Realistic User Productivity Comparisons for Upgrade Decision Making

A Comparison of AutoCAD 2008 and AutoCAD 2012 Running on HP xw4600 and HP Z210 Workstations Using NVIDIA Quadro Graphics

Conducted for

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By
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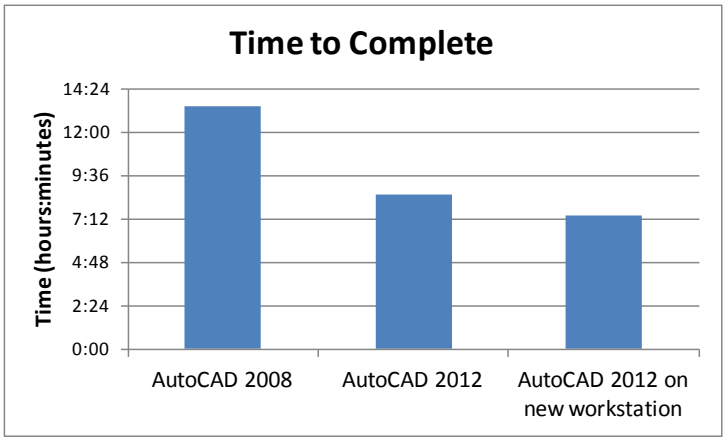
Executive Summary

While the overall performance of a software program or hardware platform can be measured using standard benchmarks, actual user productivity is a more difficult metric to gauge, since it often includes perceptions of the overall user experience and must account for differences in the methods employed while using the software.

In order to quantify the potential productivity improvement a typical user is likely to experience when upgrading to the latest version of AutoCAD as well as upgrading to a more modern engineering workstation and graphics card, we devised a series of tests involving timing the repeated re-creation of a selection of drawings using both AutoCAD 2008 and AutoCAD 2012. The drawings used were judged to be representative of those that would be produced by typical AutoCAD users.

The tests were performed by David Cohn, widely recognized as an expert in the use of AutoCAD, utilizing the features and functions he judged to be the most expedient means of producing the end result in each respective version of the software.



The results of the study were quite dramatic. It took nearly 13.5 hours to complete the eight drawings using AutoCAD 2008 compared to 8.5 hours to complete the same eight drawings using AutoCAD 2012. This represents time savings of 36 percent as a result of upgrading from AutoCAD 2008 to AutoCAD 2012, without any change in the computer on which AutoCAD was run. When the workstation was also upgraded to a more modern system running Windows 7, the time required to complete the eight drawings was further reduced to 7.3 hours, a total time savings of 45 percent compared to using AutoCAD 2008 on an older workstation.

The additional functionality available when running Windows 7, while not considered in the quantitative results of this study, could further improve overall productivity.

Upgrading one's workstation, graphics card, and operating system as well as upgrading from AutoCAD 2008 to AutoCAD 2012 results in an average overall productivity improvement of more than 80 percent.

Although the results reported in this study would likely vary depending on the level of experience of the user and the nature of the drawings being produced, similar improvements in personal productivity are likely, due to improvements in the features and functionality available in AutoCAD 2012 compared to AutoCAD 2008. This level of improvement in personal productivity is so significant that most users will find it easily justifies the cost of upgrading their version of AutoCAD as well as purchasing an up-to-date engineering workstation and graphics card.

Do new features result in increased productivity?

AutoCAD was first released in December 1982. Each release since then has offered numerous new features and functions that have contributed to improve the overall productivity and usefulness of the software beyond each previous release.

One could argue that by upgrading to the latest release, customers would actually save money because the features and functions of the new software would enable them to complete their work faster than would be possible had they used an earlier version of the software. Yet many customers skip releases for economic reasons.

Improvements in computer hardware technologies also continue at a rapid pace. The raw performance of today's Intel-based engineering workstations is more than 500 times faster than a typical personal computer used to run AutoCAD in 1982, on pace with Moore's law. Improvements in graphics processing outpace Moore's law, delivering ever-increasing power at more affordable price points.

