

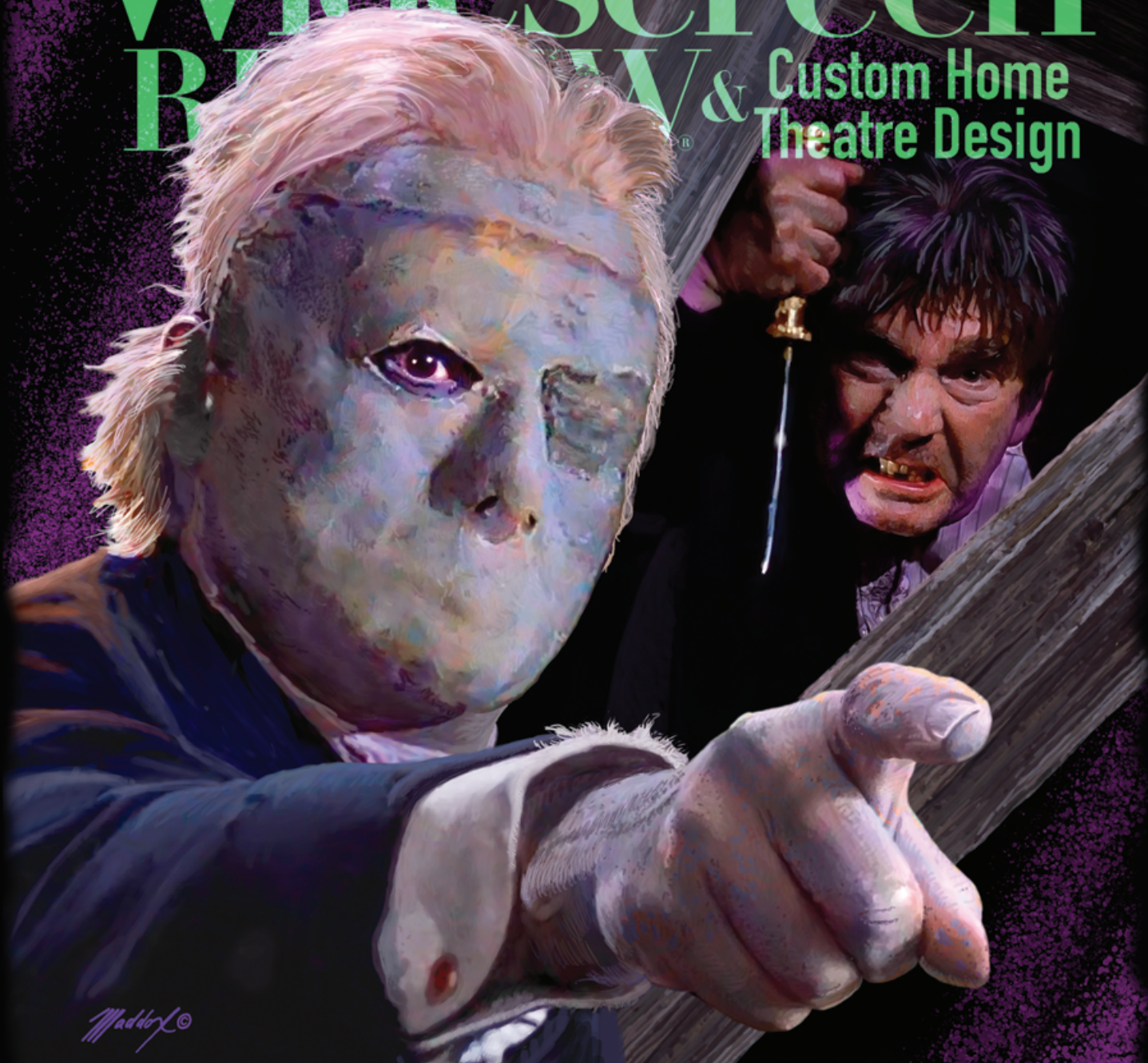
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Widescreen Review & Custom Home Theatre Design



