

# SOLIDWORKS GRAPHICS OPTIMIZATION GUIDE



sponsored by **HP** and **NVIDIA**



# ACCELERATING PRODUCT DEVELOPMENT THROUGH DESIGN VISUALIZATION

Design viz was at the heart of the engineering that enabled man to break the speed of sound in freefall

**W**hen a member of your team is about to jump out of a pressurized capsule 24 miles into the stratosphere you need to have total confidence in your engineering design. That's why Sage Cheshire Aerospace, the company behind the Red Bull Stratos space diving project, depends on SolidWorks running on HP Z Workstations with NVIDIA Quadro GPUs.

Sage Cheshire Aerospace benefited greatly from having full interactivity with 3D models when designing the capsule that protected Austrian skydiver Felix Baumgartner from subzero temperatures.

The capsule design was incredibly complex, so it was important that the team could visualize the constituent parts in context and do so in a fluid design environment.

"In the old days you'd model an assembly and it could be so math intensive that,

as you rotate it, you might wait several minutes," says Sage Cheshire Aerospace CEO Art Thompson. "That breaks the entire flow. Now with an HP Z Workstation with NVIDIA we are able to quickly rotate complex models, keep the conversations going, look at how all the pieces fit together."

## SOLIDWORKS: THE VISUALIZATION KING

SolidWorks RealView is a rendering mode that presents high quality interactive models directly inside the 3D viewport. The technology makes it possible to explore new forms and materials in tandem and get instant visual feedback on new design iterations. Designers are able to make informed judgments on aesthetics much earlier on in the product development process.

With a professional GPU SolidWorks RealView is instant so designers and

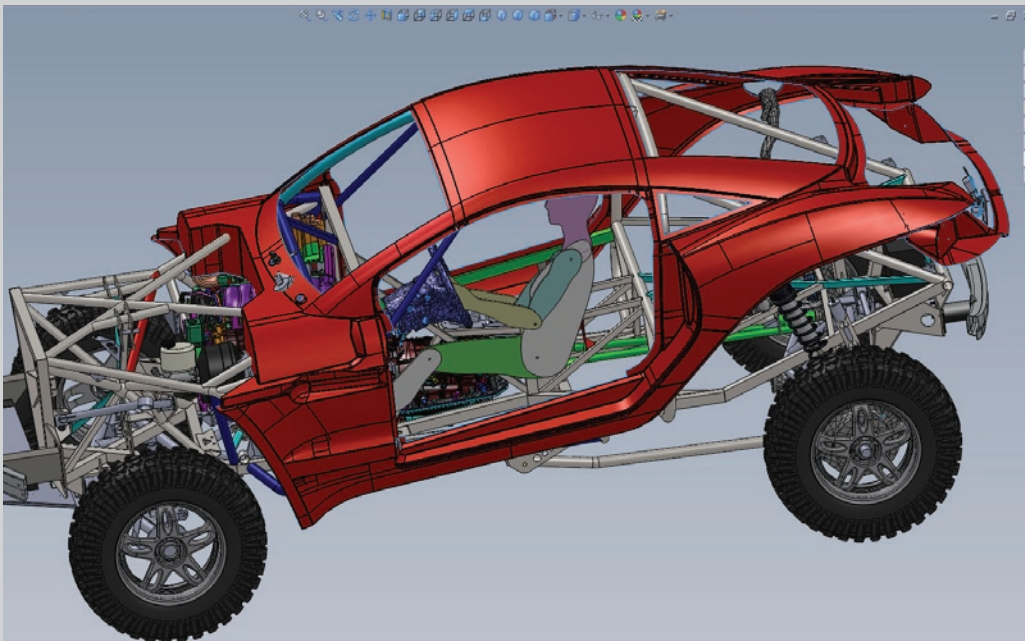
engineers do not have to spend time producing offline renders. However, when truly photorealistic visuals and animations are required ray trace rendering comes into play with PhotoView 360, a fully integrated add-in for SolidWorks or Bunkspeed, a third-party tool that works alongside SolidWorks.

[www.sagecheshire.com](http://www.sagecheshire.com)