The question becomes one of quantifying the actual productivity improvements a user could reasonably expect to achieve by upgrading from their old version of AutoCAD to the latest release while also upgrading their engineering workstation to a more modern system featuring a more advanced CPU and graphics accelerator.

Developing the Study Criteria

In the spring of 2011, HP and NVIDIA approached me to repeat aspects of a productivity study I had previously performed in which I compared AutoCAD 2008 to AutoCAD 2011. In this new iteration of the study, I would compare AutoCAD 2008 to AutoCAD 2012 (although I would utilize only those features and functions that were already included in AutoCAD 2011). The study would utilize the same drawings and techniques used in the previous study, which was originally intended to replicate how real AutoCAD users operate so as to reflect a realistic expectation of user productivity. The drawings used were typical of those produced by actual AutoCAD customers. The test required manually re-creating these drawings multiple times using both AutoCAD 2008 and AutoCAD 2012. These re-creations would utilize features and functions judged to be the most expedient method for producing the desired end results, but would not use new features and functions added to AutoCAD 2012. The time required to create each drawing would be recorded using a stop watch and rounded to the nearest minute. The drawings would be created using AutoCAD 2008 on an engineering workstation equipped with a graphics accelerator typical of those in use in 2008. The same drawings would also be created using AutoCAD 2012 on the same workstation as well as AutoCAD 2012 on a newer engineering workstation equipped with a newer graphics processing unit (GPU).

In the previous study, after considering more than 100 different drawings produced by actual AutoCAD users, I selected eight drawings, most of which I concluded would require a typical user anywhere from an hour to half a day to complete. Those same drawings would be used in this new study as well.

Each drawing was chosen based on a number of criteria designed to showcase one or more features of the software that did not exist in AutoCAD 2008 but were added in subsequent releases. While each drawing could certainly be produced using the features and functions available in AutoCAD 2008, the advanced capabilities added in subsequent releases would likely enable a typical user to produce the drawing faster using AutoCAD 2012.

Since the premise of the test was to determine how much time could be saved by using a new feature, the test itself was already predisposed to show that using AutoCAD 2012 is more productive than using AutoCAD 2008. However, since each of the drawings used in the study was originally produced using versions of AutoCAD predating the 2008 release, I concluded that the study would present a realistic analysis of the productivity gains a typical user could achieve.

In order to eliminate additional biases in the design of the study, such as improvements in speed simply due to increasing familiarity with the sample drawings, some of the sample drawings were produced first using the 2012 release of the software and then produced using AutoCAD 2008, tilting any such improvements in the favor of the

