Technical white paper

AutoCAD® 2015 performance: HP Z230 Workstations vs HP PC

Outperforms a PC by up to 95% on the Cadalyst AutoCAD benchmark

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"Productivity improvement when running AutoCAD 2015 on an HP Z230 SFF Workstation was so significant to the PC that most users will find that it easily justifies the investment in a workstation"

– David Cohn, contributing editor, Desktop Engineering

HP recommends Windows.

Executive summary

You can run most business applications on a standard personal computer (PC), but when running computer aided design (CAD) software such as AutoCAD®, you should use a workstation certified to run AutoCAD.

In order to quantify the potential productivity improvement and return on investment a typical user is likely to experience when running AutoCAD on a workstation rather than a PC, we devised a series of tests involving timing the repeated re-creation of a selection of drawings using AutoCAD 2015 on a typical older model PC and on two different HP Z230 Workstations. The drawings used were representative of those that would be produced by typical AutoCAD users.

The results of the study were quite dramatic. It took 8 hours: 15 minutes to complete the five drawings using AutoCAD 2015 on a PC compared to 6 hours: 44 minutes to complete the same five drawings using AutoCAD 2015 on an HP Z230 SFF Workstation equipped with an Intel® Core™ i7 CPU and an NVIDIA® Quadro® K420 graphics board, a time savings of 18%. When the same five drawings were created on an HP Z230 SFF Workstation equipped with an Intel Xeon® CPU, an HP Z Turbo Drive, and an NVIDIA Quadro K620 graphics board, the total time was reduced to 6 hours: 20 minutes, a time savings of 23%.

We also ran a series of industry standard benchmark tests, including the SPECviewperf® benchmark to measure 3D graphics performance and the Cadalyst benchmark to measure various aspects of system performance when running AutoCAD. While benchmarks do not measure actual user productivity, they do provide an additional metric for measuring relative system performance. **On these industry standard benchmarks, the HP Z230 SFF Workstation outperformed the PC by anywhere from 14 to 1133 percent.**

Figure 1. Total time to complete a series of five drawings in AutoCAD 2015 (lower is better).

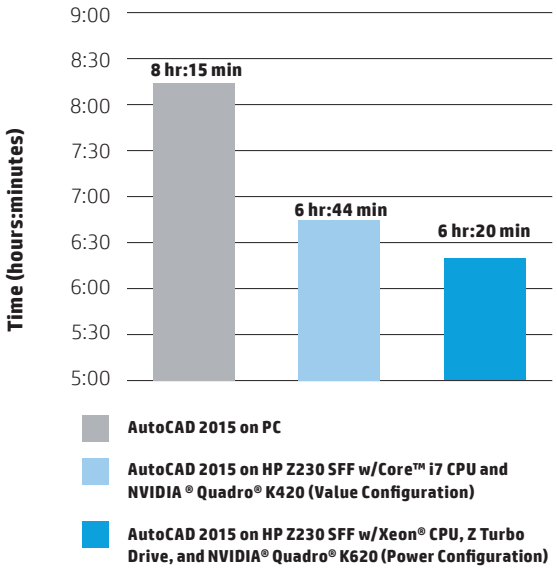
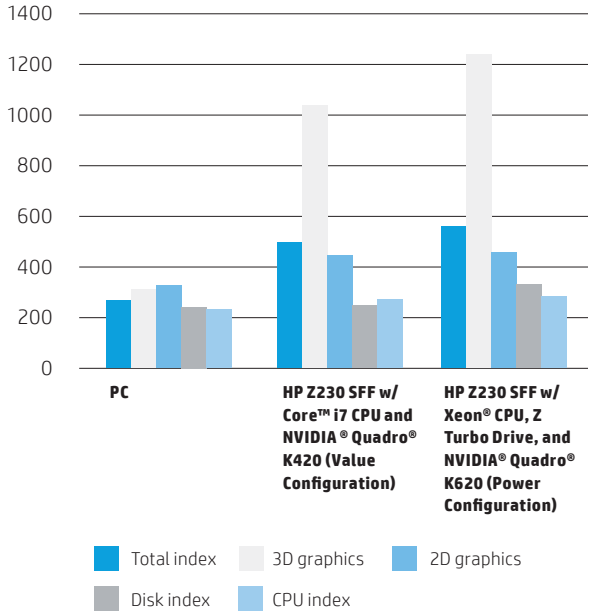


Figure 2. Cadalyst Benchmark (higher is better)



While your results will likely vary based on your level of experience and the specific nature of the drawings you produce, the results are clear—you can achieve a higher level of productivity by running AutoCAD on a workstation rather than a less-expensive PC. By running AutoCAD 2015 on an HP Z230 Workstation, you can get your work done sooner. The level of user productivity improvement when running AutoCAD 2015 on the HP Z230 Workstation was so significant compared to the PC that most users will find that it easily justifies the investment in a workstation.

HP recommends Windows.