**WATCH  
THE SAGE  
CHESHIRE  
AEROSPACE  
VIDEO**

## INSTANT VISUALIZATION INSIDE THE VIEWPORT

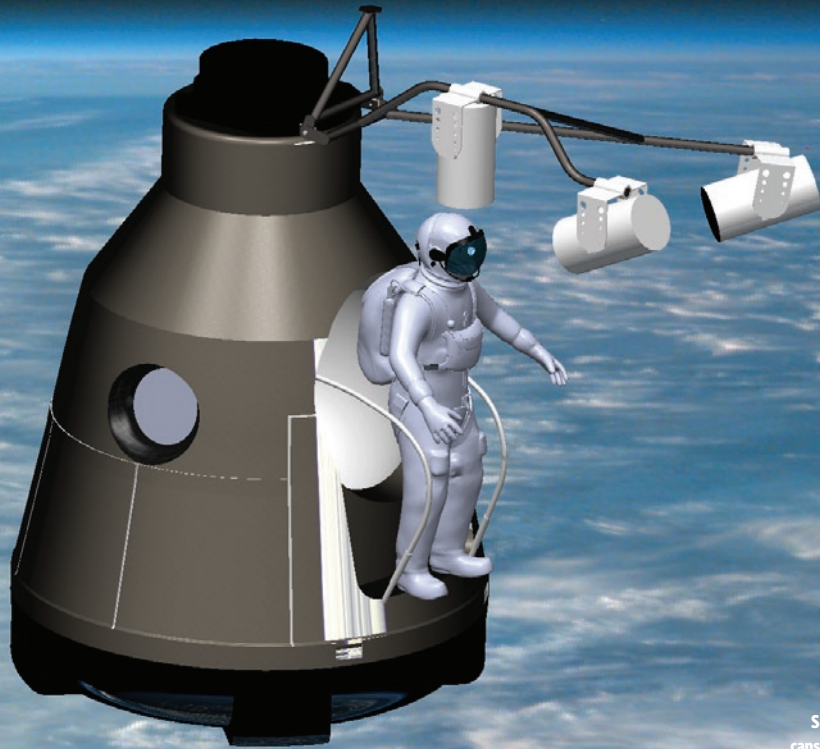


**HP Z Workstations with NVIDIA Quadro 'Kepler' GPUs can enable users to work in RealView mode all the time, rather than having to revert back to the less demanding OpenGL modes to maintain interactivity with the model**





*With an HP Z Workstation with NVIDIA Quadro we are able to quickly rotate complex models, keep the conversations going, look at how all the pieces fit together. Art Thompson, CEO, Sage Cheshire Aerospace.*



SolidWorks model of the capsule used in the Red Bull Stratos space diving project

**S**olidWorks 2014 is focused on 3D modeling and design so there is a big emphasis on providing high-quality interactive visualization capabilities in the viewport.

The software offers full control over shadows and lighting and there are a number of preset visual styles, which can be toggled between instantly to suit different workflows.

There are two main display modes inside SolidWorks: OpenGL and RealView.

OpenGL mode is used predominantly in modeling workflows to give the clearest understanding of geometry. It uses standard texture mapping and casts simple shadows on the floor. The big focus is on performance and clarity and not on realism.

OpenGL mode features a number of different display states including wireframe, shaded and shaded with edges.

'Shaded with edges' (pictured left) is arguably the most popular. It places a big emphasis on highlighting the exact topology of a model. For example, it makes it easy to see where fillet blends start and finish and is particularly useful when working with more complex surface-based geometry.

OpenGL mode provides users with full control over how a model is displayed. To facilitate modeling, most users completely shut off shadows, enable only the ambient light and use a plain white background, or one of a contrasting color, to highlight the model. Render surfaces in different colors according to the local radius of curvature. Use zebra stripes to visualize small changes in a surface by simulating the reflection of long strips of light on a very shiny surface.

Increasingly, designers and engineers are demanding higher levels of realism

in the viewport. SolidWorks RealView is used to give the SolidWorks model a much more realistic appearance. It supports environment reflections, floor shadows, multi-colored effects such as car paint, as well as ambient occlusion, an effect that delivers much more realistic real-world lighting.

Upping the visual quality inside the SolidWorks viewport can offer huge workflow benefits. Designers and engineers are able to make judgments on aesthetics throughout the product development process. In the past, to visualize a design at such levels of quality would have required a time consuming off line render.

With SolidWorks RealView the visualization is instant and the model is fully interactive. It is also possible to render out a high-res still in seconds, which can be useful for reports.

Increasing the level of realism inside the

viewport does place a bigger load on a workstation's GPU. The demands become even higher as the size and complexity of models increase.

Maintaining full interactivity with high-quality models can be a big challenge with older workstations. When rotating, panning and zooming around an assembly, frame rates or visual quality can drop.

**HP Z Workstations** are well equipped to deliver a full interactive experience with large models. With high-performance Intel® Xeon® CPUs and **NVIDIA Quadro** GPUs based on the Kepler architecture they can help users work with RealView enabled all the time, rather than having to revert back to the less demanding OpenGL modes to maintain full interactivity with the model. Reliability is also essential in demanding workflows and HP Z Workstations undergo a rigorous testing process before they are certified by DS SolidWorks.



# 3D GRAPHICS OPTIMIZATION TIPS

## How to strike a balance between visual quality and model interactivity in SolidWorks 2014

By default SolidWorks is configured to deliver good dynamic performance in the viewport. It places an emphasis on maintaining interactivity then improving quality as soon as the model stops moving.