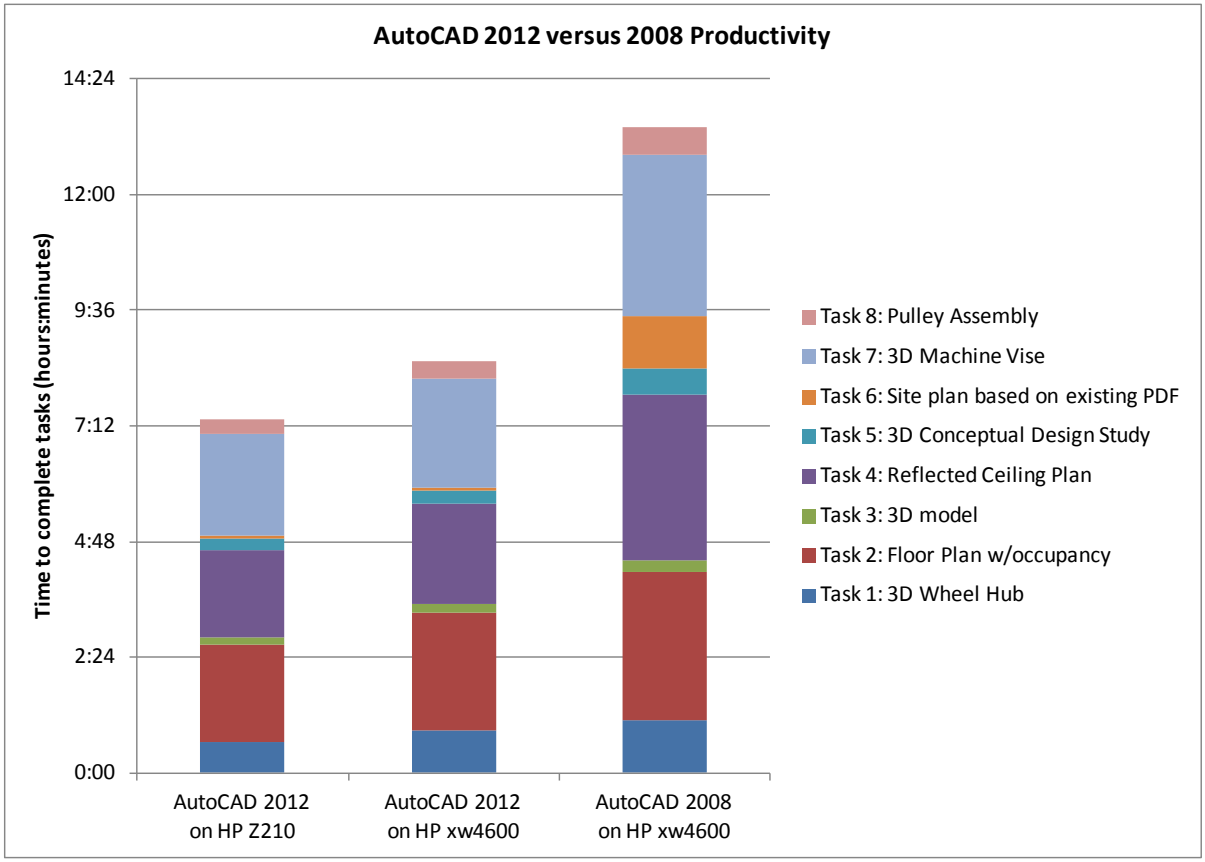
older release. Each drawing was also reproduced in each release several times and only the fastest times were ultimately included in the results.

In spite of focusing on new features, I expected to see only modest reductions in the time required to produce the drawings in the newer release. I did not expect to see dramatic improvements in overall user productivity. Most CAD drawings consist of lines, arcs, and circles, and I reasoned that there have been very few changes that would improve the speed at which a typical user would be able to create or modify the objects that represent the majority of a typical drawing. After all, how much faster can you draw a line?

Dramatic Results

The results of the study were more dramatic than I expected. It took 13 hours: 24 minutes to complete all eight drawings using AutoCAD 2008, compared to 8 hours: 32 minutes to complete the same tasks using AutoCAD 2012 on the same HP xw4600 Workstation, a time savings of 36 percent on a collection of tasks representative of work that is fairly typical of the types of drawings created and edited using AutoCAD. When these same drawings were created again using AutoCAD 2012 on a more modern computer, an HP Z210 Workstation equipped with more modern NVIDIA discrete graphics, it took just 7 hours: 20 minutes to complete all eight drawings, a total time savings of 45 percent compared to AutoCAD 2008. On individual tasks that focused on specific aspects of the software, the time required to produce the drawings went down anywhere from 33 to 94 percent.

The following chart illustrates the cumulative improvement in overall productivity, represented as the total time required to complete the eight sample drawings in AutoCAD 2012 compared to AutoCAD 2008.



Time to complete all eight drawing tasks in AutoCAD 2012 versus AutoCAD 2008.

The study in detail

The AutoCAD 2012 productivity study compared the time required to produce a collection of eight different drawings multiple times using both AutoCAD 2008 and AutoCAD 2012, 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. Results were recorded for three different scenarios:

- AutoCAD 2008 run on an HP xw4600 Workstation equipped with an NVIDIA Quadro FX 570 graphics accelerator, running Windows XP
- AutoCAD 2012 run on the same HP xw4600 Workstation running Windows XP
- AutoCAD 2012 run on an HP Z210 Workstation equipped with an NVIDIA Quadro 2000 graphics accelerator, running Windows 7

Each drawing task required many common AutoCAD commands. But each was selected because certain aspects of the drawing would expose the potential time savings that could be achieved by using features and functions not available in AutoCAD 2008 but added to subsequent releases and therefore available to someone using AutoCAD 2011, but did not employ any new features subsequently added to AutoCAD 2012.

