

Adobe® Premiere® Pro Productivity Study

A comparison of Adobe Premiere Pro CC 2014 and
Adobe Premiere Pro CS6 running on Dell Precision™ workstations



In partnership with



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The performance results and statistical information reported in this paper were derived from tests requested by Adobe, Dell, and NVIDIA. These tests were conducted over a controlled network using Adobe Premiere Pro CS6 and CC 2014 software, a Dell Precision™ Tower 7600 workstation and a Dell Precision Tower 7910 workstation, and NVIDIA® Quadro® K5200 and Quadro 5000 professional graphics cards. Tests measured selected tasks designed to simulate day-to-day postproduction needs. As with all performance tests, results may vary based on machine, operating system, filters, and even source material. While every effort has been made to make the tests as fair and objective as possible, your results may differ. Product information and specifications are subject to change without notice. Adobe, Dell, and NVIDIA provide this information "as is," without warranty of any kind, either express or implied.

Executive Summary

Computer systems are regularly measured by using standard benchmarks. However, in the field of postproduction, traditional benchmarks don't provide data that's useful for system evaluation. Too many variables exist in user workflows; each editor and each facility may use a different equation to produce their work.

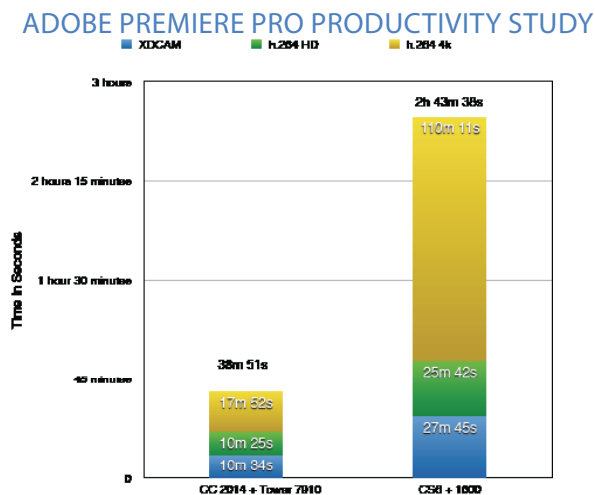
At a deeper level, user productivity is even more difficult to measure. There's a quote often used in postproduction: "A job is never finished. It is abandoned when the deadline happens." Anything that can improve productivity leads to higher-caliber finished work, given that more time is spent on making the work more finished.

I was given the opportunity to examine the time and productivity differences in a two-generation gap, between hardware and software from 2012 and today, the last quarter of 2014. A comparison between old and new software and hardware requires a flexible test bed. I needed to design a series of tests that would be meaningful to a video editor. These aren't everyday users of hardware. They require a workstation with well above average horsepower and often look at the maximum capabilities offered. For these reasons, it was important that the testing was conducted by a professional who truly understood the obstacles that stand in an editor's way to creativity and project completion.

To quantify the potential improvements a typical user is likely to experience, I took an intensive project with more than 100 effects—five minutes of 4K (UHD 3840×2160)—and pushed it through a variety of tests to clarify the likely benefits of upgrading hardware and software.

Summarized Results

Updating the hardware and software increased output productivity by 321% and improved rendering productivity by almost 36%.



Total time improvement of upgrading the hardware and software of a series of group of outputs, including an XDCAM, h.264 HD, h.264 UHD (4k) files. Shorter times is better.

This was accomplished by upgrading the following:

- The workstation from a Dell Precision T7600 to a Tower 7910
- The graphics card from an NVIDIA Quadro 5000 to an NVIDIA Quadro K5200
- Adobe Premiere Pro from Creative Suite 6 (CS6) to Creative Cloud (CC) 2014

Each increase is individually addressed in this study.

Struggle with Benchmarks in the Industry

The request to do a study like this is complicated by the variety of benchmarks on the market. None of them directly apply to work in video, particularly to the heavy lifting involved with video: output and rendering.

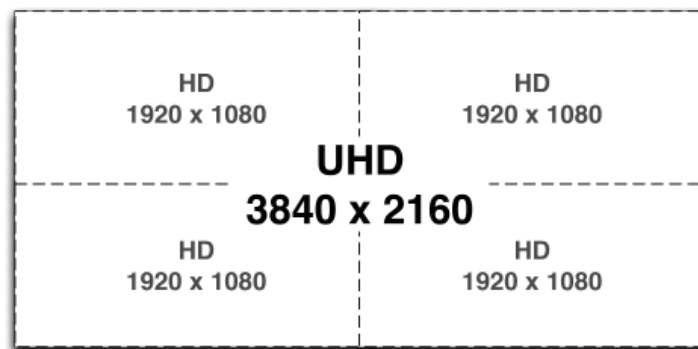
A real-world test would be ideal. This would stress the hardware and software and have measurable results that could illuminate the differences between the tools tested.

I focused on testing those events that were common stopgaps, in which work grinds to a halt. They are measurable, necessary, and unavoidable in editorial work.

Opportunity to Test a Real-World Project

I took a 4K (UHD 3840×2160) project and performed more than 100 measurements using both older (CS6) and newer (CC 2014) versions of Adobe Premiere Pro and Adobe Media Encoder on two hardware beds.

A five-minute 4K project was chosen to test the hardware and software (one test required in excess of eight hours). This project is the equivalent of performing similar testing on a twenty-minute HD project, given that UHD has four times the number of pixels as HD.



Ultra High Definition (UHD) screens carry four times the information of High Definition (HD.)

Productivity Breakdown

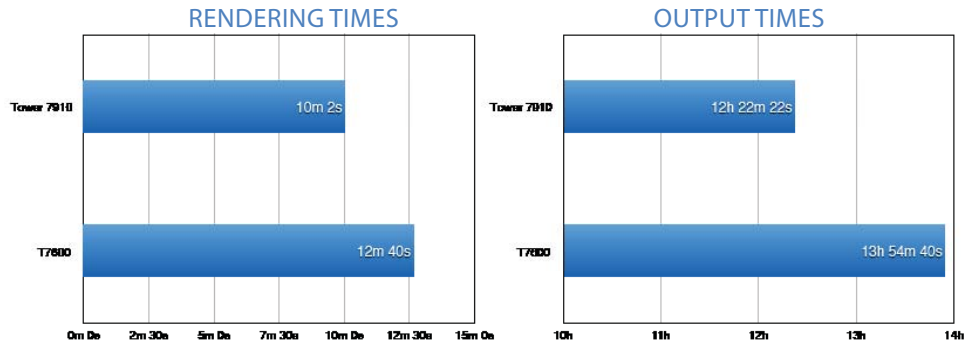
I studied three variables: upgrading Dell hardware, upgrading NVIDIA hardware, and upgrading Adobe Premiere Pro software. A summary of the basic method and results follows.

Computer Hardware

To determine the productivity change of a new Dell workstation, I tested Adobe Premiere Pro CS6 and CC 2014 on both systems. I disabled the GPU acceleration in Premiere Pro, meaning the test differentials were solely based on the Dell hardware. RAM and storage were identical on both systems.

The Dell hardware update showed productivity improvements in rendering times by over 26% and output by 12.43%.

DELL HARDWARE UPGRADE COMPARISON



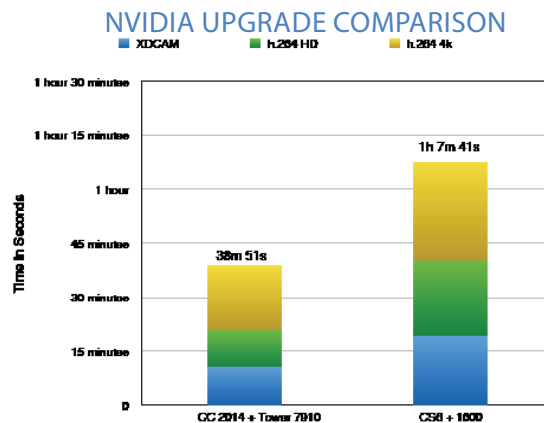
Comparison representing the gain by upgrading the Dell hardware. Shorter is better.

Additional testing of the Dell Precision Optimizer—a unique software configuration tool for adjusting the hardware settings based on advice from Adobe—yielded productivity improvements of approximately 5%.

Professional Graphics

In looking at the two hardware platforms, one with the NVIDIA Quadro K5200 card and one with the NVIDIA Quadro 5000 card, I focused on effects that were accelerated by the cards. Testing was performed on both software versions to provide enough varied measurements.

The newer NVIDIA Quadro K5200 card showed an output productivity increase of over 74% and a rendering productivity increase of almost 20% on Premiere Pro CC 2014 when compared to the NVIDIA Quadro 5000.

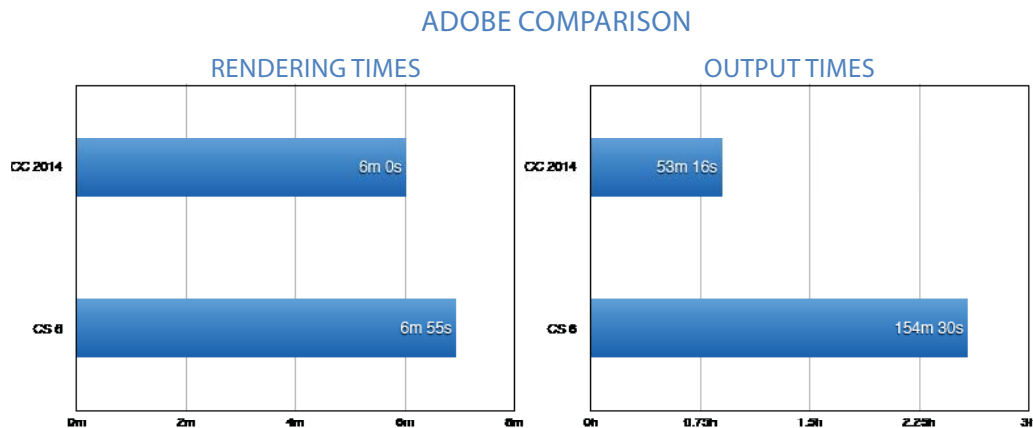


Export times of a set of files, comparing a newer system (left) with the Quadro K5200 graphics card, and an older system with the Quadro 5000 graphics card. Shorter is better.

Software

Isolating to a single hardware platform, I examined generating the same output and renders with Premiere Pro CS6 and Premiere Pro CC 2014. I performed a set of tests for the newer Dell Precision Tower 7910 with the NVIDIA Quadro K5200 card. I repeated the same tests for both versions of Premiere Pro on the Dell Precision T7600 with the NVIDIA Quadro 5000 card.

On average between the hardware platforms, output productivity improved by almost 208% and rendering productivity improvement of over 15% in Adobe Premiere Pro CC 2014.



Comparison representing the difference between upgrading Adobe Premiere Pro from CS6 to CC 2014. Shorter is better.

Conclusion

Editors will find that upgrading their hardware and software together will lead to significantly higher productivity and better final-quality work (given the standard that the work fills the available time).