Much of this is down to 'Large Assembly Mode', which automatically switches on when an assembly reaches a certain number of components.

Large Assembly Mode is a collection of system settings specifically designed to improve the performance of assemblies. The trade-off for maintaining high-levels of interactivity in the viewport, however, is a reduction in visual quality.

A number of display features are automatically turned off, including RealView, shadows, and anti aliasing which smooths jagged edges. During dynamic view manipulation, models can

also degrade, temporarily turning parts into simplified blocks.

Using high-performance HP Z Workstations with NVIDIA Quadro GPUs based on the Kepler architecture it is often possible to ramp up the visual quality in the viewport without impacting the interactivity of large assemblies.

However, in order to gain access to these advanced visualization features Large Assembly Mode must first be turned off. This can be done with the click of a button or by changing the 'number of components' threshold at which it automatically turns itself on.

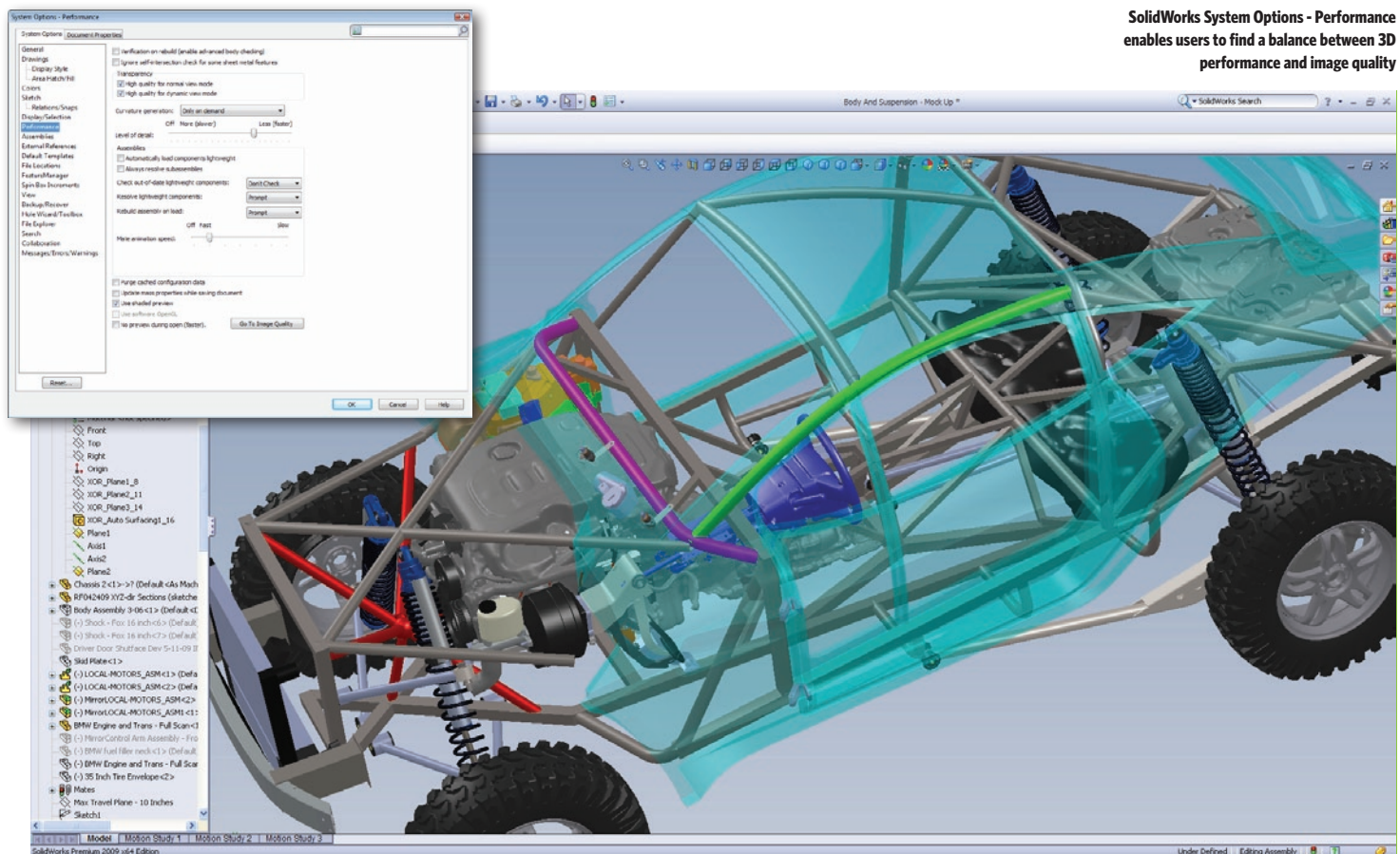
Once Large Assembly Mode is deactivated users will have access to the full range of effects, including shadows, RealView, ambient occlusion and anti-aliasing. It is also possible to dive into the SolidWorks performance system settings to fine tune the software and find that perfect balance

between interactivity and image quality.