Drawing Task #1

The first drawing represents a typical three-dimensional mechanical part that might be produced using AutoCAD—a wheel hub. Although relatively simple at first glance, the wheel hub is actually quite complex and includes a number of complex shapes that would require extrusions, lofts, chamfers and fillets as well as the use of multiple Boolean union and subtract operations and multiple user coordinate systems or work planes. Once the actual three-dimensional model was created, the task scenario required the creation of a paper space layout on which traditional top, front, and side views would be created and properly oriented and displayed at a standard scale, along with an isometric view of the model. Once this step was completed, dimensions and notes were added to the wheel hub drawing. Then, several elements of the three-dimensional model were revised and the various views updated to reflect those changes. Figure 1 shows the completed task #1 drawing.

In the previous study comparing AutoCAD 2008 to AutoCAD 2011, I had anticipated productivity improvements in a number of areas:

- Setting up layers would be faster in AutoCAD 2011 because the Layer Properties Manager is a non-modal palette compared to a dialog box in AutoCAD 2008.
- Actual drawing and editing tasks would be faster because the ribbon interface is more intuitive and puts commands where they're more easily accessed.
- Navigating within the 3D model would be much faster and more intuitive in AutoCAD 2011 thanks to the availability of the ViewCube, which is not available in AutoCAD 2008.
- Manipulating the various 3D objects to create the model would be much easier in AutoCAD 2011 thanks to the enhanced 3D gizmos compared to those in AutoCAD 2008.
- Enhancements to visual styles in AutoCAD 2011 would make it easier to see the various objects used to create the shapes combined to create the wheel hub, compared to the predefined visual styles in AutoCAD 2008.
- Selecting overlapping objects would be much easier in AutoCAD 2011 thanks to the new selection cycling functionality.

I expected to see these same types of improvements when comparing AutoCAD 2008 to AutoCAD 2012, but did not expect to see significant additional improvements.