The speed improvements and benefits run far deeper than just the numbers; the measurements are quantifiable processes that editors have to perform. There are a number of other areas where workflow is faster, but are difficult or impossible to measure.

Disclaimer

These tests are the result of my experience using these tools with my footage. None of the manufacturers changed, adjusted, or influenced these results.

While I believe that I was extremely thorough in the testing and did so with transparency, I cannot guarantee that your results will match mine. Each individual workflow (footage, effects, hardware) is unique enough that your results could differ.

The Study in Detail

In the fall of 2014, Dell, Adobe, and NVIDIA approached me to conduct a study comparing their tools from 2012 and 2014 for professional video postproduction needs. They wanted testing that would reflect real-world usage, instead of benchmarks, which typically do not resemble video production hurdles.

Essentially, I was looking at a two-generation gap in hardware and software. Sure, new is faster, but how much faster? And how much should it matter to those of us who use the tools? Often I encounter users who say that what they have is “good enough.” And I always question, is it? While each of us has to decide what “that point” is, we’re in a rapidly evolving field, where one cycle of software or hardware is noteworthy, but two may be significant. My feeling was, could I quantify how significant?

I created a study that would minimize measuring the soft, “creative” work of editorial and focused on the areas where every editor struggles—during the rendering and output phases.

Post-production work fills the available time. The most painful parts of the industry are periods in which the editor sits around and waits for the hardware to perform a calculation. During this period, the system is tied up.

This study focused on determining how much time these hardware and software updates can save the end user. I expected to see a difference, but as an experienced user, was pleased and somewhat surprised to see how significant a difference was demonstrated.

While I focused on a couple of specific slices of editorial tasks for practicality, it’s important to understand that these insights extend to everyday use for a professional. Gaining performance in the most painful areas of video creation nets the greatest possible gain as a percentage of time saved. This results in higher productivity, lower project cost, improved quality, or added complexity.

Real-World 4K Project as a Test Bed

Again, a comparison between old and new software and hardware requires a flexible test bed. What tests are meaningful to editorial users? The tests had to be designed for this group (which I belong to). These are users who push hardware, every chance they get. We’re talking about workstations that are designed with many, if not all, of the speed options possible. This type of work is never about using the minimum specifications, but rather closer to the maximum capabilities offered. That’s why I was willing to be involved—the tests would be designed by someone who truly understood the obstacles that stand in an editor’s way to creativity and project completion.

Test Beds Are a Problem

It’s pretty easy to measure generic disk speed and performance. Numerous tools on the market can measure CPU, RAM, and/or disk speed. You start the tool, point it at the hardware, and get a numeric result.

Testing actual video-editing tools, however, is much more complex to measure.

Too many user-related factors are in play to give a good indicator of the benefit of that performance by just relying on a generic hardware metric. Yes, there are common variables such as disk speed, graphic cards, CPU cores, and RAM. But it’s the nuances that are unique to each workflow (and sometimes each project) that we have to assess to understand value.

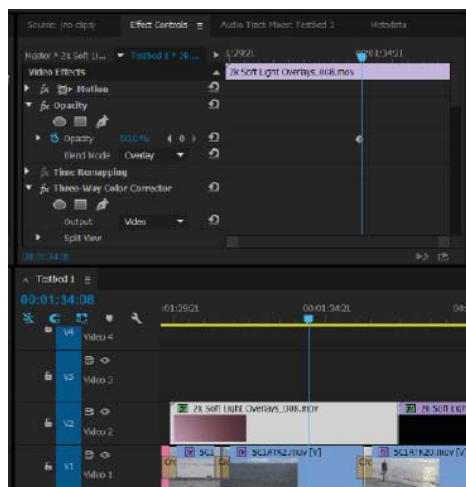
For example, what format of footage was used? Was it RED R3D? Was it XDCAM? Did someone pick a workflow that would directly use RAW sensor data? Was footage shot fairly flat? Does the footage require a LUT?

Instead of trying to pick something representative of infinite variations, I chose to use a real Premiere Pro project run through various outputs. This would help shed light on the practical speed differences between combinations of newer and older hardware and software.

It had to be a project that was *inherently stressful*. It had to be 4K.

This denser resolution represents common sizing such as ultra-high-definition (UHD) and above. The industry is moving toward 4K for some key reasons. It's the equivalent resolution of motion-picture 35 mm film. It can be scaled down to high-definition (HD) sizes. Alternatively, footage can be shot at 4K and reframed as needed to a lower HD resolution. Shooting at this size future-proofs work. Finally, it's a high enough resolution that stills can also be used in traditional print media.

The project also needed to mix in existing footage. It had to include some HD mixed in to be scaled up, commonly used transfer (or blending) modes, and lots of effects. It is expected that every shot will get some color correction.



Transfer modes permit multiple tracks to blend together. The clip in this image is using the Overlay mode.

So, I decided not to use a benchmark that can be gamed by a specific component test. It was smarter to use an actual project to make comparisons, and then measure performance based on how the whole computing solution (software and hardware) created common outputs with key variations.

Project Description

This project was a short five-minute promo to be run on HD and 4K screens. It showed scenic footage in the background for display in 4K, but also had to be portable for viewing on mobile devices and on the Web.

Description of Footage

Most of the footage was of exteriors (beaches, fields, and water), slow comfortable beauty shots cut against music. About a minute of the project had footage on a higher track of light leaks overlaid to give an organic feel. Every single shot had at least a three-way color correction (or Lumetri™ effect) for color timing.



Shot of a Bowers Beach, Delaware, color corrected with a LUT applied

Why Choosing a 4K Project Was Important

Choosing 4K footage was crucial to put the *most stress* on Premiere Pro and the hardware (both the Dell and the NVIDIA GPU^s). While the finished work is only five minutes in duration, it's more comparatively like twenty minutes of HD footage. The finished 4K material was set to UHD at a resolution of 3840×2160.

Since UHD is *precisely* four HD screens, it permits the ability to infer what output times would be like and can be compared to common HD projects.

Types of Footage

The project I used has three video formats: ProRes 4444 from a Canon C500, R3D from RED Epic, and H.264 HD footage.

The majority of the footage was shot on a Canon C500. Footage was acquired via an AJA Ki Pro Quad. The footage was captured in a QuickTime container and stored as ProRes 4444 to provide maximum flexibility. This was easier than handling the RAW or DPX files, which would have required a tethered system. Additionally, by using ProRes 4444, maximum quality was kept while reducing the overall data rate to permit future proofing without having to store or handle RAW files.

| Name | Video Codec |
|----------------------|-------------------|
| SC1ATK2.mov | Apple ProRes 4444 |
| 2k Soft Light Overla | H.264 |
| A002_C013_080604 | REDC |

A mixture of different footage and codecs was used on the project.

The RED footage was shot on a RED Epic and worked with the RAW R3D format, compressed to 6:1. No transcoding was needed because of the ability of Premiere Pro to edit native formats. Playback was significantly smoother in the newer software, the CC 2014 release, because of the ability to debayer RED footage on the NVIDIA Quadro GPU.

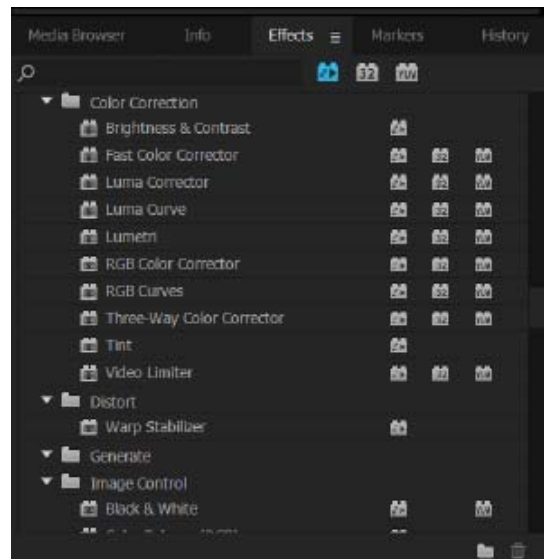
Some stock footage, primarily a variety of light leaks, was used at HD and scaled up over the footage. This footage was composited on a higher track and added with either the Screen or Overlay blending mode to interact with material on the lower track.

Editorial/Effect Choices

This project was picked to be a fair arbiter between Premiere Pro versions. Effects chosen were specifically modified to guarantee that they existed in both older and modern versions of the applications.

Adobe created a groundbreaking architecture called the Mercury Playback Engine. This technology leverages the 64-bit pipeline, all the CPU cores available, and as much RAM as possible. Additionally, the Mercury Playback Engine may employ additional acceleration through the video card, using the GPU cores and RAM—a crucial nuance for this study. This GPU-specific acceleration can be turned off to help visualize the GPU advantages.

For their workflow, editors intentionally pick effects that will benefit from the Mercury Playback Engine, guaranteeing maximum performance, and I've reflected that choice in the testing.



Optimizing Adobe Premiere Pro to use only GPU accelerated effect improves playback, rendering and output.

The following are some details about the effects chosen in the project :

- About a half dozen times, there are multiple streams of video, with scaling/picture in picture effects.
- Every clip has a Three-Way Color Corrector effect for base color correction. A smarter modern workflow would have been to use Adobe SpeedGrade™ along with its Lumetri effect. That workflow wasn't really feasible until Adobe Premiere Pro CC, so it was purposely modified for this study.
- An adjustment layer with RGB curves was used to cover the entire timeline to replicate a bleach bypass look.
- A single shot required the Warp Stabilizer (inside a nest, because of a size mismatch of the main sequence).

These effects are common and represent a good variety that would typify the requirements of other projects.

Hardware Description

Dell and NVIDIA provided hardware that represented an ideal capability for what constituted an editor's workstation in 2012 and a similar-model workstation with a 2014 configuration. These configurations were chosen based on Adobe's hardware and software specifications for Adobe Premiere Pro.

Differences, where applicable, were treated with price sensitivity. This means that while the speed of the system components and internal design had increased over time because of the pure improvements in technology, the system costs attempted to represent similar capabilities at the time of purchase. In other words, the workstations represent what you would have bought then, and what you would buy today, with the same amount of money, adjusted for inflation.

Original System

The older system was a Dell Precision T7600 workstation, with a 256 GB boot SSD running Microsoft® Windows® 7.1 Pro. It had dual Intel Xeon E5-2687W, 3.10 GHz, 8 core (16 virtual) processors and 64 GB of DDR3 RAM. Dual 1 TB 7200 RPM, RAID-0 HDDs were reserved for media storage and caches. Our graphics card was a NVIDIA Quadro 5000 with 2.5 GB of GDDR5 GPU memory and 352 NVIDIA CUDA® parallel-processing cores to provide acceleration capability to maximize the Mercury Playback Engine.