High-quality transparency can be switched on or off in dynamic view mode. It is also possible to adjust the level of detail. Setting the slider to 'off' will mean no model detail is dropped when dynamically viewing a model. Setting it to 'less' will increase performance but potentially drop more components from your assembly.

Delving even deeper into the settings Assembly Visualization can be used to check for specific components whose image quality might be slowing down the dynamic graphics performance of very large assemblies. Sort components by the number of Graphics-Triangles then hide those with high triangle counts.

Finally, when a component is hidden, by default it fades away, rather than simply disappearing. This is a nice effect, but it takes a little time so it is possible to turn that feature off to speed things up a bit.



**SolidWorks System Options - Performance**  
enables users to find a balance between 3D  
performance and image quality

Local Motors car created  
in Dassault Systèmes  
SolidWorks



## PHOTOREALISTIC QUALITY RENDERING

**V**isualization has become a core skill set for designers. This is especially true for SolidWorks users who often need to create high quality photorealistic images and animations of designs for marketing, client verification, product documentation, or sales support. Visualization can also be a powerful aid to developing several different looks based on various materials under consideration.

PhotoView 360 is a fully integrated ray tracing add-in for SolidWorks that produces photorealistic stills or animations of parts and assemblies. It is included with SolidWorks Professional and SolidWorks Premium.

PhotoView 360 is completely embedded within the SolidWorks User Interface. It leverages all of the appearances, decals

and scenes applied to your SolidWorks model. Scenes can be previewed in RealView or OpenGL, harnessing the power of the NVIDIA Quadro GPU, but for highest quality ray traced renders, it uses all of the CPU cores in your HP Z Workstation for optimal performance.

Bunkspeed is a third-party product with a workflow from SolidWorks that focuses on rendering. As it is a separate application it allows non-engineers to do the rendering work, if so desired. Users do not have to be skilled in SolidWorks to use it and are able to render a SolidWorks model without requiring a license of SolidWorks.

Bunkspeed leverages NVIDIA GPUs which means you can do your final frame renderings on the GPU while still working with SolidWorks (CPU) on other projects or design iterations.

## PHOTOVIEW 360 RENDERING WITH SOLIDWORKS

**P**hotoView 360 is a CPU-based ray trace renderer that is fully embedded within the SolidWorks User Interface. It can render photorealistic stills and animations straight from SolidWorks models, which can offer big workflow benefits for designers.

Appearances, lighting, scenes and decals that are applied to models inside SolidWorks are consistent across RealView and PhotoView 360. With a HP Z Workstation with NVIDIA Quadro GPU RealView can essentially be used as an instant preview to PhotoView 360's high-quality photorealistic output.

When preparing a PhotoView 360 render a dedicated preview window delivers a real time progressive rendering, which continually updates as changes are made to the scene. This helps users assess changes quickly before committing to a final render.

## RENDERING WITH NVIDIA IRAY - BUNKSPEED 2014

Bunkspeed SHOT is a 'push-button' 3D renderer that offers a workflow with SolidWorks 2013. SolidWorks data is imported directly or brought in using a plug-in where a button is pushed in SolidWorks and the model appears in Bunkspeed.

The model can then be 'painted' by dragging and dropping materials from a vast library. Bunkspeed can also handle design revisions by monitoring time stamps of

SolidWorks parts and assemblies. If a model changes, the assembly will automatically update within Bunkspeed - without having to re-import or re-paint the model.

Bunkspeed PRO adds features for those that use visualization tools every day, including animation, queued rendering and configurations (where designers can evaluate different color choices or aspects within a scene in a single file).

Both products use NVIDIA iray, an interactive ray trace rendering technology. NVIDIA iray can be accelerated by both CPUs and CUDA-based GPUs, but it thrives on GPUs with lots of cores and on-board memory. When using a HP Z Workstation featuring NVIDIA Maximus technology it is possible to design in SolidWorks while rendering in Bunkspeed with no noticeable slow down in performance.





# WORKSTATION TECHNOLOGY

What to look for when selecting a HP Z Workstation to partner SolidWorks

## GRAPHICS PROCESSING UNIT (GPU)

**D**emand for more realism inside the viewport means the role of the GPU has never been more important.

A modern professional GPU is recommended to attain the highest levels of interactivity with models that display realistic reflections, shadows and complex lighting. Moreover, SolidWorks RealView can only be used with a professional GPU,

such as NVIDIA Quadro (available in HP Z Workstations).