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The DARBEE™ Origin Story

Larry Pace and Jack MacDougall

Back in the 1970's, Paul Darbee was tinkering with machine vision and discovered that you can embed 3D depth information into 2D images. Why is this interesting for digital image and video processing? A good question if you are presenting images that simply capture the fidelity to the scene and are bound by the limitations of a camera system. However, if your goal is to produce lifelike images that represent how humans see, then your goal can be satisfied at a level that even the most perfect camera system cannot attain. Darbee discovered a way to make "photorealism" a limitation, rather than the ultimate realism.

To understand how embedding 3D depth information into 2D scenes is possible, one can review what has been achieved, for hundreds of years using low-tech image processing solutions. If you take a step back in time, all the way to when the trompe l'oeil artists (the original "painters of light"), you can see that scenes and subjects can be painted to hold remarkable qualities of realism that even a camera cannot replicate. Trompe l'oeil painters expressed highlights and shadows in a special way, where levels of depth, clarity and realism could be accepted by the viewer as virtual reality. Those painters did not use camera technology, they simply painted what their TWO eyes saw. They pushed the techniques to the degree that some trompe l'oeil paintings capture more depth and realism than any photograph will ever capture.

A very simplified explanation for why even a perfect camera cannot produce an image that has the depth and realism of a great trompe l'oeil painting is, cameras see and capture a single plane of light. A pair of eyes, see/capture two planes of light and the visual system processes each, and both, images. Therefore,

there is a fundamental technology platform difference between what a camera does to represent a scene and what a human visual system does. Every picture ever captured by a single lens camera system, has been captured in a process that literally threw away the opportunity to conduct computation based upon alternate viewpoint information. The brain normally makes calculations based upon information from two viewpoints, however, because the monoscopic camera can only capture one view, the alternate view information can never be available.

Darbee discovered, in a surprising and basic way, that you can overcome that fundamental limitation of camera systems. First, he showed us that you can capture multiple image views and combine them in a special and gratifying way. Second, you can capture one original viewpoint, then compute the alternate viewpoint and combine it with the original prime image. Third, you can capture or synthesize any multiplet of image viewpoints and combine them with a prime image. Since his original discovery, the inventions created by DarbeeVision Inc. and the products created, have gone on to prove to the world that photographic fidelity is not the endpoint of image realism. To summarize his discovery and invention, he used to explain... "If you compute some of the information that your brain would normally compute, as if you had seen the scene with multiple eyes or multiple viewpoints, and add that additional information back into the original 2D image, the flat-appearing 2D scene will come alive with more depth, and appear more to your visual system as if you are actually present with that beautiful virtual reality scene."



Original Image

DARBEE Image - Setting 070

DARBEE Evolution Toward 4K DVP

DarbeeVision Inc. was formed in 2009 to commercialize Paul Darbee's discoveries. Subsequent inventions, and ultimately DARBEE Visual Presence™ (DVP™) image processing solutions (some components of which are held as trade secret), are collectively the technologies which enable Darbee's discovery to be appreciated by everyone. In 2011, DarbeeVision Inc. launched the first DVP-enabled, inline, real time, simple-to-use, video processor, the DVP-5000™ "Darblet™." The impact and benefit of that HDMI 1.4 video processor took the home theatre market by storm. The company created and distributed that product with two goals: 1) introduce DVP technology to the world and 2) gain accolades.



Within a few years, and with the subsequent product launches of the DVP-4000™ (HDMI 1.3), DVP-5100CIE™ (Custom Installer Edition), and DVP-5000S™ (updated DVP-5000), not only was DVP technology recognized as a revelation for digital image and video processing, but important OEM licensing partnerships were established. DarbeeVision enabled companies such as Lumagen, OPPO, Galaxy, Cambridge Audio, and Optoma to integrate Intel FPGA-based DVP chipsets into their home theatre and gaming products. During those years, even while two rounds of 3D were foisted upon the consumer, DVP stood its ground as a technology that would allow the consumer to experience a new relationship with their TV or display. The user could experience new and often profound levels of image quality and depth, simply and without having to acquire alternate 3D source material, or 3D glasses for every household member and guest. During the HD video market period, DarbeeVision proved to the world that Paul Darbee's discoveries were worthy to become part of the fabric of imaging.