New System

The newer system was a Dell Precision Tower 7910 workstation, with a 256 GB boot SSD running Microsoft Windows 7.1 Pro. It had dual Intel® Xeon® E5-2697 v3, 2.6 GHz, 14 core (28 virtual) processors and 64 GB of DDR4 RAM. Dual 1.2 TB 10K RPM, RAID-0 HDDs were reserved for media storage and caches. The newer graphics card was a NVIDIA Quadro K5200 card (based on next-generation GPU architecture) with 8 GB of GDDR5 GPU memory and 2304 CUDA parallel-processing cores to provide acceleration capability to maximize the Mercury Playback Engine.

Displays

Dell provided a standard HD display (2K), and two Ultra HD (4K) displays for the study. Having a variety of displays permitted me experiment in setting up an optimal work environment. This way I could actually see my footage in its full resolution during editorial, and to compare it as viewed in HD. The 2K display also featured PremierColor with 99% AdobeRGB and 100% sRGB coverage for accurate depiction of the project material. The Dell models provided were the Dell UltraSharp 24" PremierColor Monitor - U2413, the Dell UltraSharp 24 Ultra HD Monitor - UP2414Q and the Dell UltraSharp 32" Ultra HD Monitor - UP3214Q.

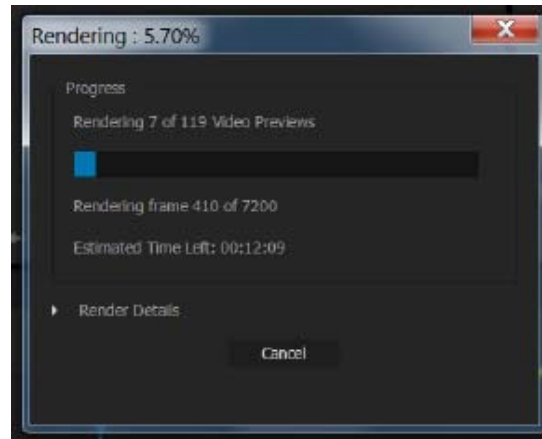
Testing Format

There are two *major* pain points in editorial: output and rendering. They are measurable, and every editor encounters them.

On the creative side, it's unrealistic to try to measure how long it takes to construct a story. News-based editors who work with deadlines, measured in hours (or minutes), work faster than documentary-based editors who may work over weeks, months, or years.

Some artists are gifted storytellers and can naturally sense how to construct complex work. Craft-based editors, whom we often think of as narrative/Hollywood editors, work from a script and meticulously have to watch every piece of footage. And there are a variety of editors between these outliers.

Yet, every single editorial group *has to output media*. Many of them may have to render to visualize playback, although the Premiere Pro tools minimize this requirement. Output and rendering are persistent bottlenecks and can't be avoided or bargained away within a project.



Rendering video previews in Adobe Premiere Pro.

Rendering was performed and measured to examine the following conditions:

- The difference between Dell hardware in terms of render times. Specific comparisons were made between new and older hardware, along with how the Dell Precision Optimizer affected render times.
- The difference between software from Adobe in terms of render times. Specific comparisons of older and newer versions of Premiere Pro on both hardware platforms were examined.
- The difference between NVIDIA hardware in terms of render times. Specific comparisons focused on the Mercury Playback Engine in Premiere Pro between CS6 and Creative Cloud on the software and hardware.

In testing rendering, I had the systems render all footage *to force rendering to provide a metric*. In optimal setups, these systems performed outstandingly with this project. Bear in mind that even with 4K media, that rendering was only minimally necessary.

Tests were performed in a detailed matrix and can be seen in the “Rendering Results” section. See the Analysis section for specific details.

Output

While rendering is a fairly straightforward measurement, output is much more complex. Most editorial projects include a minimum of two outputs: a file in a mastering codec (larger, higher quality), and a second meant for storage along with one meant for distribution (smaller, works on hardware devices such as Android and iOS).

Editors always struggle to estimate how long these outputs will take. No magic formula exists to guess the time needed, short of actually exporting the media. Output time is such a great unknown that it becomes common practice to perform a test output early in a delivery cycle to be able to accurately estimate the final encoding time.

Underneath the hood, Adobe Media Encoder is the compression engine that Premiere Pro uses. When you measure the output speed of Premiere Pro, you’re really measuring the partnership between the two tools.

Three formats were chosen for both Premiere Pro CS6 and CC:

- **XDCAM**—This is a common broadcast delivery HD output format.
- **H.264 HD**—At this time, H.264 is the most common distribution format. Down-conversion to HD represented a common file type based on the Adobe Media Encoder high-quality preset.
- **H.264 UHD**—This 4K file would represent a valuable distribution type for 4K media. The Adobe Media Encoder data rate for the HD output was quadrupled to mirror the greater pixel count between UHD and HD.

Premiere Pro CS6 has limited choices for outputting a master-quality file in 4K. While there are third-party work-arounds, there is no native output for a 4K master (aside from an unwieldy image sequence). So, the choice was made to not create a 4K master output for the CS6 tests.

Starting with the October Adobe Premiere Pro CC 2014 release (8.1), the GoPro CineForm codec was licensed and added as an output choice, giving true cross-platform 4K-master capabilities. CineForm outputs were limited to Adobe Premiere Pro CC 2014 on both hardware testing beds.

Minimizing Drive Speeds as a Factor

Both systems had identical 256 GB SSDs as OS/application drives. Both systems had identical RAID-0 internal drives, reporting speeds of 400 Mb/s. While read/write times do impact output times, this was fast enough to minimize the potential for drive speed's effect on timing results.

Test Matrix for Rendering

The following matrix represents the variety of measurements taken to demonstrate rendering speeds.

A render was performed for each of the following variations:

- Mercury Playback Engine (MPE) on/off
- Dell Precision Optimizer on/off
- Adobe Premiere Pro CS6/CC 2014

These three variations yield eight combinations for each hardware platform (T7600 and Tower 7910). All combinations were tested, for a total of 16 measurements.

Expected Insights on Rendering

It's expected that the configuration of the Mercury Playback Engine on, Dell Precision Optimizer on, and CC 2014 would produce the fastest render; and the converse, Mercury Playback Engine off, Dell Precision Optimizer off, and CS6 would be the slowest.

Values are shown in the "Analysis - Overview" section. The last section covers the analysis, where measurements were made to illustrate the productivity potential.

Test Matrix for Output

The matrix for output is more complex, given that the same eight variations (as in rendering) were tested, but there were eight outputs.

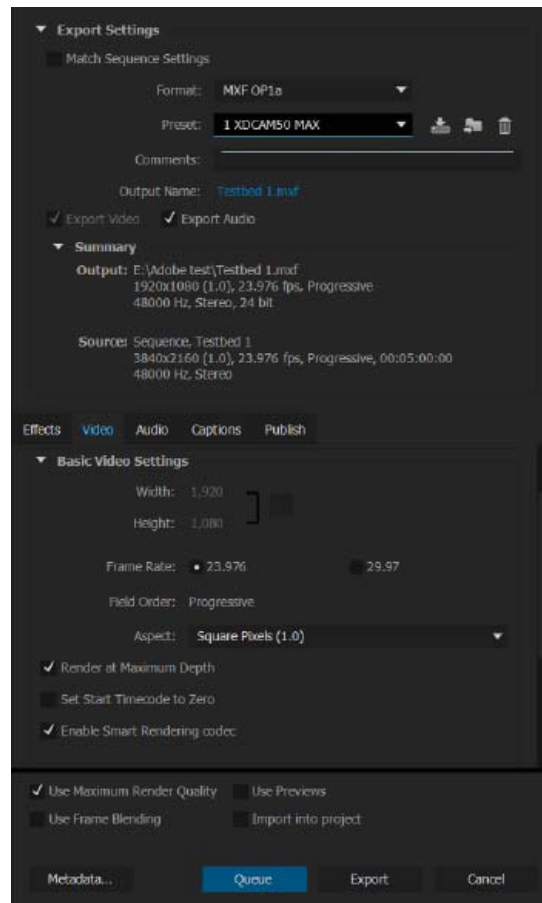
Six of these outputs would be tested on both software/hardware platforms. The 4K output could be performed on only the newer software, but both hardware beds.

The following variations, as above, were tested:

- Mercury Playback Engine on/off
- Dell Precision Optimizer on/off
- Adobe Premiere Pro CS6/CC 2014

Worth noting, 4K footage has an extra, distinctive demand: bit depth. Most HD footage has a limited (8-bit) color space, and most professional 4K cameras shoot a bit depth of 10 bits per pixel (or greater).

With these common higher bit depths at 4K, output should try to maximize its potential. Why shoot a robust and flexible format, if not to produce high-quality output? It would be unrealistic to acquire footage at this quality but choose to create low-quality output. So, the necessary settings for Maximum Bit Depth and Maximum Quality were also added to the test matrix.



Maximum Depth and Maximum Render Quality come at the cost of longer output times.

This meant that each individual output was tested on both hardware testing beds, producing 112 speed measurements.

The full matrix is shown in the “Output Results” section. The “Analysis- Overview” provides insights to illustrate the productivity potentials.

Rendering Results

Here are the results of rendering a timeline with 119 effects. These were done at the default RED timeline rendering settings of MPEG I-Frame based on Adobe Premiere Pro's sequence preset.

Renders were repeated in this matrix with the following variations:

- Hardware—Dell Precision Tower 7910 or Dell Precision T7600
- Software—Adobe Premiere Pro CC 2014 or Adobe Premiere Pro CS6
- Mercury Playback Engine on or off, addressing GPU acceleration
- Dell Precision Optimizer on or off, permitting measurement of this utility

TABLE 1 – RENDER TIMES

| | Time | Time in Seconds |
|--|---------|-----------------|
| 7910, CC, MPE on, Dell Precision Optimizer on | 5m 28s | 328 |
| 7910, CC, MPE off, Dell Precision Optimizer on | 10m 2s | 602 |
| 7910, CC, MPE on, Dell Precision Optimizer off | 5m 45s | 345 |
| 7910, CC, MPE off, Dell Precision Optimizer off | 9m 48s | 588 |
| | | |
| 7910, CS6, MPE on, Dell Precision Optimizer on | 6m 24s | 384 |
| 7910, CS6, MPE off, Dell Precision Optimizer on | 14m 8s | 848 |
| 7910, CS6, MPE on, Dell Precision Optimizer off | 7m 27s | 447 |
| 7910, CS6, MPE off, Dell Precision Optimizer off | 14m 33s | 873 |
| | | |
| 7600, CC, MPE on, Dell Precision Optimizer on | 6m 33s | 393 |
| 7600, CC, MPE off, Dell Precision Optimizer on | 12m 40s | 760 |
| 7600, CC, MPE on, Dell Precision Optimizer off | 6m 55s | 415 |
| 7600, CC, MPE off, Dell Precision Optimizer off | 13m 52s | 832 |
| | | |
| 7600, CS6, MPE on, Dell Precision Optimizer on | 7m 26s | 446 |
| 7600, CS6, MPE off, Dell Precision Optimizer on | 17m 30s | 1050 |
| 7600, CS6, MPE on, Dell Precision Optimizer off | 7m 55s | 475 |
| 7600, CS6, MPE off, Dell Precision Optimizer off | 18m 10s | 1090 |

Output Results

This section shows the results of the variety of output formats and system setups, making an in-depth examination of the various tests beds possible.

