White Paper:

The Impact of Color Technology and Refresh Rates for Desktop Monitors

Introduction

Shape, scale and resolution tend to get the most attention when businesses are weighing their options for new monitors in the workplace. However, less understood technical specifications can also have a big impact on matching the display to the task.

Measurements like refresh rates, response times and color space — details that are rarely the headliners in most manufacturers' marketing materials — can make the difference between workplace monitors that are perfectly suited to work demands and workplace monitors that hinder productivity.

While day-to-day workplace applications like office productivity and email can be handled by most conventional monitors, there are many varied jobs that require rock-solid and silky-smooth content playback and ultra-accurate color reproduction. In those cases, the people tasked with finding monitors that optimize workplace performance will benefit from understanding the small technical details associated with modern monitors and matching the specs to the needs.

This paper takes a deep look at some of the lesser-known — but oftentimes critically important — attributes of monitors and provides valuable insight for anyone trying to make the most of workplace and consumer monitor investments.

A Full Tapestry

Rich, deep and precise color reproduction may not matter in a finance department where staff members are looking at spreadsheets, Word documents, emails and invoices. But there are many tasks, across a broad spectrum of industries and use cases, where what's on the screen needs to accurately represent reality and adhere exactly to a brand's visual standards.

Global brands don't think in terms of generalized colors when it comes to creating a logo, like red or blue. They use very specific colors — among the most famous and iconic of which is Coca-Cola's particular red.

Healthcare imaging needs diverse, accurate color to analyze visual tests and make appropriate and sometimes life-dependent decisions. Exploration companies want accurate color to analyze geophysical tests that guide what are usually multimillion-dollar decisions about where to drill and dig.

Creative professionals in film, video, photography and animation all need editing monitors that accurately and precisely reflect what was captured by the camera or their original creative vision.

The dimensions, shape and pixel density (resolution) are important for these tasks. Large, wide and even curved screens can be critical to the working task because of the visual scale and depth in detail of what staffers are seeing and working on.

Conventional Monitor

Samsung UR55 Monitor

Exploring Intricacies

Just as important to their work and output are measures such as color gamut — the amount of the color spectrum that a monitor can reproduce. Gamut ties into a related term, color space, which, in simple terms, refers to the range of colors that can be represented in an image. For example, a color space of 100,000 colors would reproduce visuals that are inferior to a color space of 1,000,000 colors. This is because having 10 times the color variations will smooth out the image. It might look blotchy with fewer colors.

There are two common color spaces available with most of today's mainstream and even specialized monitors: sRGB and AdobeRGB. Here's a look at each:

sRGB stands for standard Red, Green and Blue. sRGB is the color space used on most computer monitors. It is the accepted standard for most visuals we see on screens, and a lot of today's software applications are developed around sRGB color space. For many workplace applications, the sRGB color space is sufficient.

For creative pros like gaming developers, graphic designers and motion media editors, the less common **AdobeRGB** color space measure is an important upgrade. AdobeRGB typically has a color gamut that's about 20 percent wider than sRGB.[1] More colors mean more vibrancy and depth, and far more accuracy in tasks that demand color precision.

sRGB

AdobeRGB
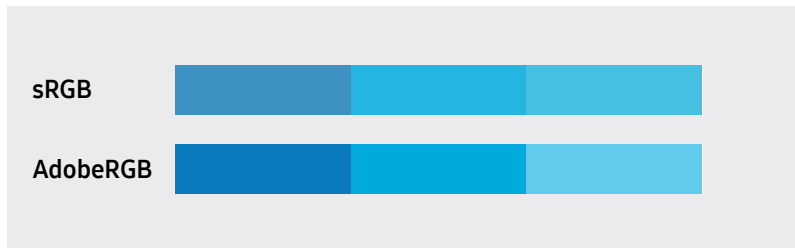
There are other color space ratings, too, such as CIE 1976, which is limited and traces back to the year for which it was named — the Stone Age for monitors.[2] At the other end of the color spectrum, NTSC is a 1953 measure of the color space that can be represented to the human eye and, despite its age, is wider than AdobeRGB.

Color Percentages

Monitors tend to be rated by what percentage of colors from a color space they can produce. A monitor's specs may say it's rated as capable of producing 80 percent of a color space. In the case of some monitors that use enhancement technology like quantum dots (see below), a display may be rated to produce more color than in the defined space, such as 125 percent of sRGB. That's possible due to more available light and the saturated colors that result.

Emerging Visual Technologies

Two emerging technologies are driving and revealing more color on monitor screens: **quantum dots** and **High Dynamic Range (HDR)**.

Quantum dots are nanoparticles that manufacturers such as market leader Samsung add to the layers of films, filters, glass and electronics that make up an LCD display.

The humanmade nanoparticle has semiconductor properties and can be as small as two nanometers. Applied to a sheet of film that sits as a layer in front of a monitor's backlight, the light passing through a quantum dot color filter results in a wider and more saturated range of colors than would otherwise be possible.

By one estimate, quantum dots increase the color gamut on monitors, such as Samsung's QLED display series, by about 50 percent.[3] A QLED display can deliver more than 1 billion colors, producing vivid, saturated colors and extraordinary levels of detail.

A separate technology — HDR — helps amplify color reproduction and the range of visible color. HDR reveals the finer elements in the brightest and darkest elements of an image or video — elements that are typically lost when shown on non-HDR screens. HDR means viewers no longer need to squint, lean in or look away confused when viewing dark, atmospheric visuals. HDR enables viewers to see it all and that can matter with everything from a nighttime movie battle to core samples and radiology scans.