The study in detail

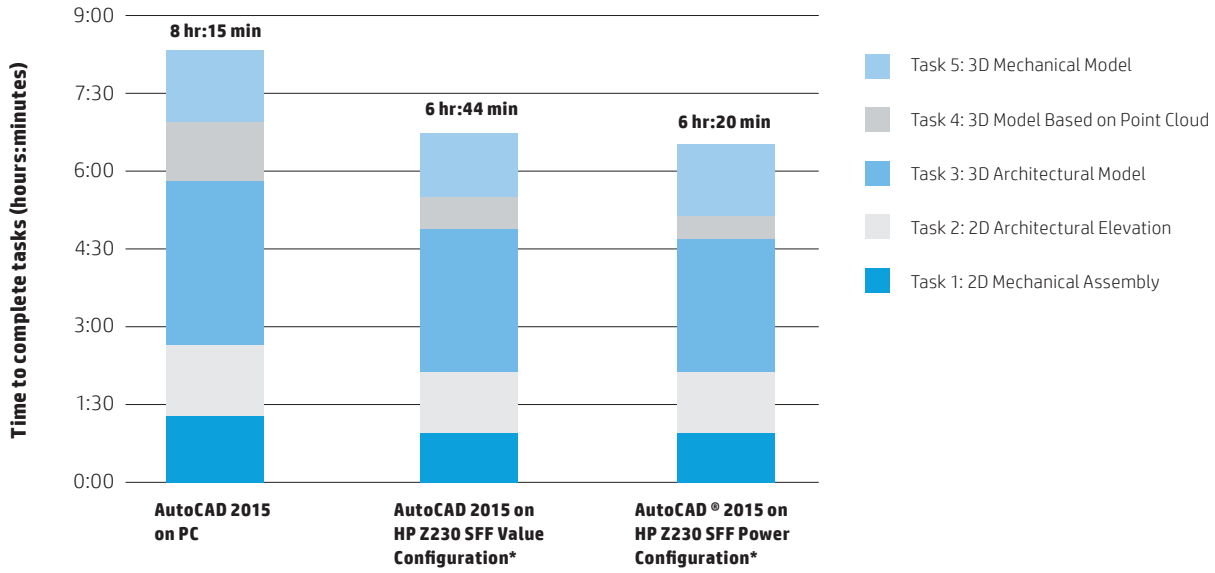
The AutoCAD® 2015 productivity study compared the time required to produce a collection of five different drawings multiple times using AutoCAD 2015. The tests were run on three different computers:

	Typical older model HP PC	HP Z230 SFF Workstation Value Configuration	HP Z230 SFF Workstation Power Configuration
Operating system	Windows 7 Home Premium 64-bit[1]	Windows 7 Professional 64-bit[1]	Windows 7 Professional 64-bit[1]
Processor[2]	Intel® Core™ i7-2600[2] (3.4 GHz quad-core)	Intel Core i7-4790[2] (3.6 GHz quad-core)	Intel Xeon® E-1241v3[2] (3.5 GHz quad-core)
Memory[3]	8 GB	8 GB	16 GB ECC memory
Hard drive[4]	7200 rpm SATA	10,000 rpm SATA	HP Z Turbo Drive
Graphics	AMD Radeon™ HD 7370	NVIDIA® Quadro® K420	NVIDIA Quadro K620

The results were quite dramatic. It took 8 hours: 15 minutes to complete all five drawings using AutoCAD 2015 on the PC, compared to 6 hours: 44 minutes on the HP Z230 equipped with an Intel® Core™ i7 CPU—a time savings of 18 percent—and just 6 hours: 20 minutes on the HP Z230 equipped with an Intel Xeon® CPU and an HP Z Turbo Drive—a time savings of 23 percent. By upgrading from a PC to an HP Z230 Workstation, the time required to produce the individual drawings was reduced anywhere from 16 to 51 percent.

The following chart illustrates the cumulative improvement in overall productivity, represented as the total time required to complete the five sample drawings on the two HP Z230 SFF Workstations compared to the PC.

Figure 3. Total time to complete a series of five drawings in AutoCAD 2015 (lower is better).



* See page 3 for configuration details on Value and Power configurations

Drawing Task #1 – 2D Mechanical Assembly

HP Z230 SFF offers a total time savings of 26% compared to a PC.
This drawing represents a typical mechanical part that might be produced using AutoCAD®—a two-dimensional cross-section through a valve assembly.

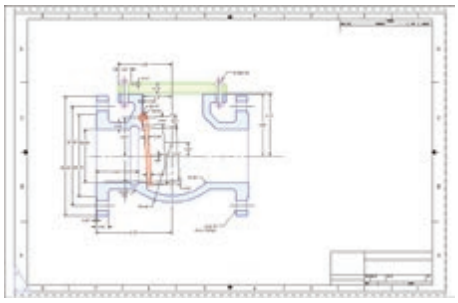
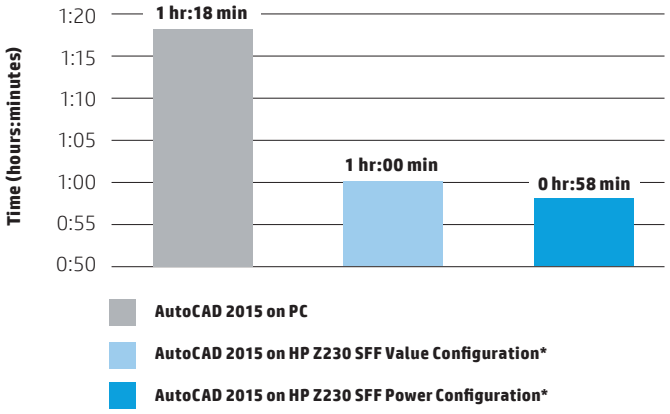