On the eve of CEDIA 2013, DarbeeVision lost Paul Darbee. Despite the heavy loss to the team, they rallied around one another and forged onward to realize the dream of bringing DVP to the mass consumer market.

Beyond 4K—The Future of DARBEE Visual Presence

Now, through testing with thousands of image display systems, it appears that when you modify an image with DVP, the resulting increased depth, clarity and realism will show up, no matter what display technology presents the image. You can appreciate the benefits whether DVP is applied to photos appearing in newspaper print, still images, moving image frames, augmented reality projection, front screen projection, and all flat panel display systems. Further, the DVP processing can be applied at any time in the life of the pixel as it has been found to survive compression and scaling. The better the fidelity of the original image, and the better the performance capability of the display system, the better DVP result that the viewer will experience. Extremely high resolution, uncompressed images and video look amazing, however, without DVP, the very same extraordinary, high-fidelity image looks dull and flat, compared to the DVP processed version. Therefore, the number of potential applications is presently too great to count. In time, the future opportunities for DVP processing will continue to emerge. For example, imaging applications for Virtual Reality, Augmented Reality and Mixed Reality, light field and holography are starting to be revealed.



Original Image

DARBEE Image - Setting 060

While DVP is founded on a few deep principles, DarbeeVision adapts DVP technology, as the relentless pursuit of increased fidelity marches on. To meet the demand for a 4K DVP solution, the company has focused on adapting the core IP to the new specifications, and eliminating the product-making side of the business. DarbeeVision has streamlined their daily work by developing 4K DVP IP instead of developing a 4K DVP video processor of their own. This is where their partnership with Pixelgen Design unfolds. DarbeeVision needed a product design partner, with a passion for uncompromising quality. The partner had to have an existing brand with global partnerships and sales channels and one who has attained acco-

lades for product development and support excellence. The partner also needed to know how to handle the emerging 4K HDMI specification, with eyes on the past, present, and future performance issues and requirements. In seeking the right partner, it turned out that DarbeeVision had already had the right long-standing and creative partner —Pixelgen Design.

Enter Pixelgen



On the scene since 2015, Pixelgen is an engineering-first organization based in Burlington, Ontario, Canada, that organically designs and manufactures professional uncompressed video connectivity products catered to larger or more expansive home theatre space installations. Without the assistance of black box OEM rebadging or external design reuse, Pixelgen is a rare breed built on in-house R&D capabilities and hardware design engineering prowess...and are doing this from the ground up in North America.

Jack MacDougall, Pixelgen Founder and CEO is a leading industry expert in uncompressed signal distribution and is highly active in the Custom Install community. Jack has authored three video signal transmission-related patents and has been an advocate for formulating best-in-class interconnect solutions from a compliance, performance, and compatibility perspective. Coming from a product engineering background in Video Broadcast and Image Processing, MacDougall's main area of expertise lies in high-speed signal integrity design methods leveraging leading-

edge technologies to maximize performance for the Pixelgen product line. MacDougall has been the recipient of several notable industry awards including the 2013 CEDIA Product Excellence Award, 2014 TWICE VIP Product of the Year (DARBEE DVP 5100-CIE), and most recently the 2019 Essential Install Smart Building Cable Solution of the Year for the Pixelgen, PXLDRIVE™ Max 4K Interconnect System. Pixelgen continues to demystify the ever-changing landscape of long-reach, high-speed interconnect and aspires to help the industry by transporting every pixel as it was intended to be viewed.

