer.

Conversely, beyond OMVD, DV-LED tends to look a bit sharper due to its higher contrast and the optical alignment constraints and screen characteristics of DLP rear projection.

Power Consumption

Per square meter power consumption of the latest generation of highly energy-efficient LED illuminated DLP cubes is approx. 100-150w per square meter in normal mode, depending on model and cube size. (Latest generation LCD panels are typically in the 150-160w range).

An important distinction to make about DV-LED is its power consumption which, unlike with DLP, is a function of the content being displayed: the brighter the content, the more the power consumption. The LED's comprising a black SCADA background, for example, are simply off. By comparison, in both DLP and LCD video walls, the light source is constant and black is created by blocking (LCD) or deflecting (DLP) the light.

Also, with DV-LED there is a linear relationship between overall display brightness level setting and power consumption.

We have ourselves measured 135w for 'average' control room content, below 100w for SCADA at 400nit, a typical control room appropriate brightness level with one DV-LED product.

Key with DV-LED is to simulate the intended content at the intended brightness to accurately access the actual power consumption.

It should be noted that DV-LED has a very high (2.5-4x) manufacturer rated maximum power draw based on the hypothetical display of peak white at peak brightness across the full display which is of course not a use case in the control room. One manufacturer has already announced a factory-set brightness limiter to reduce the peak power requirement (i.e. the number of power circuits required) when used in control room applications. There may be other power management options to further limit power requirements to more closely match actual power consumption.

Heat

Though heat is significantly a function of power consumption, DV-LED projects its heat (IR) forward, whereas DLP cubes exhaust their heat behind and or above the display wall. However, at control room brightness levels DV-LED heat projection should not be a factor.

Longevity

DV-LED is generally rated at 100,000 hours, comparable with the highest rated DLP cubes. However, at control room brightness levels (<400 nit), DV-LED may have an even longer usable life. DLP LED light engines are rated at up to 100,000 hours depending on model and brightness mode.

Please note: a DV-LED display would require substantially full replacement at the end of its life, versus replacing just the light engine for DLP.

Stability

DV-LED vendors are stating that their DV-LED walls should not require periodic color rebalancing and should remain evenly balanced with respect to color and brightness indefinitely. They do however recommend yearly inspection to identify any failed DV-LED pixels. Also, over time, brightness at a given setting will slowly diminish and an overall brightness readjustment to a wall every few years is recommended to maintain the original brightness level. This compares with typically yearly DLP alignment and color balancing, though the need has greatly diminished compared with previous lamp based DLP cubes.

Weight

Though DLP is typically floor mounted and DV-LED is typically wall mounted, it is worth noting that DV-LED typically weighs less than DLP. DV-LED product generally weighs 70-80lb per square meter excluding a mounting structure, typically 110-120lb with. DLP cubes are generally in the 130-200lb per square meter range excluding bases.

Form Factor

Compared to the depth of DLP (typically in the 1.5- 3ft range, not including any required rear access), DV-LED has a significant positive impact on space utilization, with a total installed depth typically in the 4-12" range, and one can expect architects to strongly support DV-LED adoption.

Some manufacturers are combining multiple LED tiles, typically 20, into integrated displays similar in design and size to a 55" ultra-narrow bezel LCD panel, for ease of installation and cabling.

On the other hand, the much smaller individual component tiles, when not integrated, allow any space to be filled more exactly and any curve, should it prove architecturally necessary, smoother than with DLP, LCD or integrated DV-LED product.

There is much innovation occurring in the way DV-LED tiles are packaged and mounted for ease of installation and service.

Cost Comparison between DLP and DV-LED

Direct Cost Comparison

Today's DLP projection cubes generally all meet or exceed typical control room requirements, in terms of resolution. A 60" full HD DLP cube has a pixel pitch of 0.69mm and an optimal minimum viewing distance (OMVD) of under 8ft. A 70" or 72" cube has a 0.81mm pixel pitch and an OMVD of ~9ft. A 55" HD LCD panel has a pixel pitch of 0.63mm and an OMVD of ~ 7ft.