Figure 4. Time to complete (lower is better)

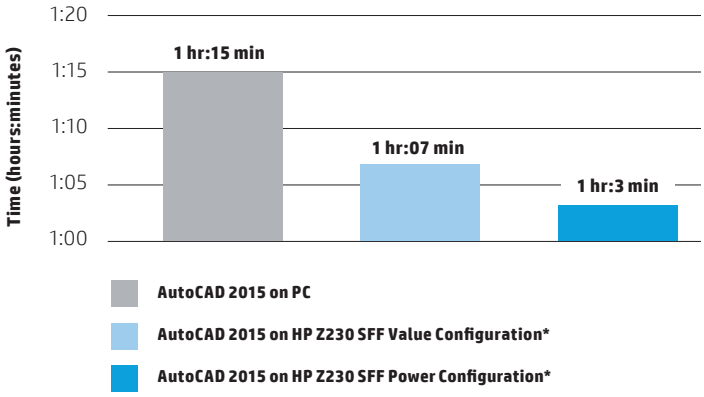


Drawing task #1 took 1 hour: 18 minutes to complete using AutoCAD 2015 on the PC versus only 1 hour on the HP Z230 Workstation equipped with the Intel® Core™ i7 CPU, an improvement of 23%. The same drawing took only 58 minutes to complete on the HP Z230 Workstation equipped with the Intel Xeon® CPU and Z Turbo Drive, a total time savings of 26% compared to the PC.

Drawing Task #2 – 2D Architectural Elevation

HP Z230 SFF offers a total time savings of 16% compared to a PC.
This drawing task was the completion of a two-dimensional elevation of a custom house.

Figure 5. Time to complete (lower is better)



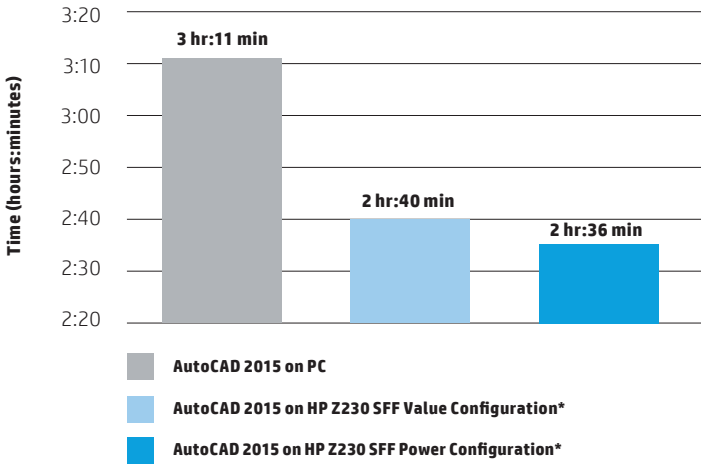
Drawing task #2 took 1 hour: 15 minutes to complete using AutoCAD 2015 on the PC versus only 1 hour: 7 minutes on the HP Z230 Workstation equipped with the Intel® Core™ i7 CPU, an improvement of 11%. The same drawing took only 1 hour: 3 minutes to complete on the HP Z230 Workstation equipped with the Intel Xeon® CPU and Z Turbo Drive, a total time savings of 16% compared to the PC.

* See page 3 for configuration details on Value and Power configurations

Drawing Task #3 – 3D Architectural Model

HP Z230 SFF offers a total time savings of 18% compared to a PC.
This drawing task was the creation of a three-dimensional model of a custom house, complete with realistic materials, and then the creation of a high-resolution rendering showing a view of the exterior of the house.

Figure 6. Time to complete (lower is better)

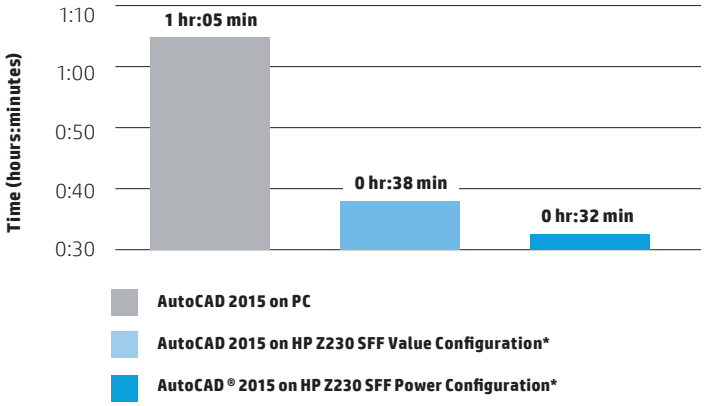


Drawing task #3 and subsequent rendering took 3 hours: 11 minutes to complete using AutoCAD® 2015 on the PC. The same drawing and rendering took 2 hours: 40 minutes to complete on the HP Z230 Workstation equipped with the Intel® Core™ i7 CPU, an improvement of 16%. The same drawing took only 2 hours: 36 minutes to complete on the HP Z230 Workstation equipped with the Intel Xeon® CPU and HP Z Turbo Drive, a total time savings of 18% compared to the PC.