Decoding the Table

Table 3 – Output Results represents 112 outputs from Adobe Premiere/Adobe Media Encoder. *Table 2- Index for Output Table*, was created to help index and sort the results from Table 3, making analysis easier. Time was measured via examining the compression time reported by Adobe Media Encoder. Time is shown both in minutes and seconds, as well as just seconds.

Formats

Four formats were tested: XDCAM, H.264 at HD (1080) sizing, H.264 at UHD (2160) sizing, and CineForm at UHD sizing (only for Premiere Pro CC 2014, as it's not supported in CS6).

Each format is represented as a number (1, 2, 3, or 4) in the Format Index column.

Test Index

To make sorting through the results faster and easier (and to prevent confusion), a test index was created. There are three conditions, yielding a matrix of eight possible tests, labeled as a-h in the following two tables:

- Mercury Playback Engine on/off, representing the GPU acceleration
- Maximum Bit Depth and Quality, representing higher preservation of color fidelity and scaling
- Dell Precision Optimizer on/off, permitting measurement of the advantage of this utility

TABLE 2 – INDEX FOR TABLE 3: OUTPUT

| Index | MPE On | Max Bit Depth & Quality | Dell Precision Optimizer On |
|-------|--------|-------------------------|-----------------------------|
| a | Y | Y | Y |
| b | Y | Y | N |
| c | Y | N | Y |
| d | Y | N | N |
| e | N | Y | Y |
| f | N | N | Y |
| g | N | Y | N |
| h | N | N | N |

TABLE 3: OUTPUT RESULTS IN DETAIL

| Format Index | Test Index | Format | Time | Time in Seconds | MPE On | Max Bit Depth & Quality | Dell Precision Optimizer On | Hardware | Software |
|--------------|------------|-------------|-------------|-----------------|--------|-------------------------|-----------------------------|----------|----------|
| 1 | a | XDCAM 50 | 10m 34s | 634 | Y | Y | Y | New | New |
| 2 | a | H.264 HD | 10m 25s | 625 | Y | Y | Y | New | New |
| 3 | a | H.264 4K | 17m 52s | 1072 | Y | Y | Y | New | New |
| 4 | a | CineForm 4K | 34m 43s | 2083 | Y | Y | Y | New | New |
| 1 | b | XDCAM 50 | 12m 53s | 773 | Y | Y | N | New | New |
| 2 | b | H.264 HD | 13m 10s | 790 | Y | Y | N | New | New |
| 3 | b | H.264 4K | 17m 56s | 1076 | Y | Y | N | New | New |
| 4 | b | CineForm 4K | 34m 42s | 2082 | Y | Y | N | New | New |
| 1 | c | XDCAM 50 | 5m 18s | 318 | Y | N | Y | New | New |
| 2 | c | H.264 HD | 5m 11s | 311 | Y | N | Y | New | New |
| 3 | c | H.264 4K | 10m 19s | 619 | Y | N | Y | New | New |
| 4 | c | CineForm 4K | 34m 39s | 2079 | Y | N | Y | New | New |
| 1 | d | XDCAM 50 | 5m 52s | 352 | Y | N | N | New | New |
| 2 | d | H.264 HD | 5m 29s | 329 | Y | N | N | New | New |
| 3 | d | H.264 4K | 10m 31s | 631 | Y | N | N | New | New |
| 4 | d | CineForm 4K | 37m 6s | 2226 | Y | N | N | New | New |
| 1 | e | XDCAM 50 | 2h 49m 53s | 10,193 | N | Y | Y | New | New |
| 2 | e | H.264 HD | 1h 57m 33s | 7053 | N | Y | Y | New | New |
| 3 | e | H.264 4K | 7h 34m 56s | 27,296 | N | Y | Y | New | New |
| 4 | e | CineForm 4K | 7h 50m 5s | 28,205 | N | Y | Y | New | New |
| 1 | f | XDCAM 50 | 16m 7s | 967 | N | N | Y | New | New |
| 2 | f | H.264 HD | 8m 7s | 487 | N | N | Y | New | New |
| 3 | f | H.264 4K | 40m 12s | 2412 | N | N | Y | New | New |
| 4 | f | CineForm 4K | 3h 10m 30s | 11,430 | N | N | Y | New | New |
| 1 | g | XDCAM 50 | 3h 17m 58s | 11,878 | N | Y | N | New | New |
| 2 | g | H.264 HD | 1h 56m 27s | 6987 | N | Y | N | New | New |
| 3 | g | H.264 4K | 7h 42m 40s | 27,760 | N | Y | N | New | New |
| 4 | g | CineForm 4K | 10h 30m 32s | 37,832 | N | Y | N | New | New |
| 1 | h | XDCAM 50 | 16m 15s | 975 | N | N | N | New | New |
| 2 | h | H.264 HD | 8m 12s | 492 | N | N | N | New | New |
| 3 | h | H.264 4K | 40m 39s | 2439 | N | N | N | New | New |
| 4 | h | CineForm 4K | 11h 28m 58s | 41,338 | N | N | N | New | New |
| 1 | a | XDCAM 50 | 19m 15s | 1155 | Y | Y | Y | Old | New |
| 2 | a | H.264 HD | 21m 8s | 1268 | Y | Y | Y | Old | New |
| 3 | a | H.264 4K | 27m 18s | 1638 | Y | Y | Y | Old | New |
| 4 | a | CineForm 4K | 42m 28s | 2548 | Y | Y | Y | Old | New |
| 1 | b | XDCAM 50 | 17m 43s | 1063 | Y | Y | N | Old | New |
| 2 | b | H.264 HD | 18m 36s | 1116 | Y | Y | N | Old | New |
| 3 | b | H.264 4K | 25m 43s | 1543 | Y | Y | N | Old | New |
| 4 | b | CineForm 4K | 39m 14s | 2354 | Y | Y | N | Old | New |
| 1 | c | XDCAM 50 | 7m 44s | 464 | Y | N | Y | Old | New |
| 2 | c | H.264 HD | 6m 35s | 395 | Y | N | Y | Old | New |
| 3 | c | H.264 4K | 17m 2s | 1022 | Y | N | Y | Old | New |
| 4 | c | CineForm 4K | 42m 23s | 2543 | Y | N | Y | Old | New |
| 1 | d | XDCAM 50 | 6m 43s | 403 | Y | N | N | Old | New |
| 2 | d | H.264 HD | 6m 29s | 389 | Y | N | N | Old | New |
| 3 | d | H.264 4K | 15m 19s | 919 | Y | N | N | Old | New |
| 4 | d | CineForm 4K | 37m 55s | 2275 | Y | N | N | Old | New |
| 1 | e | XDCAM 50 | 3h 21m 22s | 12,082 | N | Y | Y | Old | New |
| 2 | e | H.264 HD | 2h 34m 33s | 9273 | N | Y | Y | Old | New |
| 3 | e | H.264 4K | 7h 58m 45s | 28,725 | N | Y | Y | Old | New |
| 4 | e | CineForm 4K | 8h 8m 26s | 29,306 | N | Y | Y | Old | New |
| 1 | f | XDCAM 50 | 32m 5s | 1925 | N | N | Y | Old | New |
| 2 | f | H.264 HD | 28m 29s | 1709 | N | N | Y | Old | New |
| 3 | f | H.264 4K | 53m 28s | 3208 | N | N | Y | Old | New |

| Format Index | Test Index | Format | Time | Time in Seconds | MPE On | Max Bit Depth & Quality | Dell Precision Optimizer On | Hardware | Software |
|--------------|------------|-------------|------------|-----------------|--------|-------------------------|-----------------------------|----------|----------|
| 4 | f | CineForm 4K | 4h 42m 32s | 16,952 | N | N | Y | Old | New |
| 1 | g | XDCAM 50 | 3h 0m 54s | 10,854 | N | Y | N | Old | New |
| 2 | g | H.264 HD | 2h 8m 40s | 7720 | N | Y | N | Old | New |
| 3 | g | H.264 4K | 7h 32m 38s | 27,158 | N | Y | N | Old | New |
| 4 | g | CineForm 4K | 7h 47m 51s | 28,071 | N | Y | N | Old | New |
| 1 | h | XDCAM 50 | 18m 39s | 1119 | N | N | N | Old | New |
| 2 | h | H.264 HD | 11m 3s | 663 | N | N | N | Old | New |
| 3 | h | H.264 4K | 45m 49s | 2749 | N | N | N | Old | New |
| 4 | h | CineForm 4K | 3h 16m 34s | 11,794 | N | N | N | Old | New |
| 1 | a | XDCAM 50 | 22m 32s | 1352 | Y | Y | Y | New | Old |
| 2 | a | H.264 HD | 19m 46s | 1186 | Y | Y | Y | New | Old |
| 3 | a | H.264 4K | 1h 43m 4s | 6184 | Y | Y | Y | New | Old |
| 1 | b | XDCAM 50 | 21m 56s | 1316 | Y | Y | N | New | Old |
| 2 | b | H.264 HD | 18m 21s | 1101 | Y | Y | N | New | Old |
| 3 | b | H.264 4K | 1h 40m 47s | 6047 | Y | Y | N | New | Old |
| 1 | c | XDCAM 50 | 7m 15s | 435 | Y | N | Y | New | Old |
| 2 | c | H.264 HD | 6m 53s | 413 | Y | N | Y | New | Old |
| 3 | c | H.264 4K | 16m 39s | 999 | Y | N | Y | New | Old |
| 1 | d | XDCAM 50 | 6m 41s | 401 | Y | N | N | New | Old |
| 2 | d | H.264 HD | 6m 23s | 383 | Y | N | N | New | Old |
| 3 | d | H.264 4K | 15m 36s | 936 | Y | N | N | New | Old |
| 1 | e | XDCAM 50 | 1h 8m 1s | 4081 | N | Y | Y | New | Old |
| 2 | e | H.264 HD | 1h 8m 28s | 4108 | N | Y | Y | New | Old |
| 3 | e | H.264 4K | 3h 18m 14s | 11,894 | N | Y | Y | New | Old |
| 1 | f | XDCAM 50 | 8m 44s | 524 | N | N | Y | New | Old |
| 2 | f | H.264 HD | 7m 8s | 428 | N | N | Y | New | Old |
| 3 | f | H.264 4K | 46m 33s | 2793 | N | N | Y | New | Old |
| 1 | g | XDCAM 50 | 1h 8m 8s | 4088 | N | Y | N | New | Old |
| 2 | g | H.264 HD | 1h 8m 38s | 4118 | N | Y | N | New | Old |
| 3 | g | H.264 4K | 3h 23m 47s | 12,227 | N | Y | N | New | Old |
| 1 | h | XDCAM 50 | 8m 32s | 512 | N | N | N | New | Old |
| 2 | h | H.264 HD | 6m 52s | 412 | N | N | N | New | Old |
| 3 | h | H.264 4K | 46m 31s | 2791 | N | N | N | New | Old |
| 1 | a | XDCAM 50 | 27m 45s | 1665 | Y | Y | Y | Old | Old |
| 2 | a | H.264 HD | 25m 42s | 1542 | Y | Y | Y | Old | Old |
| 3 | a | H.264 4K | 1h 50m 11s | 6611 | Y | Y | Y | Old | Old |
| 1 | b | XDCAM 50 | 21m 52s | 1312 | Y | Y | N | Old | Old |
| 2 | b | H.264 HD | 26m 48s | 1608 | Y | Y | N | Old | Old |
| 3 | b | H.264 4K | 1h 51m 35s | 6695 | Y | Y | N | Old | Old |
| 1 | c | XDCAM 50 | 7m 51s | 471 | Y | N | Y | Old | Old |
| 2 | c | H.264 HD | 7m 37s | 457 | Y | N | Y | Old | Old |
| 3 | c | H.264 4K | 19m 52s | 1192 | Y | N | Y | Old | Old |
| 1 | d | XDCAM 50 | 7m 56s | 476 | Y | N | N | Old | Old |
| 2 | d | H.264 HD | 7m 37s | 457 | Y | N | N | Old | Old |
| 3 | d | H.264 4K | 19m 51s | 1191 | Y | N | N | Old | Old |
| 1 | e | XDCAM 50 | 2h 46m 24s | 9984 | N | Y | Y | Old | Old |
| 2 | e | H.264 HD | 2h 45m 36s | 9936 | N | Y | Y | Old | Old |
| 3 | e | H.264 4K | 7h 46m 3s | 27,963 | N | Y | Y | Old | Old |
| 1 | f | XDCAM 50 | 21m 52s | 1312 | N | N | Y | Old | Old |
| 2 | f | H.264 HD | 16m 34s | 994 | N | N | Y | Old | Old |
| 3 | f | H.264 4K | 3h 5m 59s | 11,159 | N | N | Y | Old | Old |
| 1 | g | XDCAM 50 | 2h 44m 8s | 9848 | N | Y | N | Old | Old |
| 2 | g | H.264 HD | 2h 44m 11s | 9851 | N | Y | N | Old | Old |
| 3 | g | H.264 4K | 7h 46m 46s | 28,006 | N | Y | N | Old | Old |
| 1 | h | XDCAM 50 | 21m 43s | 1303 | N | N | N | Old | Old |
| 2 | h | H.264 HD | 15m 58s | 958 | N | N | N | Old | Old |
| 3 | h | H.264 4K | 3h 4m 11s | 11,051 | N | N | N | Old | Old |