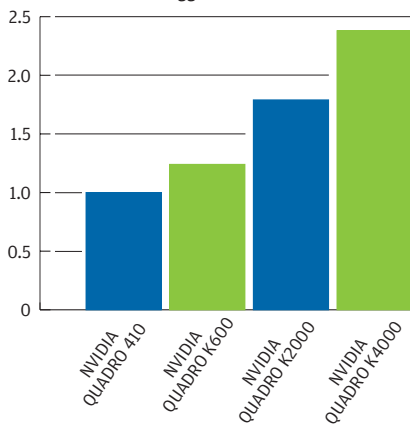
GPU memory is an important consideration. For SolidWorks 1GB is a minimum but, if the Quadro card is to be used for GPU rendering in Bunkspeed, 3GB or more is recommended.

NVIDIA Quadro Kepler GPUs are designed and built specifically for professional workstations. The GPUs have been optimized for performance and reliability when accelerating SolidWorks and other 3D applications.

NVIDIA Quadro is available for all levels of use. For SolidWorks, the Quadro K2000 (2GB) is well suited to small assembly modeling from 100 to 300 components, while the Quadro K4000 (3GB) is better matched to more demanding workflows with 500 to 2,000 component assemblies.

When using a single GPU to render with NVIDIA Iray in Bunkspeed, the Quadro K4000 (3GB) or Quadro K5000 (4GB) are good options. However, for best performance and workflow consider a HP Z Workstation with NVIDIA Maximus multi-GPU technology.

**SPECapc SolidWorks 2013 Results  
RealView graphics composite <sup>7</sup>**  
(bigger is better)



## HP Z820 WORKSTATION

## NVIDIA MAXIMUS - PROFESSIONAL MULTI-GPUs

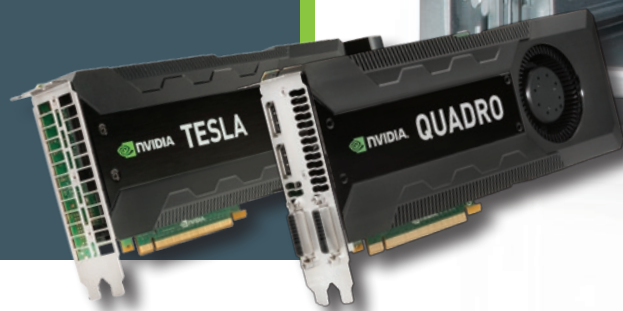
An HP Z Workstation with NVIDIA Maximus technology features multiple NVIDIA Quadro graphics or NVIDIA Tesla compute GPUs for ultimate performance. In applications with multi GPU support enabled, it allows performance to scale because each additional GPU adds more horsepower for a faster and more efficient workflow.

For example, in a SolidWorks / Bunkspeed workflow, combining

NVIDIA Quadro K4000 and Tesla K20 GPUs delivers interactive 3D graphics in SolidWorks, while simultaneously rendering scenes in Bunkspeed using Iray.

NVIDIA Maximus is not limited to one type of application, such as rendering with Iray. A multi-GPU workstation can also be used to accelerate solvers in NVIDIA CUDA-optimized simulation tools, including DS Simulia Abaqus and Ansys.

An HP Z820 Workstation can be fitted with up to three GPUs, in any combination.



## PROCESSOR (CPU)

The CPU is one of the most important components in a HP Z Workstation.

For SolidWorks the clock speed of the CPU (GHz) is a top priority as it impacts all core operations and 3D graphics performance. Multiple CPU cores will boost multi-threaded processes, such as file open and save, boolean operations, and when using SolidWorks Simulation. Four or six cores in a single CPU is a good choice.

To boost performance when rendering with SolidWorks PhotoView 360 consider dual processors with multiple CPU cores.

For certified performance, Intel® Xeon® processors are recommended.

## MEMORY (RAM)

16GB of memory is considered to be a good amount for mainstream product development workflows while 32GB is recommended for particularly complex datasets.

With SolidWorks it is important to consider that other applications — Bunkspeed, for example — may be running at the same time, which will also have an impact on memory use.

ECC memory, available in all desktop HP Z Workstations, is recommended for the highest quality results and it is important that memory is properly configured (pairs for two channels, quads for four channels).

## STORAGE (HARD DRIVES)

A Solid State Drive (SSD) is recommended for optimal performance. Complex datasets should load and save quicker and, as latency is low, the HP Z Workstation will feel more responsive. Random read / write access is also fast, which is particularly important when multi-tasking and swapping between applications.

While SSDs are superior to traditional hard disk drives (HDDs) in terms of performance, their cost per GB is still relatively high. As a result, SSDs are commonly ring fenced for operating system, applications and current datasets, while a high capacity HDD drive is used to store other assets and datasets.