Drawing Task #4 – 3D Model Based on a Point Cloud

HP Z230 SFF offers a total time savings of 51% compared to a PC.
This drawing task was the creation of an AutoCAD 3D model based on point cloud data that was first imported into Autodesk® Recap™ and then attached to an AutoCAD drawing.

Figure 7. Time to complete (lower is better)

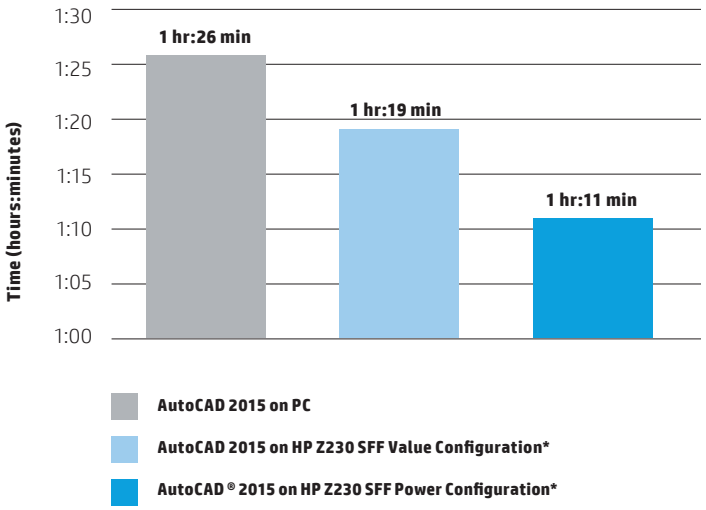


Drawing task #4 took 1 hours: 5 minutes to complete using Autodesk Recap™ and AutoCAD 2015 on the PC. The same drawing took only 38 minutes to complete on the HP Z230 SFF Workstation equipped with the Intel® Core™ i7 CPU, an improvement of 42%. The same drawing took only 32 minutes to complete on the HP Z230 Workstation equipped with the Intel Xeon® CPU and HP Z Turbo Drive, a total time savings of 51% compared to the PC.

Drawing Task #5 – 3D Mechanical Model

HP Z230 SFF offers a total time savings of 17% compared to a PC.
This drawing task was the creation of a three-dimensional model of hand drill, complete with realistic materials, and then the creation of a high-resolution rendering showing the drill sitting on a table.

Figure 8. Time to complete (lower is better)



Drawing task #5 and subsequent rendering took 1 hour: 26 minutes to complete using AutoCAD® 2015 on the PC, including the time required to apply materials, add lights, and render the scene. The same task took 1 hour: 19 minutes on the HP Z230 SFF Workstation equipped with the Intel® Core™ i7 CPU, an improvement of 8%. The same drawing took only 1 hour: 11 minutes to complete on the HP Z230 Workstation equipped with the Intel Xeon® CPU and HP Z Turbo Drive, a total time savings of 17% compared to the PC.

Factors contributing to productivity improvements

The reduction in the time required to produce the task drawings on the HP Z230 Workstations compared to the PC resulted from the differences in the system configurations.

CPU
Although all three computers were equipped with Intel quad-core CPUs, the HP Z230 Workstations were equipped with faster, more powerful CPUs than the PC. The faster CPUs enabled the workstations to complete operations such as rendering and 3D modeling operations—revolving, extruding, lofting, and so on—much faster than the PC. The more powerful CPUs had their greatest impact on drawing tasks 3, 4, and 5—the 3D modeling tasks.

RAM
The HP Z230 Workstations identified as Power Configuration came equipped with fast (1600 MHz) ECC (error correction code) memory, compared to slower (1333 MHz) non-ECC memory in the PC. ECC memory protects against data corruption by automatically detecting and correcting memory errors. This can be very important in mission critical applications such as AutoCAD 2015, which is why ECC memory is used in workstations. But ECC memory is typically not available in consumer PCs.

* See page 3 for configuration details on Value and Power configurations

GPU

The GPU (graphics processing unit) included in each computer had significant impact on the overall system performance. The PC used in the study was equipped with a consumer-level graphics card, while the HP Z230 Workstations were equipped with NVIDIA® Quadro® professional graphics. AutoCAD® 2015 performance is accelerated by the NVIDIA Quadro graphics cards and the NVIDIA Quadro graphics driver software is tested and certified by Autodesk® for AutoCAD 2015. In addition, AutoCAD 2015 features new UI (user interface) and point cloud capabilities that are enhanced by professional graphics cards, such as the NVIDIA Quadro. The NVIDIA Quadro graphics resulted in improved graphics performance, allowing for faster manipulation of both the 2D drawings and 3D models. This resulted in more responsive AutoCAD performance on the workstations compared to the PC, resulting in an improved user experience and significant time savings.