Analysis—Overview

Data presented in a table by itself doesn't tell the whole story. In addition, loose data can be overwhelming. Interpreting the data yields insights about both performance comparisons and productivity gains. What becomes even more valuable in illustrating improved performance is to determine the percentage of time saved and the percentage of productivity increase, along with creating graphs to help visualize the data.

Productivity Formula

Let's start at the tip of the iceberg. To see these values (the percentage of time saved and the increase in productivity), we start with the amount of change in the time saved.

To illustrate this, we're going to look at a specific example and derive the formula for other measurements.

Let's compare the amount of time it takes to output our package of footage from the older hardware (Dell T7600) to the newer (Dell Tower 7910), using Adobe Premiere Pro CC 2014. It took a total of 6609 seconds to output four files with the T7600. The newer system, the Tower 7910, took only 4414 seconds. The newer hardware outputted the same files in 2195 fewer seconds.

To express this as time saved, we'd divide that value by the *original* time and multiply by 100 to get a percentage:

$$33.21\% = \frac{(6609 - 4414)}{6609} \times 100$$

This formula can be generalized as the following:

$$\text{Percentage of change} = \frac{(\text{Original Duration} - \text{New Duration})}{\text{Original Duration}} \times 100$$

That reveals the reduction in time taken; but not the increase of productivity.

To measure the increase of productivity, it's *nearly the same formula*, but instead of dividing using the original duration (6609), we want to know how much faster we are on today's system.

So we take the time difference and instead divide by the new duration to reveal productivity:

$$49.72\% = \frac{(6609 - 4414)}{4414} \times 100$$

While this render was 33% faster to output, we became *nearly* 50% more productive just by using new hardware. So the generic productivity formula becomes:

$$\text{Percentage of productivity} = \frac{(\text{Original Duration} - \text{New Duration})}{\text{New Duration}} \times 100$$

With these two formulas in hand, we can measure our hardware and software differences.

Observations on New Hardware

Outside of the testing, it's important for me to note my subjective user experience between working on the newer hardware and software versus the older.

Everything was snappier. Editorial felt sharper and more precise. Maybe it was the removal of something as small as a 100-millisecond lag, but everything flowed faster on the newer system.

From a numerical standpoint, the extra horsepower and capabilities don't fully explain why the subjective experience was better. It was non-quantifiable, but important to note.

4K Screen Difference

While there are secondary benefits, the whole reason to shoot 4K is to be able to have the final work seen by an audience in its full resolution. When formats change, as in this case from HD to 4K, compromises are par for the course. Historically, editors are used to being forced to work in a lower format and spot checking—zooming to 100%, due to expense of new technologies. This is exactly how the Standard Definition to High Definition changeover happened.

But this doesn't (and shouldn't) have to be necessary. Dell provided an HD display, and *two* UHD (4K) displays for testing. This permitted me to *actually see my footage* in its full resolution during the editorial process, and to compare my same footage viewed in HD. The Dell screens I used were the UltraSharp 24" screen (UP2414Q) and the Dell UltraSharp 32" (UP3214Q).

I cannot overstate how valuable it was to actually see the full resolution while editing. Seeing the raw detail is something that you just miss when forced to work only on an HD screen.

After some significant use and trying various configurations, two display combinations seemed to be practical and resemble system configurations for the real world:

- Single display, running at full 4K, 3840×2160 resolution with full-screen previews.

I utilized the interface like any other system. Adobe has a feature that permits a quick toggle to full-screen playback. I could quickly work and toggle (when needed) to preview my 4K footage.

Of course, setting the fonts larger is important not only in the Windows interface, but also in Premiere Pro CC 2014. By doing so, everything was readable and extra sharp.

Choosing between the 24" and the 32" becomes mostly a question of desk space, although my eyes preferred the 32".

- Two displays—a standard HD screen and one of the 4K systems running at full 3840×2160 resolution.

Premiere Pro has the flexibility to use a second display as a preview monitor (different from the full-screen toggle above). This permitted using both screens for an interface, previewing in 4K or any combination of the two screens.



Using Adobe Premiere Pro on the smaller 4K screen (Dell UltraSharp 24"), while viewing the full 4K picture on the Dell UltraSharp 32" was my preferred setup.

A footnote: I observed that a single NVIDIA Quadro K5200 card couldn't drive two 4K screens simultaneously at full resolution *and* activate the Mercury Playback Engine acceleration. This shouldn't be a surprise—it's the equivalent of *eight HD displays*—and I was asking it to *additionally* accelerate the playback of 4K content. If you want to run this advanced setup, you would upgrade to two NVIDIA Quadro graphic cards, one for each display. The Dell workstation is ideally suited for such an upgrade, both in available slots and available power.

Regardless of your setup, the key takeaway remains — it's almost impossible to be too rich or have too much real estate in editorial software. Having a 4K monitor to work in 4K becomes a valuable necessity.

Observations on New Software

With each iteration of Premiere Pro, it's clear that Adobe has been studying the user experience over the past few years. Many visual interface features have been added to Premiere Pro CC (such as timecode overlays), improved (font sizing in the display), or cleaned up (hidden panel menus unified). These improvements are subtle, but so numerous that I had forgotten the struggles I used to have when working in Premiere Pro CS6. There seems no way to quantify this, but having used the most recent release, going back to CS6 is painful. The UI improvements and cleanup are substantial.

One additional area can't be measured for a different reason. There is essentially an *infinite increase* in speed with the Premiere Pro CC and SpeedGrade CC workflow.

Adobe SpeedGrade Workflow Difference in CC 2014

When Adobe acquired Iridas SpeedGrade in the fall of 2011, it was seen as a smart industry move to fill an empty spot in their toolset — professional level color correction. It surprised everyone when SpeedGrade was added so quickly to CS6 in April the following year. However due to a cumbersome workflow, many users didn't use Speed Grade in their daily post-production after CS6 was released. The CS6 workflow required the generation of Digital Picture Exchange (DPX) files. A single frame of HD is uncompressed; it can be eight *megabytes* per frame, or over 800 GB *per hour*. This was the standard method of getting video into Iridas SpeedGrade—something that would be improved in the CC release the following year.

This DPX workflow made working through Adobe SpeedGrade CS6 difficult, even on short-form pieces. At 4K, that size of a single frame becomes 32 megabytes per frame, or over 3.2 TB per hour. And this didn't include the additional *rendered media* that would be returned to Premiere Pro CS6.

All this changed with the Adobe Creative Cloud release. The Lumetri Deep Color Engine was implemented as a single effect in Premiere Pro CC. The need to render DPX and the media demands disappeared. The entire workflow became as simple as opening a Premiere Pro timeline in SpeedGrade, color grading, and returning to Premiere Pro to see a single effect.

A crucial but frequently overlooked advantage of this interchange is the capability to do this multiple times. Commonly, a change happens *after* the color-correction pass. With this new workflow, going back and forth could be done at a zero time cost.

Everyone working at 4K should color-correct their footage. Frankly, everyone should do so with any footage they ever work on—4K, HD, or any other format. While the color tools in Premiere Pro are adequate, the ones in SpeedGrade are designed for a colorist's needs.

Yes, I tried implementing SpeedGrade in the CS6 release back in 2012. Although it worked and provided a professional color-grading environment, I used it minimally, given the costs of time and file size. With the Creative Cloud release, SpeedGrade has become my go-to method for color grading, given its flexibility with Premiere Pro.

Analysis—Hardware

When slicing the data to isolate for the difference between the two Dell workstations, I specifically chose to *eliminate* the advantages provided by the NVIDIA graphics card. In this way, I could see what sort of advantages the workstation hardware could provide for non-GPU-accelerated effects.

In comparing the hardware platforms, by testing the handling of non-accelerated effects (eliminating the GPU speed increase), the Dell hardware update improved productivity by 26.25% and output by 12.43%.

Workstation Hardware Data and Interpretation—Rendering

The MPE minimizes rendering. But when the GPU isn't significant (because of effect choice or system design), the CPU does all the work. The choice to render a section of video is specifically to permit visualization. Often rendering is repeated at least three times: once to get an initial idea of playback, a second time to get close to the desired look, and at least a third time to fine-tune.

When rendering is necessary, the faster the render occurs, the sooner an editor can *feel* the story come together and make the creative changes.

To simulate and measure this value, I required the entire timeline to be rendered, for a total of 119 effects, with no benefits from the GPU.