# HP Z WORKSTATIONS OPTIMIZED FOR SOLIDWORKS

**HP Workstations deliver the performance, reliability, and application certifications required to accelerate product development workflows**



	<b>HP Z230</b> Workstation performance and reliability at starting prices that rival desktop PCs SolidWorks usage: Simple 3D assemblies	<b>HP Z420</b> High levels of performance and expandability in an accessible tool-free mini-tower form factor SolidWorks usage: Complex 3D assemblies and visualization	<b>HP Z820</b> Dual-socket workstation delivers exceptional performance, industrial design, and tool-free serviceability Large, complex 3D datasets, simulation, visualization, iray rendering (Bunkspeed)
<b>Operating System</b>	Windows 7 Professional 64 (available through downgrade rights from Windows 8 Pro 64) <sup>6</sup>	Windows 7 Professional 64 (available through downgrade rights from Windows 8 Pro 64) <sup>6</sup>	Windows 7 Professional 64 (available through downgrade rights from Windows 8 Pro 64) <sup>6</sup>
<b>Processor</b>	Intel® Xeon® E3-1270 v3 (3.5 GHz) (4 Core) <sup>1</sup>	Intel® Xeon® E5-1650 v2 (3.5GHz) (6 Core) <sup>1</sup>	2 x Intel® Xeon® E5-2637 v2 (3.5GHz) (4 Core) <sup>1</sup>
<b>Memory</b>	16GB ECC, DDR3 1,600 MHz <sup>3,4</sup>	32GB ECC, DDR3 1,600 MHz <sup>3,4</sup>	32GB ECC, DDR3 1,600 MHz <sup>3,4</sup>
<b>GPU</b>	NVIDIA Quadro K2000 (2GB GDDR5)	NVIDIA Quadro K4000 (3GB GDDR5)	NVIDIA Maximus (NVIDIA Quadro K4000 (3GB GDDR5) + NVIDIA Tesla K20 (5GB GDDR5)) or NVIDIA Quadro K5000 (4GB GDDR5)
<b>Storage<sup>5</sup></b>	256GB SATA SSD + 1TB SATA HDD	512GB SATA SSD	512GB SATA SSD



**H**P offers a complete range of desktop and mobile workstations built for the challenges of product development—from part and assembly modeling with SolidWorks to photorealistic renderings and animations with Bunkspeed PRO.

The HP Z Workstation family meets the full range of workstation needs—from performance-driven computing and design work in space-constrained environments to

extreme visualization with complex datasets.

HP ZBook Mobile Workstations offer high performance with exceptional battery life and feature a chassis inspired by aerospace craftsmanship and materials.

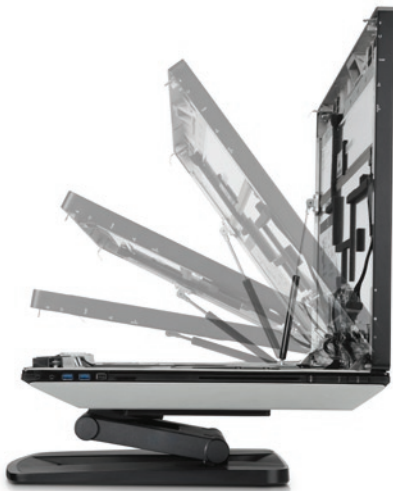
There are other specific advantages for SolidWorks customers. DS SolidWorks itself uses HP Workstations and Mobile Workstations to develop, test, and demonstrate its applications.

*DS SolidWorks itself uses HP Workstations and Mobile Workstations to develop, test, and demonstrate its applications.*



	<b>HP Z1</b> HP Z Workstation performance and reliability expertly designed into the back of a 27-inch diagonal beyond HD display  SolidWorks usage: Boardrooms, for Design Review	<b>HP ZBook 15</b> 15.6-inch diagonal display mobile workstation redesigned for productivity on the go.  SolidWorks usage: Mobile design and engineering	<b>HP ZBook 17</b> HP's most powerful mobile workstation with incredible expandability and a 17-inch diagonal display.  SolidWorks usage: Mobile design, engineering, simulation, and visualization of large datasets; laser scanning
Operating System	Windows 7 Professional 64 (available through downgrade rights from Windows 8 Pro 64) <sup>6</sup>	Windows 7 Professional 64 (available through downgrade rights from Windows 8 Pro 64) <sup>6</sup>	Windows 7 Professional 64 (available through downgrade rights from Windows 8 Pro 64) <sup>6</sup>
Processor	Intel® Xeon® E3-1245 v2 (3.4GHz) (4 Core) <sup>1</sup>	Intel® Core® i7-4800MQ (2.7GHz) (4 Core) <sup>1</sup>	Intel® Core® i7-4800MQ (2.7GHz) (4 Core) <sup>1</sup>
Memory	32GB ECC, DDR3 1,600 MHz <sup>3,4</sup>	16GB DDR3 SDRAM, 1,600 MHz <sup>3,4</sup>	32GB DDR3 SDRAM, 1,600 MHz <sup>3,4</sup>
GPU	NVIDIA Quadro K4000M (2GB GDDR5)	NVIDIA Quadro K2100M (2GB DDR3)	NVIDIA Quadro K4100M (4GB GDDR5)
Storage	512GB SATA SSD	750GB HDD + 24GB SATA SSD SRT	512GB SATA SSD + 750GB HDD

## HP Z WORKSTATIONS DESIGNED FOR PROFESSIONALS



The HP Z1, a high-performance all-in-one workstation with a stunning 27-inch diagonal beyond HD display, features an innovative chassis for easy serviceability and upgrades.