Hard drive

The hard drive can have a very significant impact on system performance and user productivity. Whenever you start a program or open or save a file, you access the hard drive. The hard drive in the PC used in this study was a 500 GB 7200 rpm hard drive typical of those found in most consumer PCs, whereas the HP Z230 identified as Value Configuration came with a 1 TB 10,000 rpm hard drive. The faster the rotation speed, the higher the transfer rate, which can translate into faster performance. The HP Z230 identified as Power Configuration was augmented by the inclusion of an HP Z Turbo Drive. This solid state drive, which installs in a standard PCIe slot, can help reduce boot up, calculation, and graphic response times. In particular, by loading AutoCAD and Autodesk Recap™ on the HP Z Turbo Drive and also saving data to the Z Turbo Drive, we achieved dramatic reductions in the amount of time it took to index and load point clouds in drawing task 4.

Conclusion

The results of this study were both dramatic and conclusive—AutoCAD 2015 is more responsive and typical drawing tasks can be completed considerably faster when the software is run on a certified workstation such as the HP Z230 SFF compared to running AutoCAD 2015 on a comparable older model PC, with an average overall time savings of more than 20 percent.

When creating typical drawings, running AutoCAD 2015 on a certified HP Z230 SFF Workstation resulted in time savings ranging from 8 to 51 percent depending on the workstation configuration and the nature of the drawing.

In addition, on industry standard benchmarks, the HP Z230 SFF Workstation out-performed the PC by anywhere from 14 to 1133 percent.

While different individuals will likely experience varying degrees of improvement, depending on the nature and complexity of the drawings and their skill levels, similar levels of improvement are highly likely. Most users will be able to get more work done faster as a result of using a certified workstation such as the HP Z230 SFF compared to a PC, easily justifying the purchase of a workstation. The improvement in user productivity is so significant that most users should recognize a very fast return on their investment, easily justifying the cost of purchasing a workstation certified for AutoCAD 2015.

Benchmark Results

In addition to the user productivity analysis performed using the five drawing task scenarios, we also performed more traditional quantitative analysis of the computer hardware using a number of different benchmarks, including the SPECviewperf® benchmark to measure 3D graphics performance and the Cadalyst benchmark to measure various aspects of system performance when running AutoCAD.

These benchmarks are synthetic tests that generally yield a single number or series of numbers that show the relative performance of the entire computer or a particular subsystem (such as the graphics accelerator or hard drive). While the resulting numbers can be compared to see which system or subsystem is faster, these types of tests do not provide significant insight into actual user productivity. That said, they do provide an additional metric for measuring the relative performance of the computers used in this study.

We performed a total of four different benchmark tests:

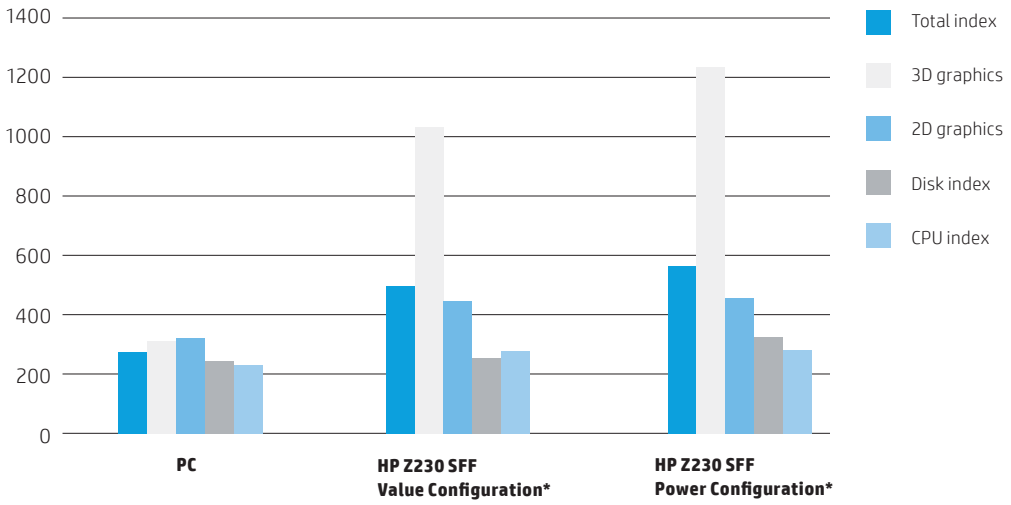
- The Cadalyst benchmark
- SPECviewperf
- An AutoCAD rendering benchmark
- An AutoCAD script to measure performance when working with very large drawing files

Cadalyst Benchmark

The Cadalyst benchmark is designed to test and compare the performance of systems running AutoCAD®. The benchmark compares the test times of the system with a set of base times, and computes an index number. An index score of 135, for example, means that the system being tested is 135 times faster than the base system for the functions tested. The total index score is calculated based on sub-index scores for four areas of performance: 3D graphics, 2D graphics, disk, and CPU.