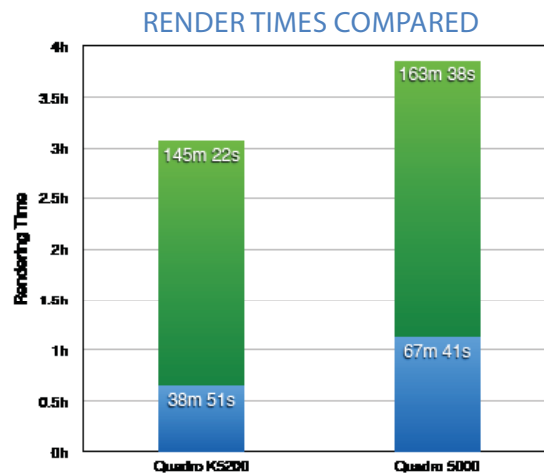
In the following table, we're looking at the render time difference between the two hardware systems (Tower 7910 and T7600) with just the Premiere Pro CC 2014 release.

| Premiere Pro CC 2014 | Time in Seconds |
|------------------------|-----------------|
| Render time Tower 7910 | 602 |
| Render time T7600 | 760 |
| | |
| Percentage faster | 20.79 % |
| Productivity increase | 26.25 % |

As expected, the newer hardware is faster than the older hardware.

This extends to the older CS6 software. It's nearly an identical speed increase.

| Premiere Pro CS6 | Time in Seconds |
|------------------------|-----------------|
| Render time Tower 7910 | 848 |
| Render time T7600 | 1050 |
| | |
| Percentage faster | 19.24 % |
| Productivity increase | 23.82 % |



Render times of both versions of Adobe Premiere Pro combined, comparing Dell hardware platforms with the CPU only. Shorter is better.

Workstation Hardware Data and Interpretation—Output

When considering CPU, I believe that the prior section on rendering speedup is *more important* than output times.

When you need to render, it's for one of two reasons: the hard drives cannot deliver the data fast enough, the effects are too complex for real-time playback, or the codec is too complex to decode in real time. The latter case most likely results from choosing effects that the GPU does not accelerate. Accelerated GPU-based effects play back in real time—so when rendering is required, it's the CPU that's more heavily relied upon.

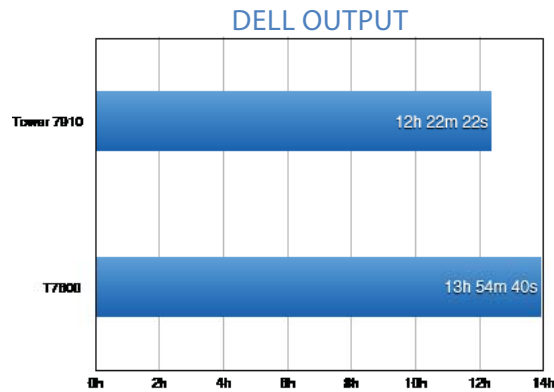
So, I consider the advantage that the CPU represents for rendering (noted in the preceding section) more important than the advantage that it provides for output. When rendering is needed, the CPU is the critical factor for visualization that enables an editor to “see” the work and make creative decisions.

For output, similar to rendering, the GPU acceleration was turned off completely, to force the CPU to do all the work.

Added to the output matrix was the choice to use the Maximum Bit Depth and Maximum Quality (for scaling.) Both of these settings significantly increase output times, but are respectful of the higher quality and bit depth of the 4K footage.

In the following table, you're looking at three outputs: XDCAM HD, H.264 HD, and H.264 UHD combined. CineForm output was ignored to provide comparison with the older software consideration.

| Premiere Pro CC 2014 | Time in Seconds |
|------------------------|-----------------|
| Output time Tower 7910 | 44,542 |
| Output time T7600 | 50,080 |
| | |
| Percentage faster | 11.06 % |
| Productivity increase | 12.43 % |



Output comparison on Dell hardware with no GPU acceleration.
Shorter is better.

When looking at the older software, an interesting anomaly took place. The older software was sometimes faster *solely* in non-GPU acceleration.

The same exact tests with GPU acceleration yielded expected results: the new software was significantly faster than the old. But in this specific test of this project, Premiere Pro CS6 was faster than the Premiere Pro CC 2014.

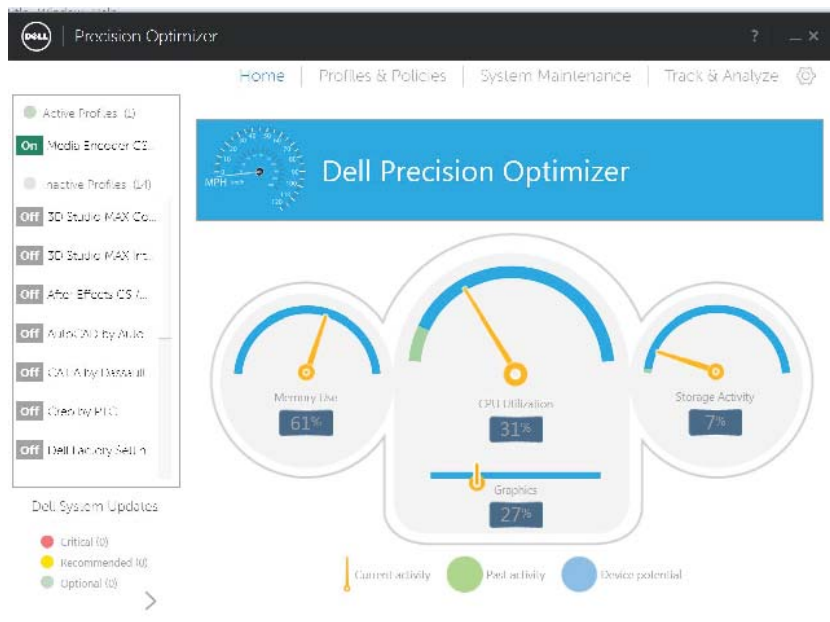
When this occurred, I performed tests using a different project that did *not show this inconsistency*. Therefore, something odd that may be specific to my project seems to be producing this response. Given that it was limited to this project, Adobe requested my footage and is looking into the anomaly. Further investigation is warranted.

| Premiere Pro CS6 | Time in Seconds |
|------------------------|-----------------|
| Output time Tower 7910 | 20,083 |
| Output time T7600 | 47,883 |
| Percentage faster | 58.06 % |
| Productivity increase | 138.46 % |

As a footnote, when the GPU is enabled, for these same exact tests, the new version of the software is often more than 500% faster than the non-GPU-accelerated times.

Dell Precision Optimizer

When I tested this hardware, I also tested Dell's exclusive workstation performance software, the Dell Precision Optimizer. This software offers a variety of useful features including maximized system performance, simplified system management, and tracking and analysis of system resources. To enable Adobe products, Dell consulted with Adobe to develop unique profiles that improved off-the-shelf performance by adjusting settings such as Intel® Hyper-Threading, number of CPU cores, graphics and power. This free software and the profiles were available for Premiere Pro, Adobe Media Encoder, and After Effects, along with other non-Adobe software.



The Dell Precision Optimizer main interface shows system status between Memory, CPU, GPU and storage based on the application profile running at the time.

The Dell Precision Optimizer provided an intuitive and quick way to get the maximum performance from the hardware, along with a visual set of performance meters. Most important, from a user perspective this was a simple set it and forget it one-click adjustment to improve system performance. Without this helpful tool, digging through various obscure settings to optimize was necessary, if the user was even aware of them.

To get a fair average for the speed improvement, I combined multiple render times. I included renders with the GPU acceleration on and off, along with combining both older and newer versions of Premiere Pro. This way, I was looking more at how the Dell Precision Optimizer changed the entire system's performance, rather than a single test.

Solely through software adjustments, Dell is improving Premiere Pro performance by approximately 5% in rendering tests.

| Renders (in Seconds) | Tower 7910 | T7600 |
|------------------------------|------------|-------|
| Dell Precision Optimizer on | 2162 | 2649 |
| Dell Precision Optimizer off | 2253 | 2812 |
| Percentage faster | 4.04% | 5.80% |
| Productivity increase | 4.21% | 6.15% |

To measure output, I focused on the compression/output that would be the most numerically intensive. This would be the 4K output of the CineForm codec.

The following chart shows the CineForm codec on both platforms, with the GPU acceleration on and off, specifically examining the percent change from the Dell Precision Optimizer.

Here are the results, in seconds.

| 4K | Tower 7910 MPE Off | Tower 7910 MPE On | T7600 MPE Off | T7600 MPE On |
|---------------|--------------------|-------------------|---------------|--------------|
| Optimizer on | 28,205 | 2083 | 29,306 | 2548 |
| Optimizer off | 37,832 | 2082 | 28,071 | 2354 |
| | | | | |
| Percent | 25.45% | -0.05% | -4.40% | -8.24% |

The Dell Precision Optimizer gave its best improvement on the newer hardware. The Dell Precision Optimizer had a negligible impact when it came to the addition of the GPU acceleration. So, on the newer workstation, I'd recommend setting the Dell Precision Optimizer on all the time for both Premiere Pro and Adobe Media Encoder.

Problematically, Dell Precision Optimizer slightly reduced output on older workstations. I learned from Dell's Performance Engineering group that the Dell Precision Optimizer Adobe profile was built on a newer platform, the T7610, and while fully supported on the T7600, generally, the further you go back on hardware generations the less return you get with performance improvements. On older hardware, I'd suggest turning on the Optimizer acceleration for Premier Pro but turning off the Optimizer for Adobe Media Encoder.

Analysis—Professional Graphics

There is no question—if you're on a system that doesn't have GPU acceleration, stop reading and immediately go purchase hardware that supports it. The difference is astonishing: 18 times faster, for a productivity increase of over 1000%.

In the study, comparing the two graphics cards by testing accelerated effects (showing the GPU speed increase) increased rendering productivity by 19.82% and output by 74.22%.

Measuring the GPU

In Premiere Pro CC 2014, the handling (debayering) of certain formats, such as RED, could now be handled by the GPU. Prior to this release, the only way to improve render and output times was to purchase a \$7,000 RED Rocket card.

Between the advantage of GPU-driven systems and improvements by Adobe of handling intensive formats like RED, there's no question that having GPU acceleration is a necessity. But a refined question is, what difference does the NVIDIA Quadro K5200 make as compared to the NVIDIA Quadro 5000?

The focus for this part of the study was to measure that difference, so here are the key statistics for these cards:

| Card | Cores | RAM | Year | MSRP on Release |
|--------------|-------|--------|------|-----------------|
| Quadro 5000 | 352 | 2.5 GB | 2010 | \$2,249 |
| Quadro K5200 | 2304 | 8 GB | 2014 | \$2,249 |

The Quadro K5200 was installed in the newer Dell Tower 7910 workstation. The Quadro 5000 was installed in the older Dell T7600 workstation. I ran tests on both systems with the Premiere Pro CC 2014 and the Premiere Pro CS6 software.