Pixelgen first caught the attention of the CI world with their highly acclaimed Ultra HD signal recovery product, PXLDRIVE (pronounced "Pixel Drive") Max 4K Interconnect. This one-of-a-kind retrofit product has the ability to revive uncompressed signals up to the maximum UHD 18 Gbps bitrate (4K/60 8-bit 4:4:4, for example) over buried in-wall cabling up to 20 meters—which may otherwise have to be deemed obsolete and unusable once inevitably upgrading the system to 4K. PXLDRIVE is the only UHD restorative product with an auto-adaptive equalizer chipset, which is designed to automatically detect the cable's loss regardless of length or wire gauge and apply the appropriate gain to the incoming signal. PXLDRIVE is acclaimed as the ultimate 4K "fixer"—no external power, and zero compression—and truly plug and play.

In the early years, rather than strategizing an aggressive "Sell, Sell, Sell!" plan, Pixelgen knocked on the doors of several CI industry giants and influencers such as Kaleidescape, OPPO Digital, JVC, Barco Residential and Paradigm/Anthem (to name a

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"I don't think I could do without this sub, so I bought it!"

— Hugh Mandeson,
Audiophile Voice,
Volume 17, No. 4

VTF-3 MK5 HP

"If I were shopping for a subwoofer at its price point, it would very likely be my first choice."

— James Larson,
Audioholics,
Dec 1 2016

VTF-2 MK5



PERFORMANCE ★★★★★
FEATURES ★★★★★
BUILD QUALITY ★★★★★
VALUE ★★★★★

"the only sub on our list that netted five stars across the board"

Bob Ankosko,
Sound & Vision.com,
Dec 2014

VTF-15H MK2



few) and hand-delivered the yet-to-be-named 'PXLDRIVE' prototype for evaluation. It should be noted that prior to a solution such as this, it was clear that these equipment manufacturers had a common problem with tech support surrounding cables, they were often left to point in different directions when it came to these issues, as they simply didn't have a way to reuse pre-existing cables when upgrading their equipment to 4K in the field. The collective feedback was consistent. It had become clear that PXLDRIVE was a highly effective product in the making and that the market very much needed it.

So, Pixelgen got to work, and with a few bumps along the way, in early 2017, Pixelgen had perfected PXLDRIVE and delivered the first products off the line (in Canada) to these same manufacturers. In time, sales channels were created to support these manufacturers and in turn, technical support for cable-related issues plummeted. It was now a simple case of pointing to PXLDRIVE. These strong partnerships have since spawned some incredible application opportunities and all because Pixelgen looked for the problem first, then sought out a means to fix it.

The next step for Pixelgen was to go further, with the same effectiveness of reliability and interoperability. Enter PXLGLASS™. Available in lengths from 10 to 50 meters, this fixed-length interconnect was built with a 'Hybrid Fiber/Copper' wiring approach. The high-speed signaling transports data over glass OC3 Fiber while the critical low-speed communication signaling responsible for High-bandwidth Digital Content Protection (HDCP), Consumer Electronics Control (CEC) and HDMI Ethernet and Audio Return Channel (HEAC) is exchanged over copper wire with active signal boosters at each end of the interconnect itself. What makes PXLGLASS special is that each HDMI signal is encapsulated within the interconnect itself with active intervention, ensuring that all external equipment operate in harmony with one another... a long-standing

issue in the CI field. Once again, the industry embraced this.

What Pixelgen has contributed is to be applauded. The company has provided premium, highly interoperable interconnect solutions for all lengths (including retrofitting and even shorter cabling for rack applications) while maintaining full functionality, and have done all of this without resorting to compression methods or other shortcuts. Pixelgen believes in one length, one solution and does not subscribe to providing multi-tiered, same-length solutions—"this cable will do this, but not that." Every long-reach Pixelgen solution acts no differently than a simple 1-meter cable. Simple.