The HP Z1 features a custom line of NVIDIA Quadro GPUs, which utilize less power, generate less heat and require less cooling.

## MINIMIZE DOWNTIME

HP continually pushes itself in every aspect of workstation design. For serviceability, its trademark tool-less design helps minimize downtime when users need to make upgrades and repairs.

HP Z Workstations, desktop and mobile, feature single latch entry in order to get quick access to key components inside.

Fans, power supplies, optical drives and other components inside desktop HP Z Workstations feature green access points which makes them easy to remove and click back into place. Blind mate connectors on hard drive caddies mean users don't have to worry about power and data cables. Memory modules and graphics cards are located for easy access. Integrated handles and slide rails are built into the chassis to make it easy to move machines around the office.

HP Z Workstations have also been engineered to minimize the noise produced by cooling fans. The HP Z820,

for example, uses ducts to channel airflow over individual CPUs and memory banks to maximize cooling efficiency.

For even quieter operation, liquid cooling in the HP Z420 and HP Z820 enables machines to be pushed to the limit, while reducing fan noise by up to 50%.

Meanwhile, HP ZBook Mobile Workstations feature a precision aluminum chassis for aesthetics and strength.

**HP Z Workstations feature green access points to help locate and service internal components**



## HP AND NVIDIA SOLIDWORKS TESTING AND CERTIFICATION

Product development professionals demand performance and reliability from their workstation hardware. HP Z Workstations undergo a rigorous testing process before they are proven and certified by DS SolidWorks and HP.

HP's application certification process is designed to ensure users receive the best possible experience when running SolidWorks on HP Z Workstations.

A key part of this process is 3D graphics and here HP performs in-depth graphics driver quality testing and performance measurement. If graphics issues are identified then HP works with NVIDIA and DS SolidWorks to resolve them, helping protect users' investment in software and HP hardware.

## TUNE YOUR SYSTEM FOR SOLIDWORKS

HP Performance Advisor, an HP tool for performance optimization, delivers a simple, effective way to keep your HP Workstation operating at its peak potential.

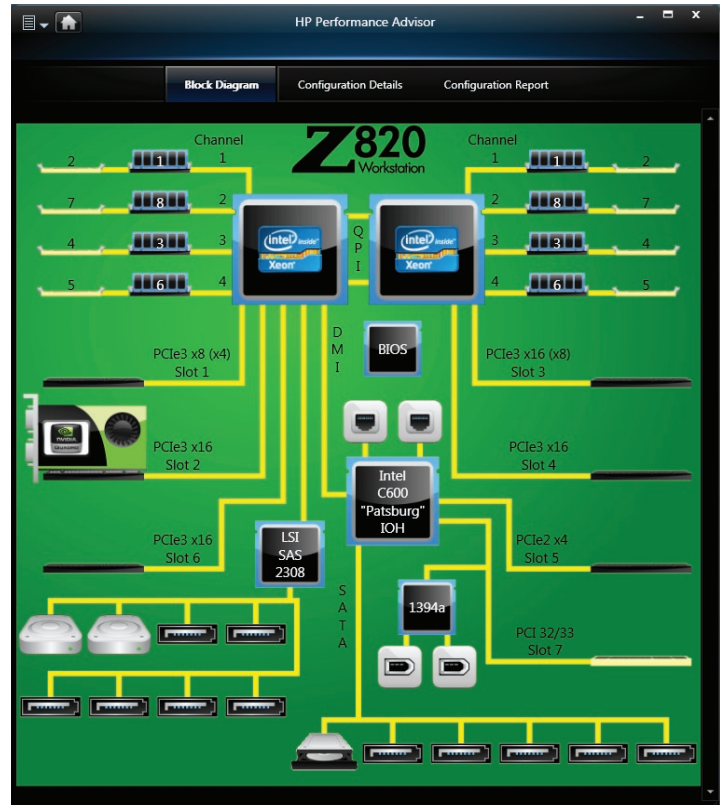
A software wizard can take you from initial configuration and customization through the optimization of your system for SolidWorks and other applications.

It can help ensure you are using the best certified graphics driver for your installed applications, optimized for performance and stability. It can also offer advice and apply BIOS settings. For example, enabling Intel Hyper-Threading<sup>2</sup> to get maximum performance when rendering with PhotoView 360 in SolidWorks.

It can also help you gain a quick and accurate understanding of your entire system in one simple, interface, and then help identify bottlenecks by tracking use of memory, CPU and other resources. This can help ensure maximum performance throughout the entire life of your HP Z Workstation.