To reveal the differences between both cards, I compared rendering times and output times of the same exact material. The timeline was specifically designed to utilize multiple accelerated effects powered by the Mercury Playback Engine. Every single clip had at least one effect that would benefit from this GPU-driven acceleration.

Given the significantly longer render times for *non*-GPU-accelerated effects, editors minimize the use of effects that stall playback or create the need for rendering. When possible, an editor will pick the accelerated effects.

With 4K footage being so heavy, compared to HD—given we’re pushing four times the number of pixels—so I made sure to pick effects for this project that would permit the easiest playback and output for clients.

GPU Hardware Data and Interpretation—Rendering

Rendering was unnecessary with the GPU activated. The systems played back the material flawlessly.

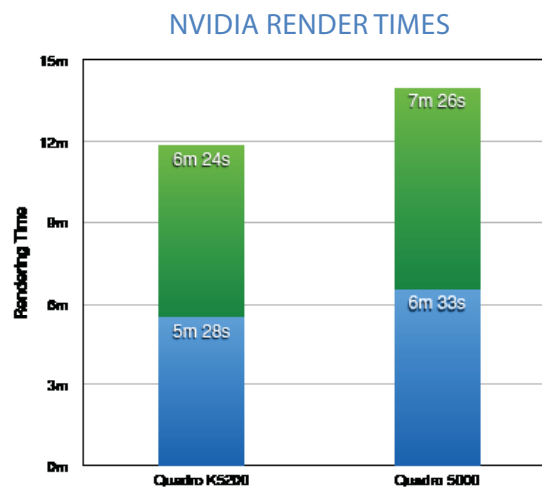
Given that I wanted to measure the speed change, I forced the systems to render. The render occurred quickly on both systems, given that the source materials were 4K in various containers and codecs. The Quadro K5200 ending up running 16.54% faster, for a productivity gain of 19.82%.

Using Premiere Pro CC 2014, with the Mercury Playback Engine enabled, I got the following results.

| Adobe Premiere Pro CC 2014 | Time in Seconds |
|----------------------------|-----------------|
| Quadro K5200 | 328 |
| Quadro 5000 | 393 |
| Percentage faster | 16.54% |
| Productivity increase | 19.82% |

Similar measurements occurred with Premiere Pro CS6.

| Adobe Premiere Pro CS 6 | Time in Seconds |
|-------------------------|-----------------|
| Quadro K5200 | 384 |
| Quadro 5000 | 446 |
| Percentage faster | 13.90% |
| Productivity increase | 16.15% |



Output comparison on Dell hardware with no GPU acceleration. Shorter is better.

GPU Hardware Data and Interpretation—Output

The numbers here are more valuable when talking about output over rendering. My reasoning for this is fairly simple: the GPU acceleration provided permitted playback of all the media, meaning rendering wasn’t necessary.

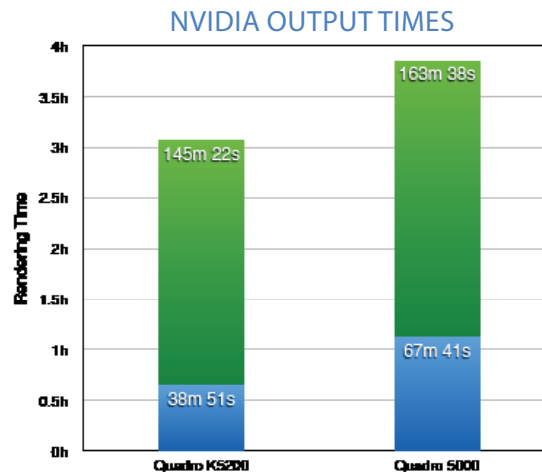
I took a look at the same comparison. How did the same version of software output the three key formats (XDCAM, H.264 HD, and H.264 UHD)?

When outputting, I saw a time savings of 42.60%.

| Premiere Pro CC 2014 | Time in Seconds |
|-----------------------|-----------------|
| Quadro K5200 | 2331 |
| Quadro 5000 | 4061 |
| | |
| Percentage faster | 42.60 % |
| Productivity increase | 74.22 % |

Taking a look at Premiere Pro CS6, I saw an improvement on all but one test.

| Adobe Premiere Pro CC CS6 | Time in Seconds |
|---------------------------|-----------------|
| Quadro K5200 | 8722 |
| Quadro 5000 | 9818 |
| | |
| Percentage faster | 11.16 % |
| Productivity increase | 12.57 % |



Output times of both versions of Adobe Premiere Pro combined on the same NVIDIA graphics card. Shorter is better.

I can only guess at the factors that give the CS6 a smaller increase. Adobe Premiere Pro CC 2014 has been optimized for RED debayering, which explains the significant speed jump in general from the older software to the newer. While CS6 could handle 4K, few users were pushing the barrier. My guess is that coding improvements have happened to further speed up output.

Three Observations

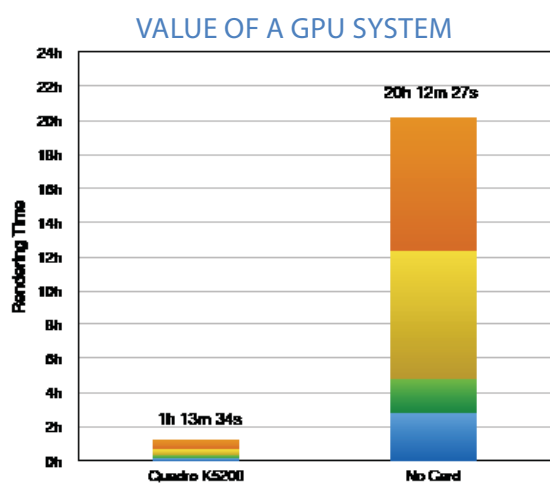
I think it's important to mention three reflections I had while performing these tests: one about the value of having a GPU card, a second about the unnecessary rendering, and the third on bit depth.

The Value of a GPU Accelerated System—1500%

I did not mention an analysis that I did solely for my own curiosity: how much more productive is a system that takes advantage of the GPU acceleration?

Outputting the four formats took about 1 hour and 15 minutes with the NVIDIA K5200. With the card disabled? The same exact output took over 20 hours.

We're talking about a time savings of 93% and a productivity increase of over 1500%. This leads me to this conclusion that it's *crucial* to have a GPU-accelerated system.



Output times from Adobe Premiere Pro CC 2014 with an NVIDIA K5200 compared to the same system with GPU acceleration turned off. Shorter is better.

Rendering Consideration

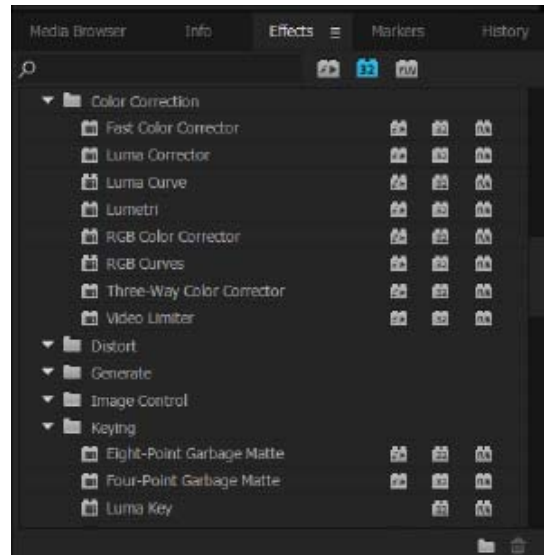
Rendering wasn't necessary for playback.

The system was capable of playing the timeline at full 4K resolution. The only way that I could get Premiere Pro to drop frames was to exceed the data rate (more streams) coming off the hard drive. With the GPU active, system performance was so good, that it was nearly invisible that I was working with 4K. The system was as responsive as working with HD materials.

High Bit Depth

Most of the cameras that can shoot 4K also shoot a high bit depth—and this is accounted for in the output. The higher bit depth permits a greater ease in color grading. Basically, it would be wasteful to work in these high-quality formats and not preserve the extra visual data.

Choosing to maintain the color fidelity generally means picking effects that support 32 bits per channel over 8 bits per channel. Given that many HD formats only support 8-bit acquisition, it's a minor difference on whether or not to choose effects that support 32 bits.



The Effect panel has the 32 bit switch thrown in this screenshot.

Because most 4K formats support higher bit depth per channel (10, 12, or higher depths), use of these effects is warranted (and preferred), when possible.

Additionally, for highest quality output, the Render at Maximum Depth setting needs to be on. Doing so permits the more complex video space calculations to occur, ensuring that output retains this extra quality.

In some cases, this doubles the output time. For example, for XDCAM, one output went from approximately six minutes to ten minutes with the switch turned on. In other cases, like the CineForm format (testable on only the CC 2014 release), *it caused no increase of time whatsoever*.

Analysis—Software

The span of time between the release of Premiere Pro CS6 and CC 2014 is more than two years, but I don't feel that correctly represents the improvements that the title change denotes. There have been more than eight software upgrades, adding features and expanding the toolset.

I isolated the test of the software update to each hardware platform. Both Premiere Pro CC 2014 and Premiere Pro CS6 were tested on the Dell Tower 7910 system with the NVIDIA K5200 graphics card.

The same comparison was performed on the Dell T7600 system with the NVIDIA Quadro 5000 card.

Output had a dramatic difference: an average of 65% faster or a 207.97% improvement in productivity. Rendering wasn't as dramatic, but still yielded an average speed improvement of 13.23% or a productivity improvement of 15.28 %.

Software Data and Analysis—Rendering

As noted in the GPU-hardware section “Rendering Considerations”, rendering was something that I forced for measurement needs. Rendering was virtually unnecessary, as playback was smooth as long as I didn't exceed the data-rate drive bottleneck. With that factor in mind, I consider the section on output more significant than this section on rendering.

I forced rendering the entire timeline to provide a measurement metric, along with the situations that inevitably occur when non-accelerated effects might be used. The function was to see the magnitude of difference between CC 2014 and CS6 on both hardware platforms respectively.

Everything rendered about 15% faster than the older software.

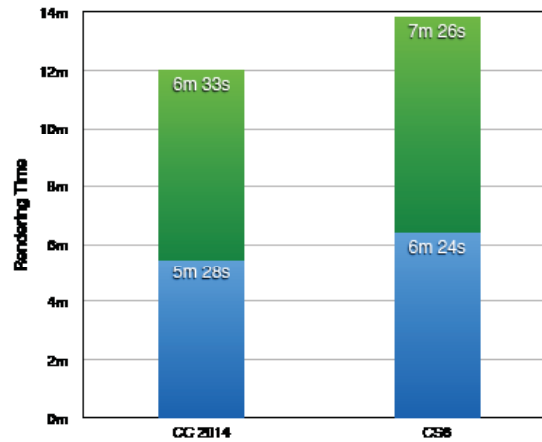
Results on the Tower 7910 (newer) hardware system:

| Dell Tower 7910 & Quadro K5200 | Time in Seconds |
|--------------------------------|-----------------|
| Adobe Premiere Pro CC 2014 | 328 |
| Adobe Premiere Pro CS6 | 384 |
| Percentage faster | 14.58% |
| Productivity increase | 17.07% |

I measured similar results on the T7600 (older) hardware system:

| Dell T7600 & Quadro 5000 | Time in Seconds |
|----------------------------|-----------------|
| Adobe Premiere Pro CC 2014 | 393 |
| Adobe Premiere Pro CS6 | 446 |
| Percentage faster | 11.88% |
| Productivity increase | 13.49 % |

ADOBE DIFFERENCE AVERAGED BETWEEN HARDWARE PLATFORMS



Render times of Adobe software on both hardware platforms. Shorter is better.