This benchmark was originally developed by Art Liddle, the former technical editor of Cadalyst magazine. We used the latest version of the benchmark, which is compatible with AutoCAD 2015. The total Cadalyst benchmark index improved 83 percent on the HP Z230 identified as Value Configuration and 95% on the Power Configuration compared to the standard PC.

Figure 9. Cadalyst Benchmark (higher is better)



SPECviewperf®

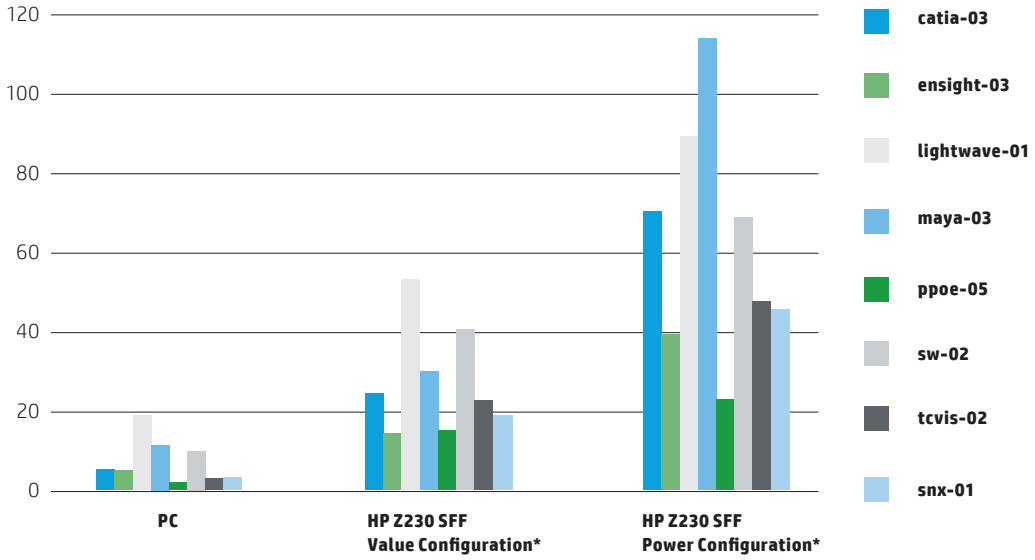
The SPECviewperf benchmark measures the 3D graphics performance of systems running under OpenGL. The benchmark renders a series of large datasets created in eight different CAD and DCC (digital content creation) programs, recording the number of frames displayed per second. Each viewset represents the rendering portion of the actual application. The benchmark then reports its results as the weighted geometric mean as the single composite metric for each viewset. This benchmark tests only the graphics performance, and is truly a synthetic metric rather than a measure of actual application performance. That said, it does provide a useful comparison of the relative performance of different workstations and graphic card combinations. We also included it among the benchmark tests we performed due to its extensive use throughout the industry.

There have been numerous versions of the SPECviewperf benchmark. We tested using both Viewperf version 11 and version 12. Both versions of the benchmark can be run at various resolutions and as both a single-threaded test and in several multi-threaded variations. We performed our tests at a resolution of 1280 x 1024 as a single thread. The results presented here are based on Viewperf version 11.

As expected, the results improved significantly on the HP Z230 SFF Workstations compared to the PC thanks to the workstation-class NVIDIA® Quadro® graphics boards.

* See page 3 for configuration details on Value and Power configurations

Figure 10. SPECviewperf® (higher is better)



Depending on the viewset, the SPECviewperf® results improved anywhere from 141% to 629% on the HP Z230 Workstation identified as Value Configuration, with an average improvement of 338% over the PC. On the HP Z230 Power Configuration, the results improved between 360% and 1333%, with an average improvement of 849% compared to the PC.

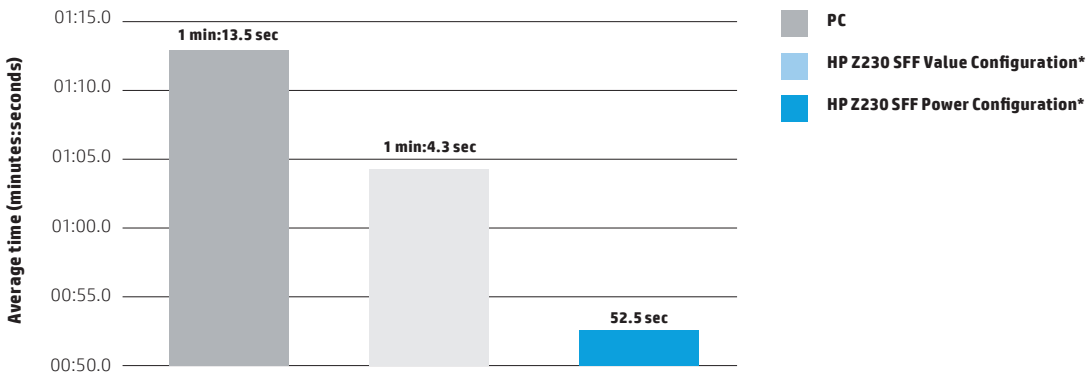
AutoCAD® Rendering Benchmark

The AutoCAD rendering benchmark consists of a sample 3D drawing of a single-family house. This drawing file was originally provided by Autodesk®. A script file is used to render a previously saved interior view of the house multiple times at "Presentation" quality at an output size of 1280 x 1024. The Mental Ray® rendering engine in AutoCAD automatically records the time required to render each image. The result reported is the average time required to create each rendered image.