The Pixelgen, PXLVISION™ 4K Video Processor, Powered By DARBEE

The PXLVISION 4K Video Processor is the industry's first stand-alone 4K video processing solution with embedded 4K DVP technology utilizing Intel Field Programmable Gate Arrays (FPGAs). Placed at either end of any HDMI connection, PXLVISION will support the maximum HDMI 2.0b specification (18 Gbps) and support all combinations of 4K resolutions, HDR formats, bit depths, frame-rates and sub-chroma sampling. For control, PXLVISION will support the classic tactile push-button interface and IR/Remote Control for DVP strength and menu navigation (similar to the DVP-

The advertisement features a 3D white character wearing a yellow hard hat and a white shirt with "DPL" on it, carrying a brown briefcase and standing on a yellow airplane. The airplane has "48G Reference Standard™" written on its side. The background is a blue sky with white clouds. In the top left corner, the "DPL LABS™" logo is displayed. Below it, the text "New 48G Reference Standard Tests Begin" is followed by a bulleted list: "• 10 Additional Performance Tests", "• 160 Dynamic Eye Diagrams", and "• Addition Functional Testing". In the top right corner, the text "On Final Approach" is written. At the bottom right, the website "www.dpllabs.com" is displayed in white on a dark blue background.

DPL LABS™

New 48G Reference Standard Tests Begin

- 10 Additional Performance Tests
- 160 Dynamic Eye Diagrams
- Addition Functional Testing

On Final Approach

www.dpllabs.com

5000S), however, it will also enrich the end-user experience with intuitive two-way Bluetooth communication together with a downloadable Pixelgen mobile iOS/Android app. The app will unleash the full gamut of PXLVISION capabilities, including DVP control. With two-way Bluetooth communication, Pixelgen plans on adding some interesting user-friendly features such as live 4K status information feedback and Extended Display Identification Data (EDID) management to ensure that enthusiasts and professionals alike

know exactly which signals are passing through PXLVISION, at all times. PXLVISION will also support HEAC, CEC 2.0 as well as HDCP 2.3 and will utilize a single USB-C power connection that will also double as an in-field firmware port for future updates. The unit itself will be comprised of a familiar Pixelgen look and feel, housed in a sleek brushed aluminum material with a premium finish and laser etched markings.

Interview Q/A (Larry Pace)

Gary Reber, Widescreen Review: How is DARBEE Visual Presence (DVP) image processing technology different from other image enhancement solutions?

Larry Pace, DarbeeVision: There has been a relentless pursuit to reproduce the fidelity factors of the scene. Photography started as black-and-white, then went to color, more pixels were added, more color, more contrast and sharpness. DVP is successful because it comes from an entirely different approach. This special technology synthesizes and embeds depth cues into images that your brain would normally do by comparing the two eye viewpoints. When you take a picture, the depth cues are not in the scene, so you cannot capture and reproduce them. The depth cues are computed by your brain, from having observed the scene by way of the two viewpoints. In this way, DVP depth cues are unlike fidelity factors. We analyze the image on a per pixel basis to determine how depth would be computed by your visual system and brain, then modify each pixel's luminance in such a way that the entire image holds the information required to understand it better.

WSR Reber: Can you give examples for how DVP is compatible with the modern imaging technologies?

Pace: For resolutions, including 4K, 8K and beyond, DVP is fully agnostic to the high or even very high pixel formats. We have very successfully processed ultra-high megapixel count image files. What we see, in general, is that as the quantity of pixels increases and the quality of the pixel data increases, DVP processing does a better job. For high dynamic range images, DVP creates an HDR-like perceptual improvement in the local dynamic range, and remember, this shows up while neither having to increase the requirement of encoding, nor implementing expensive decoding hardware, nor implementing expensive screen technology upgrades. These are not necessary because the human eye system does the decoding. For wide color gamuts, even though

we do not process color data, DVP makes dynamic range of the colors look better. DVP is compatible with, and an enhancement for all color technologies that support standard color and wide color. For example, it would be compatible and complementary to Quantum Dot or eeColor applications. High frame rates allow greater persistence of spatial information to your visual system. This factor also makes DVP show up better.