Observations on Rendering

While I was pleased by the 15% speed increase, I don't feel that rendering is as crucial of a concern for most users.

Additionally, these were not 4K renders, but rather HD renders. I kept the timeline configuration at the default rendering capability. I could have devised a 4K render format, but it would have been difficult to match on the CS6 software. Most users do not utilize their render files, which is why Adobe calls them *previews*.

Software Data and Analysis—Output

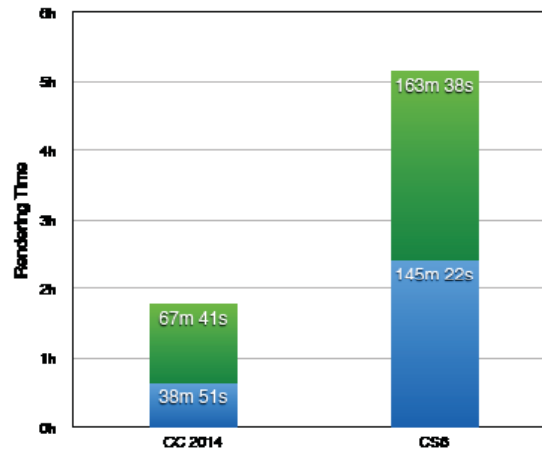
Output received a significant speed improvement, markedly so on the newest hardware. On the newer hardware bed, there was a 73.27% speed increase, creating a 274.17% productivity improvement. For the older system, the speed increase was 58.64%, for a 141.76% productivity improvement.

| Dell Tower 7910 & Quadro 5200 | Time in Seconds |
|-------------------------------|-----------------|
| Adobe Premiere Pro CC 2014 | 2331 |
| Adobe Premiere Pro CS6 | 8722 |
| Percentage faster | 73.27% |
| Productivity increase | 274.17% |

Even on older hardware, this change was noteworthy.

| Dell T7600 & Quadro 5000 | Time in Seconds |
|----------------------------|-----------------|
| Adobe Premiere Pro CC 2014 | 4061 |
| Adobe Premiere Pro CS6 | 9818 |
| Percentage faster | 58.64% |
| Productivity increase | 141.76 % |

ADOBE DIFFERENCE AVERAGED BETWEEN HARDWARE PLATFORMS



Output times of Adobe software on both hardware platforms. Shorter is better.

Discussion Points

Discussing only that the average speed was up to 65% faster on the newer hardware system doesn't do justice to three areas: interface improvement, SpeedGrade integration, and After Effects integration.

These aren't numerically quantifiable, but are key factors to mention, nonetheless.



Adobe Premiere Pro CS6 is on the Left. Adobe Premiere Pro CC 2014 is on the right.

Interface Improvements

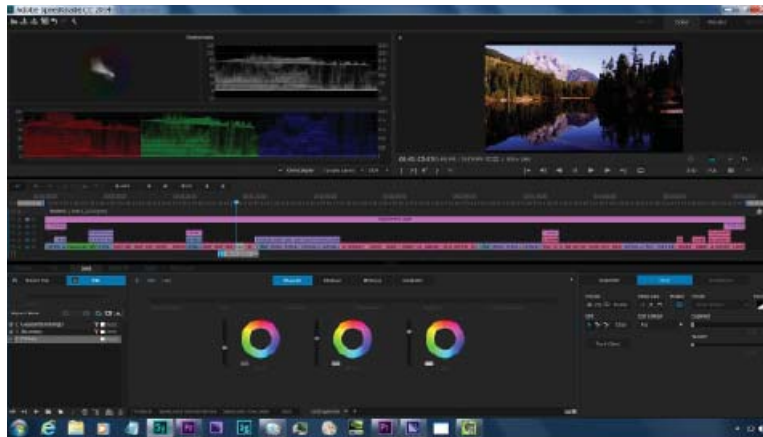
In its October 2014 release, the Premiere Pro interface experienced a major overhaul that went beyond just a coat of paint. Hidden settings menus became more obvious and unified, with easier-to-find elements. It's generally easier to see elements along with highlight states. There are search bins that automatically collect clips with matching criteria.

User interfaces are always evolving. When I open CS6 and then use CC 2014, it's astonishing how a cleanup like this makes me more efficient as an editor.

Adobe SpeedGrade and Direct Link

As mentioned in the overall software observations, there's also been a major workflow improvement since CS6 with Adobe SpeedGrade.

Frankly, I can't understand how any professional would not be doing professional-level color grading, especially with 4K material. There are great tools on the market, but none of them have the advantage of working with Premiere Pro without having to create render files.

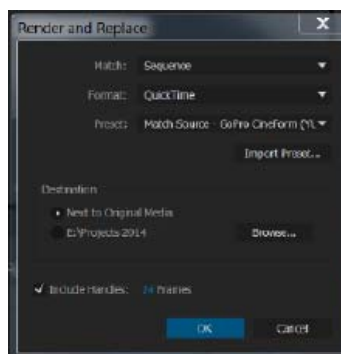


Adobe SpeedGrade's Direct Link to Adobe Premiere means unlimited changes – making workflow between the two effortless.

Looking at the workflow between Premiere Pro CS6 and SpeedGrade against the new Direct Link workflow (with the Lumetri effect) is infinitely faster and therefore impossible to measure.

Adobe After Effects—Render and Replace

Something that I did not measure but is also worth mentioning is a new workflow that came out in the CC 2014 release. This feature is called *Render and Replace*.



The Render and Replace feature lets you flatten video clips and After Effects compositions, speeding up the performance of VFX-heavy sequences in Premiere Pro.

In Creative Suite 6 Production Premium, users used Dynamic Link when working between on one line and Adobe After Effects. It was possible to embed After Effects compositions directly in the timeline of Premiere Pro. When edits were made in After Effects, the composition was automatically updated in the timeline without intermediate rendering. However, when playing back the After Effects compositions in the timeline, playback would drop frames unless the entire composition was cached to disk. This would force users into rendering this section in Premiere Pro if they wanted to see real-time playback.

In Premiere Pro CC, a new feature called Render and Replace permits replacing the composition with a piece of media (guaranteeing clean playback) but also with the flexibility to revert back to the flexible After Effects composition.

This is another difficult-to-quantify speedup that just wasn't possible with CS6.

Conclusions

The results of this study are both dramatic and conclusive — upgrading to the latest versions of hardware and software yield significantly higher productivity in the editorial field.

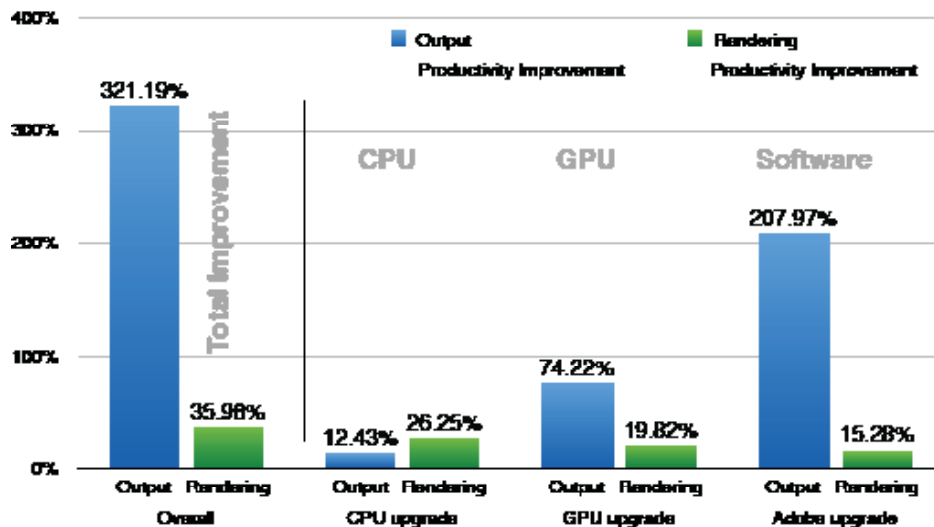
Using a 4K timeline and focusing on the quantifiable and measurable areas of rendering and output upgrading products from two cycles ago (2012 versions compared to their 2014 counterparts) carries major benefits.

Overall, updating the hardware and software yielded an output productivity increase of 321% and improvement of rendering productivity of about 36%.

Breaking this down further, upgrading the Dell workstation showed productivity improvements in rendering times by more than 26% and output by 12.43%. The Dell Precision Optimizer added approximately a 5% benefit.

When looking at the NVIDIA upgrade, the tests showed an output productivity increase of greater than 74% and a rendering productivity increase of almost 20%. While not an intended measurement from this study, output productivity was an unbelievable 1500% over the same system without NVIDIA graphics hardware.

Lastly, looking at the software, the average increase between the two systems yielded an output productivity improvement of about 208% and a rendering productivity improvement of well over 15%.



Productivity improvement measured in percentage, for each of the different upgrades, as well as the overall upgrade. Larger values are better.

Key improvements by Adobe with the interface of Premiere Pro and a renderless Direct Link with Adobe SpeedGrade produce improvements that aren't measurable, but are as just as significant.

While different individuals will likely experience varying degrees of improvement, depending on their specific source footage and workflows, similar improvements are highly likely. Most users will be able to get more work done faster or more-complex work finished as a result of making these upgrades. The amount of improvement is likely to be recognized as significant, and easily justifies the cost of upgrading.

About the Author

Jeff I. Greenberg is the owner of J Greenberg Consulting, LLC, a group that provides consulting and educational services in the field of film and video.



He has two decades of experience as a postproduction consultant and master instructor (trainer for other trainers) for Adobe, Apple, and Avid, specializing in the areas of editorial, workflow, compositing, sound, color grading, and compression.

Consistently voted as one of the top seminar speakers, Jeff teaches seminars at events such as NAB Show, Adobe MAX, IBC, International CES, CABSAT, and Inter BEE. He's the chair for the Editors Retreat, an annually held exclusive getaway for TV, film, and video editors.

Jeff is a published author of several books on the subject of editing and postproduction. He recently finished *Adobe Premiere Pro: Studio Techniques* (Adobe Press). Jeff writes for various blogs and creates training materials for lynda.com (<http://lynda.com/>) and macProVideo.com (<http://macProVideo.com>).

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