Since the mental ray rendering engine used in AutoCAD is multi-threaded, this test is an excellent indication of the advantage of using multiple CPUs and/or multi-core CPUs; the more cores available, the faster the performance, with the differential being almost linear. This test has been used extensively for several years as part of a suite of benchmarks performed when evaluating all computer systems for reviews published in Desktop Engineering magazine, so historical performance results for other systems are also available. This is a very valuable benchmark for anyone who intends to produce rendered images from 3D AutoCAD models.

As expected, the HP Z230 SFF Workstations were able to complete the rendering much faster than the PC. The HP Z230 Value Configuration completed the rendering in 1 minute: 4.3 seconds, an improvement of 14% over the PC, which took 1 minute: 13.5 seconds. The results for Power Configuration were even better—52.5 seconds—an improvement of 40% over the PC.

Figure 11. AutoCAD Rendering Benchmark (lower is better)



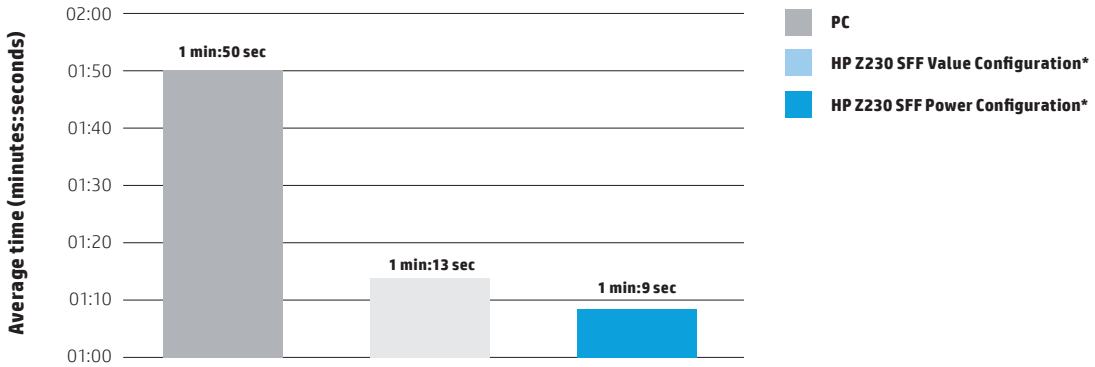
* See page 3 for configuration details on Value and Power configurations

AutoCAD® Large Drawing Benchmark

This benchmark is meant to gauge the performance of the system running AutoCAD when working on large models. The test records the time it takes to load a large AutoCAD drawing file (28 MB) provided by an actual AutoCAD customer, and then performs numerous pans, zooms, and viewpoint changes as well as changes in the visual style used to display the model, all drawing manipulations that a typical user would perform during the course of his or her work, yet tasks that are quite time consuming when working with large models. Unlike many of the other benchmarks, this test provides data that can serve as an indicator of actual user productivity.

Again, as expected, the HP Z230 SFF Workstations significantly outperformed the PC on this test. It took 1 minute: 50 seconds to complete this test on the PC running AutoCAD 2015 compared to 1 minute: 13 seconds on the HP Z230 SFF Value Configuration, a performance improvement of 51 percent. The Power Configuration was even faster, completing the test in 1 minute: 9 seconds, an improvement of 59% over the PC.

Figure 12. AutoCAD Large Drawing Benchmark (lower is better)



About the drawings used in the study

The AutoCAD 2015 productivity study compared the time required to produce five different drawings multiple times using AutoCAD 2015 running on a PC and two different HP Z230 SFF Workstations, using the features and functions judged to be the most expedient method for producing the desired end result. The time required to create each drawing was recorded using a stop watch and rounded to the nearest minute.

In order to eliminate biases in the design of the study—such as improvements in speed simply due to increasing familiarity with the task drawings—the drawings were produced first on the HP Z230 Workstations and then on the PC, tilting any such bias in favor of the PC. Each drawing was also reproduced on each computer several times and only the fastest times for each system were included in the final results.

Drawing Task #1 – 2D Mechanical Assembly

The following steps were used to complete this task:

1. Each of the three parts was initially modeled separately with the part boundaries, hatch patterns, and background or hidden lines drawn on their own separate layers.
2. The parts were then moved and rotated into the proper positions to create the completed cross-section of the valve assembly.
3. A second drawing was created consisting of a bordered sheet and title block, using a sample template included with AutoCAD.
4. The first drawing showing the cross-section of the valve was inserted into the second drawing as an external reference so that it displayed inside the bordered sheet and title block, with the viewport set to an appropriate scale so that the drawing would fit onto the bordered sheet and the viewport border would not be visible.
5. Dimensions were then added to the valve assembly drawing.
6. The bordered sheet drawing was then updated so that it reflected the changes made to the externally referenced valve assembly drawing.