WSR Reber: What about the range of displays? Does display technology matter to you (LCD, OLED, projection, EPD, etc.)?

Pace: The better the display technology can maintain fidelity to the captured scene, the better DARBEE Visual Presence shows up. We like to say that DARBEE Visual Presence is compatible and complementary to all display technologies.



Interview Q/A (Jack MacDougall)

Gary Reber, Widescreen Review: What inspired Pixelgen to enter the world of video processing and the 4K DVP solution specifically?

Jack MacDougall, Pixelgen: In a way, entering the world of Image Processing with DVP was a natural evolution for Pixelgen. Within our class-leading, long-haul 4K signal transmission methods such as PXLDRIVE and PXLGLASS, we pioneered cutting-edge technologies as a means of delivering these signals perfectly intact—that is, no compression and full interconnect functionality. With the new Pixelgen PXLVISION 4K DarbeeVision solution and latest Intel FPGAs, it allows us to do things with these unscathed pixels we have worked so hard to maintain and in ways that have never been done before. The 4K DVP effect is simply unrivaled in my eyes. It continues our company mantra of high value-add, simplicity, and reliability toward some truly incredible application potential—even outside the home theatre.

WSR Reber: How did DarbeeVision and Pixelgen meet?

MacDougall: This is something I think about often. In 2013, CEDIA Expo Colorado, there was an event prior to the public opening called CEDIA Unveiled. This event allowed the press to tour around the new product offerings, one 8-foot table at a time. I attended this event as an exhibitor, working as an engineering OEM consultant for a cable reseller under the company name, PhaseHD. So, just me at this point, Pixelgen was still a few years away yet.

When the event was winding down, I was able to walk the floor before teardown. As I serpentine my way through the setups, I came across something that I had not seen thus far, a company promoting something that was *not* interconnect related—so yeah, this intrigued me. I approached the table and found myself inadvertently staring at a 24- to 30-inch monitor that was displaying a city park landscape with a sweeping left-to-right vertical demo-line that essentially rolled over what I can only assume was the inferior capabilities of the monitor itself. Having worked for a prominent Image Processing Semiconductor company in the past, I was familiar with many of video processing tricks, but I had never seen anything like this.

I eventually started talking to some of the DarbeeVision staff about what I was watching and in retrospect, I think they approached me because they were worried about me as I blankly stared at the screen. The DarbeeVision team was friendly, engaging and extremely knowledgeable. After a few discussions with their head engineer, Will, I was introduced to Larry.

Larry asked a bit about my work, and we walked back to my home booth, and it was clear that he “got it” immediately. So that was the beginning of the relationship. A few years later, I was available to have my team assist in the hardware build of the DVP 5100-CIE (Custom Installer Edition), a rack-mountable 1080p DVP-enabled processor with many installer-friendly features, including built-in, long-reach cabling capabilities. This is where Larry and I started to see our synergies and strengths in action, and this is what would eventually set us up for the next act, 4K PXLVISION, Powered By DARBEE.



WSR Reber: It is obvious that you are a big fan of DarbeeVision, can you describe your first viewing experience of the 4K DVP?

MacDougall: Yes, a big fan—probably Fanboy territory. It all started back in the spring of 2019, in a darkly lit Pixelgen lab. A few of our engineers were huddled around some sort of experiment on the bench (which I cannot recall honestly). Away from the huddle, I was watching a streaming video clip running through our DVP-5100CIE unit from a laptop at the time, and I switched the video format from 720p to 1080p and noticed how the DVP aspect of the experience was enhanced, and I felt like it wasn't just the resolution boost—it was something else. Out of curiosity, I called up Larry and asked him (like everyone else) if there was a way I could test out DVP at 4K. The answer was, yes, obviously. Fast forward a few weeks and I swapped out the DVP-5100CIE with an Intel Altera 4K Evaluation kit Larry had sent me, loaded with the brand-new 4K DVP prototype. First, I played back the same clip I had previously played at 1080p and then switched to 4K. I was absolutely awe-struck and knew immediately that this was something special. I feel it does a disservice to say that the image “popped,” as this term is thrown around a lot, but it truly did... but not in a way that distracted me from what I was watching and certainly not like those high refresh rates responsible for the dreaded “Soap Opera” effect. Simply put, I enjoyed viewing the 4K content more with DVP enabled. I moved to an optimal viewing distance and observed the image of a tropical sunset with a rocky shoreline in the foreground. The remaining sky-blue in the distance was completely flat, as it should be, when I turned the 4K DVP on, but the details surrounding the glimmering sun-reflected water near the rocks started to shine more naturally. It felt like the image was mimicking the sights I would see from being there in person, but again, in a way that did not feel synthetic or contrived.