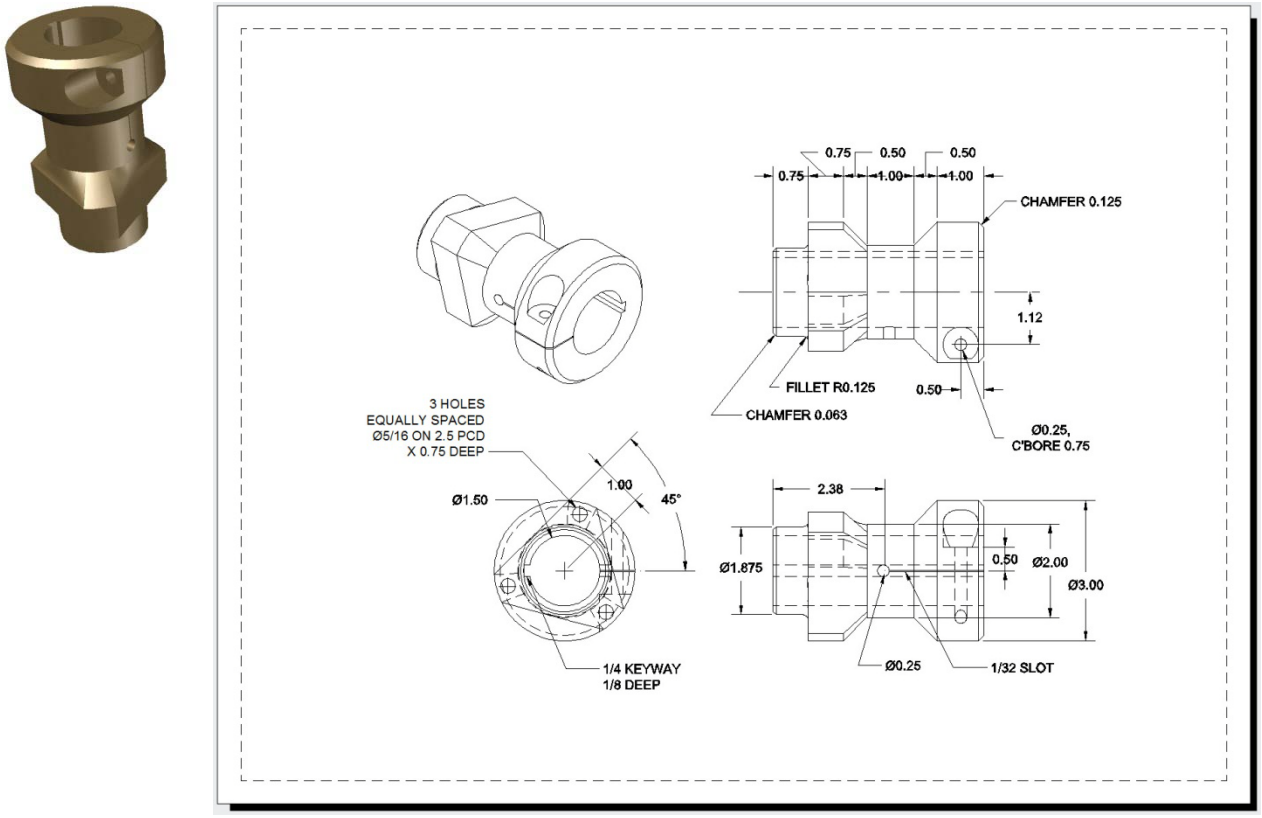
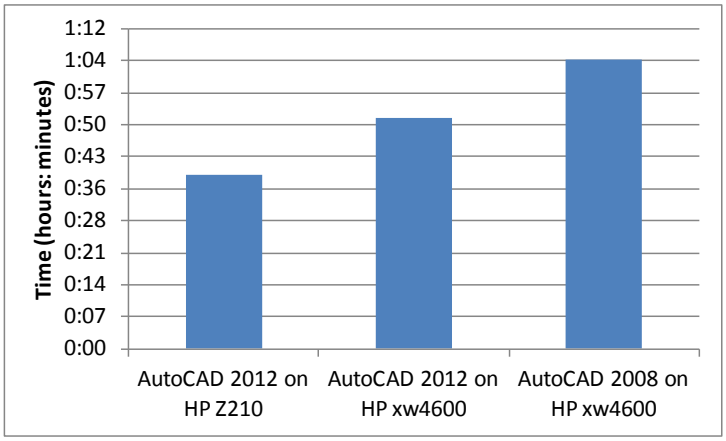


Figure 1: The task # 1 model and completed drawing – a 3D wheel hub.

This drawing took 1 hour: 5 minutes to complete using AutoCAD 2008 on the HP xw4600 Workstation. The same drawing took only 52 minutes to complete using AutoCAD 2012 on the same workstation, a time reduction of 20 percent. When the same drawing was created using AutoCAD 2012 on the HP Z210 Workstation, the time required went down an additional 13 minutes or 25 percent.



Task#1: 3D Wheel Hub.

AutoCAD 2012 was more efficient in the creation of the task #1 drawing than AutoCAD 2008, largely thanks to the improved accessibility afforded by the ribbon interface, the more intuitive nature of using the ViewCube and 3D gizmos when working in 3D, and the ease with which objects can be selected thanks to the new selection cycling

functionality. When the improvement due to the upgraded workstation was factored in, the overall time required to complete this task improved by a total of 40 percent from AutoCAD 2008, with the additional improvement largely due to improved HP workstation system and NVIDIA graphics performance when working in 3D.

Drawing Task #2

The second drawing task was the recreation of a complex floor plan for a hospital facility. The drawing is a design development stage drawing showing all walls, doors, windows, and plumbing fixtures. Each object type would be created on its own appropriate layer (for example, a walls layer, a doors layer, and so on). Wall intersections needed to be cleaned so that the walls could be filled with a solid-fill hatch pattern. After completing the plan, all the rooms needed to be labeled. Then, area fills were added to indicate the occupancy/usage of each space. Since all plumbing fixtures, door swings, and labels needed to remain visible in the final drawing, the area fills needed to be faded so that they did not overpower the appearance of the drawing. The final drawing needed to be presented on a D-size architectural bordered sheet which would also include a legend identifying the different occupancy/usage types along with the square footage for each occupancy type. Figure 2 shows the completed task #2 drawing.