* See page 3 for configuration details on Value and Power configurations

Drawing Task #2 – 2D Architectural Elevation

The following steps were used to complete this task:

1. A copy of the outline of the basic architectural elevation was inserted as an external reference.
2. Standard AutoCAD commands were used to recreate the elevation, essentially tracing over the external reference by snapping to the underlying geometry. Thicker profile lines were created to clearly show which portions of the house were closer to the front of the view.
3. The elevation was then embellished to create a client presentation by adding hatches and fills to represent brick, stucco, roofing materials, and so on. Because brick was the major building material and the craftsmanship of the masonry was an important consideration for the client, care needed to be taken to ensure that the brick coursed properly. The brick also needed to be shown with a filled background to make it stand out from the rest of the materials.

Drawing Task #3 – 3D Architectural Model

The following steps were used to complete this task:

1. A 3D wireframe armature defining the basic dimensions of the house as well as 2D elevations and floor plans was used as the basis for building the 3D model. The terrain surface was also modeled in advance.
2. Walls were extruded from the floor plan views, thus creating solids.
3. Solids were created representing door and window openings. These were then subtracted from the walls to create actual openings.
4. Solids representing the actual doors and windows were then created to fill those openings.
5. Roofs and floors were modeled based on the 3D wireframe.
6. Additional 3D parts, such as stairs and railings were imported from existing files.
7. Materials were assigned to all of the solids comprising the model.
8. A camera was placed at a predetermined position, thus creating a view.
9. The view was rendered at a resolution of 2048 x 1536 using the Presentation rendering preset, with sunlight providing the only illumination and sky background and illumination enabled.

Drawing Task #4 – 3D Model Based on a Point Cloud

The following steps were used to complete this task:

1. A laser scan saved in PCG format was imported and indexed using Autodesk® Recap™ and saved as a Recap™ project file.
2. The Recap™ project file was then attached to an AutoCAD drawing.
3. The gas station canopy and pump islands were modeled as solids in AutoCAD by snapping to geometry in the imported point cloud.

Drawing Task #5 – 3D Mechanical Model

The following steps were used to complete this task:

1. A drawing containing predefined profiles and path curves was used as the basis for creating the individual parts of the drill.
2. Each part was created as a separate solid by either revolving the pre-defined profiles, lofting between the profiles, or extruding the profiles along a pre-defined path.
3. The individual solid parts were then moved and rotated in 3D to place them into the proper positions within the drill assembly.
4. Some of the individual solids were then combined using Boolean operations as needed.
5. Numerous fillets were added where various parts joined.
6. A simple model of a table was created and the drill positioned on that table.
7. Materials were then assigned to the various parts and to the table.
8. A camera was placed at a predetermined position, thus creating a view.
9. The view was rendered at a resolution of 2048 x 1536 using the Presentation rendering preset.

Calculating the percentage of time saved

For each of the five task scenarios, we measured the time required to complete the drawings using the PC and the two different workstation configurations. The results in the report are then explained in terms of the amount of time saved as a result of running AutoCAD 2015 on the HP Z230 SFF Workstation compared to the PC.

$$\text{Percent time saved Z230 SFF Workstation to PC} = \frac{\text{PC time} - \text{Z230 SFF time}}{\text{PC time}}$$

HP recommends Windows.

HP Z Workstations for AutoCAD® featuring Lynn Allen

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About the Author

David Cohn is the Technical Publishing Manager at 4D Technologies, where he develops the CADLearning® courses and eBooks for AutoCAD and other Autodesk® products. He has more than 30 years of hands-on experience with AutoCAD as a user, developer, author and consultant. He has been benchmarking computer hardware and software since 1985 and has published hundreds of articles and reviews as a contributing editor to Desktop Engineering magazine, the former publisher and editor-in-chief of CADCAMNet and Engineering Automation Report, and the former senior editor of Cadalyst magazine. He is also the author of more than a dozen books about AutoCAD. A licensed architect, David was also one of the earliest AutoCAD third-party software developers, creating numerous AutoCAD add-on programs. He has also taught college-level AutoCAD courses and is always a popular presenter at Autodesk University.

Screen images courtesy of Autodesk®

The author was commissioned and provided products by HP.

1. Not all features are available in all editions or versions of Windows. Systems may require upgraded and/or separately purchased hardware, drivers and/or software to take full advantage of Windows functionality. See microsoft.com.
2. 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.
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. Maximum memory capacities assume Windows 64-bit operating systems or Linux. With Windows 32-bit operating systems, memory above 3 GB may not all be available due to system resource requirements.
4. For hard drives and solid state drives, 1 GB = 1 billion bytes. TB = 1 trillion bytes. Actual formatted capacity is less. Up to 10 GB of system disk (for Windows 7) is reserved for system recovery software.

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