A Refreshing Difference

Refresh rate is the measurement of the number of times a monitor updates each second with new images. A visual on a display monitor may appear solid to the naked eye, but what's imperceptible to normal vision is how the screen is actually refreshing itself as frenetically as 240 times each second. The higher the refresh rate, the smoother the delivered visuals.

The most common refresh rate for today's desktop monitors is 60Hz, a technical description of the screen refreshing itself 60 times per second. There are monitors that support 75, 120, 144 and even 240Hz refresh rates — the highest level aimed primarily at the fast-paced gaming market.

For conventional workplace tasks, such as working on documents or within collaboration tools, 60Hz is usually sufficient. Higher refresh rates become important when

movement within the content is involved. The majority of Hollywood movies are shot and produced at 24 frames per second, making a 60Hz monitor more than capable of keeping up. But video being shot these days, even via smartphone cameras, can have far higher frame rates, and a 60Hz monitor may not be up to the task.

When refresh rates and frame rates are mismatched, it can result in something called screen tearing. When a computer's graphic card is pushing out more frames than the monitor's refresh rate can handle in a given moment, users may see two half-frames on a screen at once, bisected horizontally and slightly misaligned.

Another technical term closely related to refresh rate is response time — the time it takes a pixel to change colors, like going from white to black. A monitor can only refresh as quickly as the LCD display can make the rapid-fire color changes, pixel by pixel.

A lower response rate — 4 milliseconds versus 16 milliseconds, for example — reflects faster changes and higher performance.

Putting Specs to Work

The need for creative pros and gaming developers to have super-fast, smooth visuals is obvious. But there are other use cases that also benefit from that kind of performance.

For example, people working in financial markets are working with a full array of monitors at their desks that are steadily showing a range of hyper-kinetic financial indicators. Tickers — information moving across screens — are common, and slow refresh rates and response times may cause what should be smooth and real-time crawls to instead slow down or even briefly stop.

In other cases, visuals that need to be crisp for interpretation are blurred as the monitor tries to keep pace with the information coming in real time. Dynamic charting that reflects instantaneous trading information may also lag, and a typical trader may have eight or more charts open on a screen at a given time as well as multiple other screens showing messaging and news alerts.

In a system where split-second decisions matter and algorithms drive many aspects of trading, even momentary delays on what's visible on a screen can be costly and unacceptable. Higher refresh rates, such as 120Hz, reduce or eliminate the risk.

The visual entertainment industry is also evolving. Film shot in 24 frames per second has been the standard for decades, but in recent years, filmmakers have experimented with shooting at much higher frame rates — all the way up to 120 frames per second.

For medical professionals on both the research and treatment side, high resolution, deeply detailed and rich visuals contribute directly to critical insights and accurate diagnoses. Specialists and patients both want absolute accuracy and certainty when it comes to reviewing tests such as CT scans and mammograms.

They also want to be fast. Some medical imaging uses multiple frames, best viewed in high-speed multiframe image sequences. That includes tests such as tomosynthesis, breast ultrasound and breast MRI. Slow refresh and response times could result in blurring or lost detail.

Other Factors

Tuning the monitor to the need is important, but decision makers should also weigh other factors when matching displays to the working scenario.
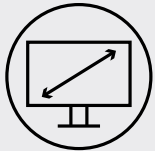
Form Factor

Widescreen displays are allowing multitaskers to run several software applications on a single screen, negating the need for side-by-side or stacked monitors. Wide and super-wide screens also enable some professionals, such as project managers and motion graphic designers, to view entire timelines without needing a bottom scroll bar.
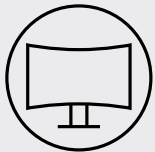
Ergonomics

Seen at first as a novelty, curved monitors have found a home at workstations for busy professionals who want or need to be immersed in their working activities and who benefit from a curved design that equalizes the focal distance of whatever and wherever elements are located on a screen, thus reducing eye strain.
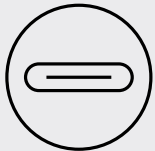
Clutter and Costs

Monitors that fully support USB Type-C connectors reduce or often eliminate the need for costly and trouble-prone desktop docking stations. This also reduces the number of connector cables needed and turns monitors into USB hubs.
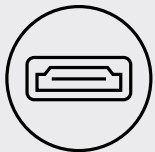
Source Signal

A monitor's output is only as good as its input. A premium monitor with all of the technologies in place to optimize visuals still depends on its input signal, which requires suitable integrated or supporting graphics capabilities on the computer and the proper cables to relay that signal.

Making Good Choices

There's more than meets the eye when it comes to desktop monitors. It would be easy to simply look at demonstration monitors and make selections based on the form, price and how the content looks on a screen.

But a great-looking monitor at first blush might not hold up under pressure, as its specifications won't fully support the content being viewed.

Conclusion

While in some cases most monitors may be sufficient for a desk job, there are many workplace scenarios where the wrong monitor could result in slowed, suboptimal production and delays. This can lead to costly mistakes for a company or, in the case of medicine, caregivers and their patients. On the other hand, choosing the right monitor for the right reasons ahead of time can seriously improve your capabilities when it matters most and single you out from the slower competition.

Learn more about Samsung's wide variety of desktop monitors and the use of quantum dot technology along with best-in-class refresh rates.

Footnotes

1. https://www.trustedreviews.com/news/monitor-colour-spaces-adobergb-srgb-2949078
2. https://insights.samsung.com/2019/08/21/the-evolution-of-desktop-monitors/
3. http://energy.mit.edu/news/running-the-color-gamut/

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