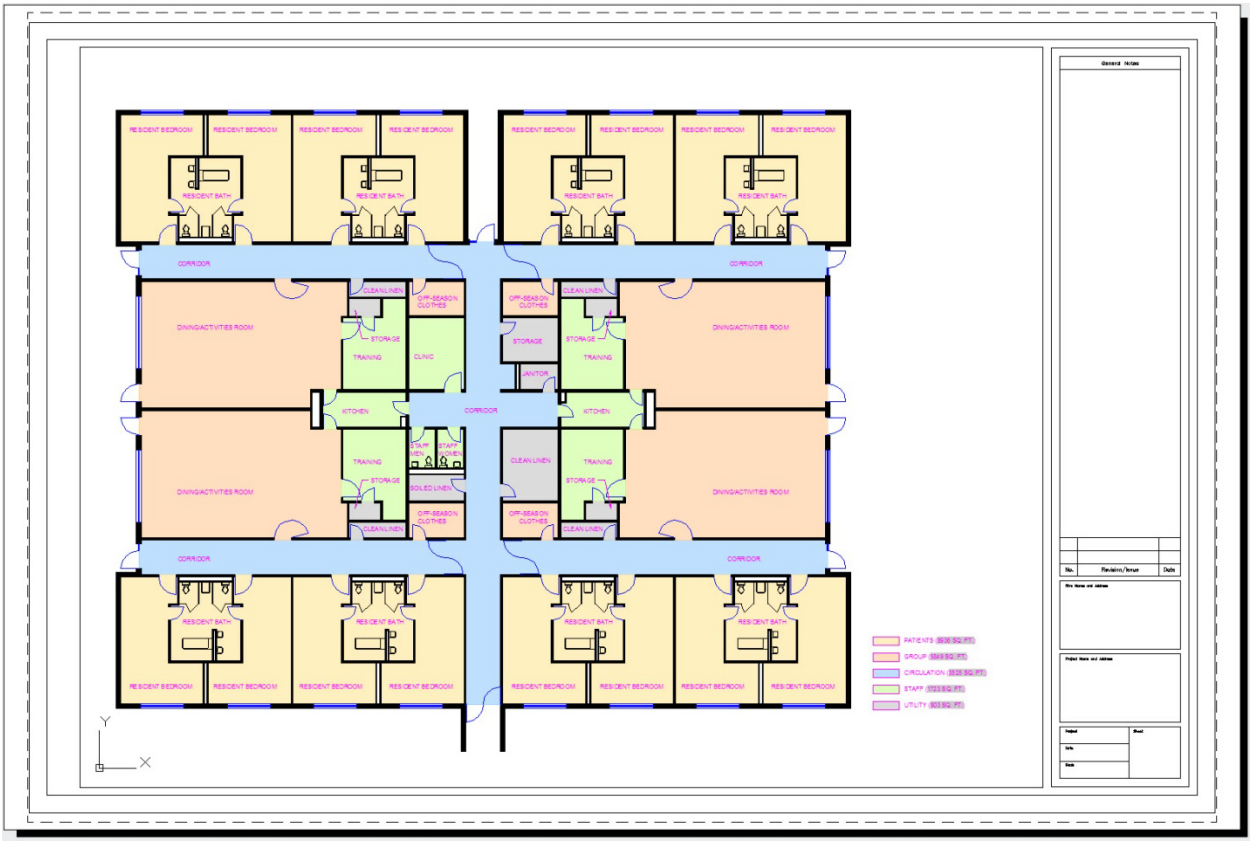


Figure 2: Completed task #2 drawing – a floor plan including occupancy and area calculations.