HP Performance Advisor is included with HP Z Workstations.

HP Performance Advisor features an interactive block diagram to give a crystal clear picture of all the components inside your HP Z Workstation.



## ACCESS AND SHARE DESIGNS REMOTELY

With HP Remote Graphics Software (RGS) it is possible to access your graphics-intensive workstation applications wherever you have network access or share designs with your extended team. The software offers complete access to the power of a HP Workstation from any Windows or Linux computer in any location.

There are a number of different use cases for HP RGS. For real-time collaboration across multiple sites it is possible to share your workstation screen with multiple users simultaneously. Participants can be granted 'view only' or full interactive access.

For example, HP RGS could be used in conjunction with Bunkspeed to explore different colors or finishes with clients or members of the supply chain.

HP RGS can also be used to support workers across multiple sites. A company's workstation resources can be consolidated in a single location and the workforce

can connect in from any computer at any location.

The software also provides flexibility for mobile workers, who are able to get complete remote access to the full power of their HP Z Workstation while away from their desk. This could be from home, the shop floor, client offices, or the boardroom.

With HP RGS no CAD data ever leaves the HP Z Workstation. Only pixel data is streamed which means huge CAD data sets don't have to be moved between sites, which can be slow and can lead to sync issues. HP RGS can also help protect intellectual property as no CAD data is made available to take off site.

HP RGS is included as standard with all HP Z Workstations. For set up HP RGS sender and receiver software needs to be installed on workstation and client.

The latest version of the software boasts a massive reduction in required bandwidth for RGS connections, helping extend the reach of remote access.



## HP Z DISPLAYS

HP Z Displays offer outstanding image accuracy, exceptional adjustability, and mission-critical reliability optimized for professional use. Built with IPS Gen 2 panels, HP Z Displays deliver power savings over first-generation IPS technology and extra-wide viewing angles that foster collaboration.

The HP Z24i 24-inch IPS Display (pictured) features a 1,920 x 1,200 resolution while the HP Z27i 27-inch IPS Display takes this even higher to 2,560 x 1,440.



## LEARN MORE

### Create better designs with Dassault Systèmes and HP Workstations.

With HP and Dassault Systèmes, you can be confident that you've picked a winning combination. Just consider the unique HP and Dassault Systèmes relationship, plus HP-optimized workstations for CATIA, SolidWorks, and other Dassault applications. HP Workstations have numerous certified applications, unique innovations, and a complete range of HP solutions.

For more information, go to [www.hp.com/go/solidworks](http://www.hp.com/go/solidworks)



**3D SOLIDWORKS**

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1. Multi-Core is designed to improve performance of certain software products. Not all customers or software applications will necessarily benefit from use of this technology. 64-bit computing on Intel® architecture requires a computer system with a processor, chipset, BIOS, operating system, device drivers, and applications enabled for Intel® 64 architecture. Processors will not operate (including 32-bit operation) without an Intel® 64 architecture enabled BIOS. Performance will vary depending on your hardware and software configurations. Intel's numbering is not a measurement of higher performance. See [intel.com/info/em64t](http://intel.com/info/em64t) for more information.
2. Intel® Hyper-Threading - The hyper-threading feature is designed to improve performance of multi-threaded software products; please contact your software provider to determine software compatibility. Not all customers or software applications will benefit from the use of hyperthreading. Go to [intel.com/info/hyperthreading](http://intel.com/info/hyperthreading) for more information, including which processors support HT Technology.
3. Each processor supports up to 2 channels of DDR3 memory. To realize full performance at least 1 DIMM must be inserted into each channel.
4. Intel® Xeon E3, Intel Core i3 and Intel Pentium processors can support either ECC or non-ECC memory. Intel Core i5 and i7 processors only support non-ECC memory.
5. For hard drives and solid state drives, 1 GB = 1 billion bytes. TB = 1 trillion bytes. Actual formatted capacity is less. Up to 10GB of system disk (for Windows 7) is reserved for system recovery software.
6. This system is preinstalled with Windows® 7 Pro software and also comes with a license and media for Windows 8 Pro software. You may only use one version of the Windows software at a time. Switching between versions will require you to uninstall one version and install the other version. You must back up all data (files, photos, etc.) before uninstalling and installing operating systems to avoid loss of your data.
7. Chart compares four different NVIDIA Quadro GPUs so users can get an idea of relative 3D performance. Testing is based on the RealView graphics composite score taken from the SPECapc SolidWorks 2013 benchmark. All GPUs were tested with a HP Z220 Workstation, running Microsoft Windows 7 64-bit operating system with 311.44 NVIDIA graphics driver. Specification of system: Intel Xeon E3-1245v2, 16GB, 256GB Micron SSD. Tests were run June 2013 by NVIDIA.

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