This corresponds to the front edge of the first row of consoles being at minimum 5-6ft from the front surface of the video wall, allowing for the depth of the console and seating position of the operator. Any further away and even a 70" or 72" DLP cube will exceed the visual acuity of the first row of operators. However, whereas DLP cube resolution (i.e. pixel pitch) generally exceeds control room requirements, and pixel pitch is not even a primary cost factor, with direct view DV-LED the cost is almost entirely a function of pixel pitch, with even nearly comparable pixel pitch to DLP currently a multiple of DLP's cost. So, the big question with DV-LED is just how small a pixel pitch do you really need?

The cost of DV-LED is directly related to the number of individual LEDs per given area, i.e. the pixel pitch/density. And although 1.6mm pixel pitch with an OMVD of 18ft, even 1.8mm with an OMVD of 20ft might be suitable for some very large walls with significant minimum viewing distances, the maximum pixel pitch for most control room implementations is realistically 1.2mm with an OMVD of ~14ft. Pixel pitch options vary by manufacturer and product line with common sizes being: 0.9mm, 1.2mm, 1.4mm, 1.5mm, 1.6mm and 1.8mm.

Also, whereas when DLP is viewed closer than the OMVD, the display content simply looks less 'sharp', when DV-LED is viewed closer than the OMVD, it looks uncomfortably pixelated, especially when viewing static data/graphics. For DV-LED it is particularly important to select a sufficiently fine pixel pitch for the viewing comfort of the closest operators.

Indoor, high pixel density direct view DV-LED suitable for control room use is an emerging technology and prices are declining primarily driven by the scale and efficiency of DV-LED component manufacture. However, LED component capacity constraints in this fast growing market have recently slowed the inevitable price decline.

Currently, very ballpark, 1.2mm DV-LED is ~2.5x DLP per square meter. 1.6mm ~1.5x. 12-18 month price projections suggest 1.2mm DV-LED may be at ~1.5x DLP and 1.6mm at or close to price parity with DLP cubes (for reference a premium quality 70" front serviceable product).

0.9mm DV DV-LED is expected to follow the same trajectory: in 12 months maybe costing what 1.2mm costs today, and continuing to fall similarly.

One more comparative cost factor to consider: unlike with DLP, with DV-LED it is strongly recommended to purchase 10% spare parts up front so that any replacement panels/components are from the same production batch for a better visual match.

Though DV-LED is in almost all scenarios more costly as of the date of this paper, the premium over DLP is diminishing.

Indirect Cost Comparison: Processing

Processing cost (specifically output channels and software licenses) is correlated with overall pixel space. A lower, but acceptable pixel density (i.e. pitch) DV-LED solution would result in a lower processing cost.

Indirect Cost Comparison: Installation and Setup

Depending on the size and physical location of the wall(s) and the modular design of the DV-LED solution, installation and setup cost could be lower for DV-LED than for DLP.

Indirect Cost Comparison: Structural

Depending on the size, shape and physical location of the wall(s) along with any seismic bracing requirements, wall-mounted DV-LED may represent a significant cost saving over stacked, base mounted DLP cubes.

Conclusion

1.6 mm DV-LED should reach overall project price parity with DLP within 12-18 months, 1.2mm DV-LED within maybe 24-30 months, based on current price trends. But it will likely be 3-4 years before 0.9mm DV-LED reaches price *and* performance parity with DLP with its typical 0.8mm pixel pitch. The further out your project and/or the further the closest operators, the greater the viability of DV-LED. For shorter time frames and/or viewing distances DLP is likely the wiser choice.

About the Author

Paul Noble is an entrepreneur with a unique blend of tech and business experience. He founded Activu Corporation (formerly Imtech) over thirty years ago in New York, as the first company to develop and sell video wall technology in the United States. Born in London, Paul attended the London Film School and had an early career in film and television before moving to the United States. He later went on to receive an MBA from Columbia Business School. He can be reached at 973.343.4949 or paul.noble@activu.com.

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