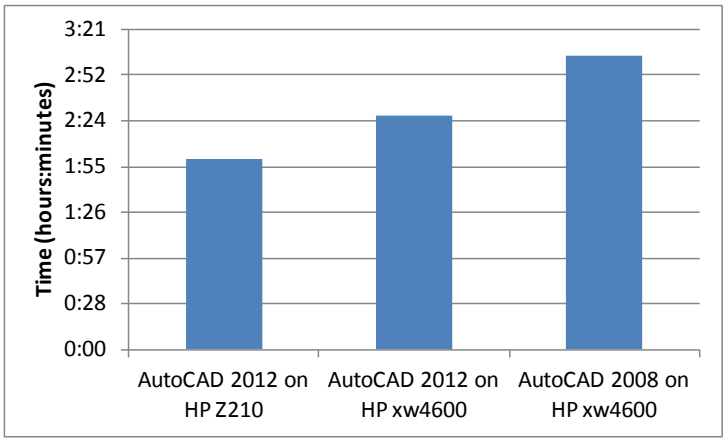
In the previous study comparing AutoCAD 2008 to AutoCAD 2011, I had anticipated productivity improvements in a number of areas:

- Setting up layers would be faster in AutoCAD 2011 because the Layer Properties manager is a non-modal palette compared to a dialog box in AutoCAD 2008.
- Actual drawing and editing tasks would be faster because the ribbon interface is more intuitive and puts commands where they're more easily accessed.

- Area fills added as hatch patterns would be faster and easier to create in AutoCAD 2011 because they could be previewed as they were being added, whereas in AutoCAD 2008, they would not become visible until after they were added.
- In AutoCAD 2011, the ability to control transparency, to send hatch patterns to the back, and to bring text to the front would make it easier to ensure that the area fill appeared behind other objects, whereas in AutoCAD 2008, this can only be accomplished by using DRAWORDER and the transparent appearance of filled areas controlled by creating a color-based plot style table that used screening for the fill colors.

I expected to see these same types of improvements when comparing AutoCAD 2008 to AutoCAD 2012, but did not expect to see significant additional improvements.

This drawing took 3 hours: 5 minutes to complete using AutoCAD 2008 on the HP xw4600 Workstation. The same drawing took only 2 hours: 27 minutes to complete using AutoCAD 2012 on the same workstation, a time reduction of 21 percent. When the same drawing was created using AutoCAD 2012 on the HP Z210 Workstation, the time required went down an additional 27 minutes or 18 percent.



Task #2: Floor plan floor plan including occupancy and area calculations

AutoCAD 2012 was more efficient in the creation of the task #2 drawing than AutoCAD 2008, largely thanks to the improved accessibility afforded by the ribbon interface, the ability to preview hatches, and the ability to easily create transparent objects. When the improvement due to the upgraded workstation was factored in, the overall time required to complete this task improved by a total of 35 percent from AutoCAD 2008, with the additional improvement largely due to improved HP workstation system and NVIDIA graphics performance when working with large filled areas in the drawing.

Drawing Task #3

The third drawing task was the creation of a small three-dimensional model. This model is actually a variation of a model used during the AutoCAD 2011 product launch demo. That demo showed how improvements to existing solid creation and editing functionality made it easier to create 3D objects thanks to the ability to select edge and face sub-objects as profiles or curves for defining new objects. The modeling process for this object began by creating a simple solid box. A second solid box was added and then various faces and edges were revolved and extruded to create the model. These objects were then combined using Boolean union and then solid cylinders subtracted to create the holes. Finally, fillets were added. Figure 3 shows the completed task #3 drawing.