Original Image

DARBEE Image - Setting 100

WSR Reber: There is the obvious fit for PXLVISION within the home theatre space, but what other applications could take advantage of the 4K DVP IP using this product?

MacDougall: You're right, home theatre is the perfect fit for PXLVISION and is an area we hope to live in for a long time. However, the consumption of entertainment is changing every day now, especially due to COVID. There is no doubt that people were forced into the realities of staying home and staying safe, but I feel like this has started a new trend of home entertainment in and out of the home in non-traditional ways. For example, in the past few months (and at much-higher-than-normal frequency), integrators and enthusiasts alike have been contacting us for ways to get from A to B, where "A" started in the home and "B" was outside somewhere in a backyard by the pool. So, with the obvious drawbacks of outdoor viewing using 4K TVs or projection, PXLVISION can provide that much-needed pop and realism for maximum enjoyment in all environments... and weather. As far as applications outside the residential bubble, we have already had interest in areas of mass consumption such as stadium screens for sporting events, commercial projection mapping and signage. We have also had talks with several well-known equipment manufacturers about the value PXLVISION can offer towards Flight Simulation, Surveillance, Virtual/Augmented Reality, Instant Replay/Slow Motion broadcast and even Medical Imaging. Yes, 4K DVP is that good, and Pixelgen is extremely excited to support these adjacent markets and unique applications.

WSR Reber: What is the future for PXLVISION? Are there any follow-up plans for the initial standalone dongle itself?

MacDougall: The relationship between DarbeeVision and Pixelgen is simple. DarbeeVision will pursue embedded 4K DVP opportunities for sources and displays while Pixelgen, with PXLVISION, will reside in setups that are not yet supported with 4K DVP. It is important to mention that both companies have the same goal in mind—get DVP tech to the world in more and more accessible ways, embedded or external. In a way, this promotes some friendly competition. With this, Pixelgen is already planning on future hardware iterations utilizing 4K DVP. We are already in the product definition stage of a Custom Installer rack-mount edition and an uncompressed IP-based extender pair as well. Beyond that, there are even plans for an active cable with embedded 4K DVP. Of course, our focus right now lies in the timely release of the standalone 4K PXLVISION in its dongle form factor, so first things first. It's important to keep in mind that DVP can scale with whatever

video parametric is thrown at it. DVP is well suited to work its magic alongside future video formats such as 8K, higher frame rates and deeper bit-depths for future HDR format support (for example), which will surely add more new product potential within the PXLVISION portfolio as standards evolve. Pixelgen, alongside DarbeeVision, are ready and excited to adapt accordingly.

Conclusion

DarbeeVision is back, and its supporters [myself included] are thrilled at the news of DVP making its long-awaited and triumphant return with the announcement of the Pixelgen PXLVISION 4K Video Processor, powered by DARBEE. It is clear that both DarbeeVision and Pixelgen are harnessing their greatest strengths to make PXLVISION a reality, and in very uncertain times no less. Today, both companies are forging forward with the development of PXLVISION. Almost exclusively working from home, due to the COVID-19 pandemic, they have their engineers hard at work with one goal in mind, to deliver 4K DVP to the world for all to enjoy. It is a happy and healthy distraction. **WSR**