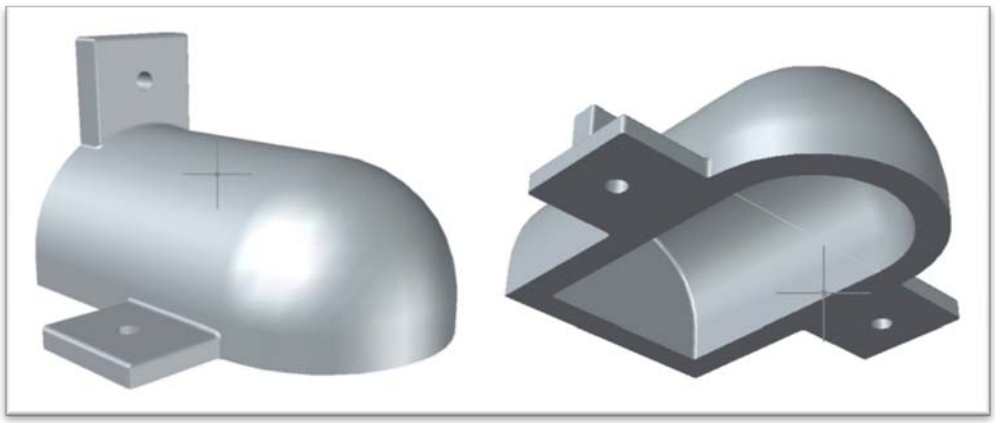


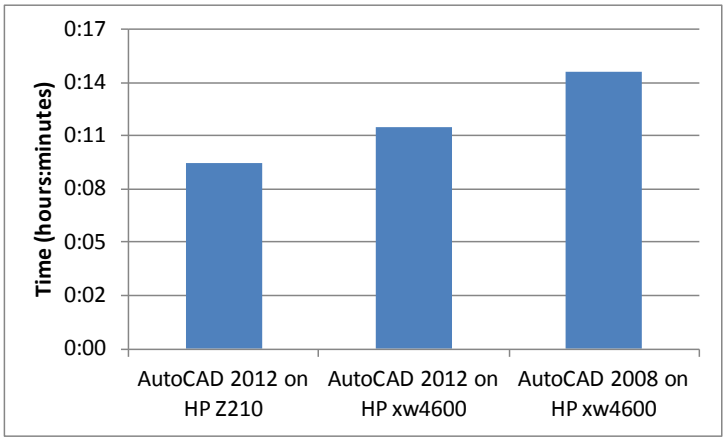
Figure 3: Completed task #3 drawing – a small 3D model.

In the previous study comparing AutoCAD 2008 to AutoCAD 2011, I had anticipated productivity improvements in a number of areas:

- Improved command accessibility thanks to the ribbon interface.
- Improved 3D navigation thanks to the ViewCube.
- Improved 3D object manipulation thanks to the enhanced 3D gizmos.
- Improved sub-object selection.

I expected to see these same types of improvements when comparing AutoCAD 2008 to AutoCAD 2012, but did not expect to see significant additional improvements.

This drawing took 15 minutes to complete using AutoCAD 2008 on the HP xw4600 Workstation. The same drawing took 12 minutes to complete using AutoCAD 2012 on the same workstation, a time reduction of 20 percent. When the same drawing was created using AutoCAD 2012 on the HP Z210 Workstation, the time required went down an additional 2 minutes or 17 percent.



Task #3: A small 3D model

AutoCAD 2012 was more efficient in the creation of the task #3 drawing than AutoCAD 2008. The major portion of the 3 minute difference was the elimination of several steps required to create the flat vertical portion of the model in AutoCAD 2012 compared to AutoCAD 2008 as a result of the ability to extrude a curved edge of a solid to create a surface that could subsequently be used to cut a solid. When the improvement due to the upgraded HP

workstation and NVIDIA graphics was factored in, the overall time required to complete this task improved by a total of 33 percent compared to AutoCAD 2008.

Drawing Task #4

The fourth drawing task was the completion of a reflected ceiling plan for a rather complex office building. The floor plan of the office build was previously created. The task in this case was only to create the reflected ceiling plan. Portions of the floor plan were at odd angles, however, and one wing of the building curves. The ceiling tile pattern could be created as a user-defined hatch pattern but would need to be centered appropriately in each individual room as well as along a curving corridor. Blocks representing 24x48 light fixtures and round down lights as well as HVAC supply and return air diffusers and sprinklers would need to be added to the ceiling plan. Figure 4 shows the completed task #4 drawing.

Because of the new features available in AutoCAD 2011 compared to AutoCAD 2008, I had anticipated a number of productivity improvements. The most significant impact on the time required to complete this drawing would be in the addition of hatch patterns to represent the ceiling tiles in each room. In particular, I anticipated that being able to see and manipulate the angle of the hatch pattern and the origin of the pattern within each room would provide a significant reduction in the time required to complete this drawing in AutoCAD 2012 compared to AutoCAD 2008, but I did not expect to see a significant additional improvement resulting from upgrading to AutoCAD 2012.

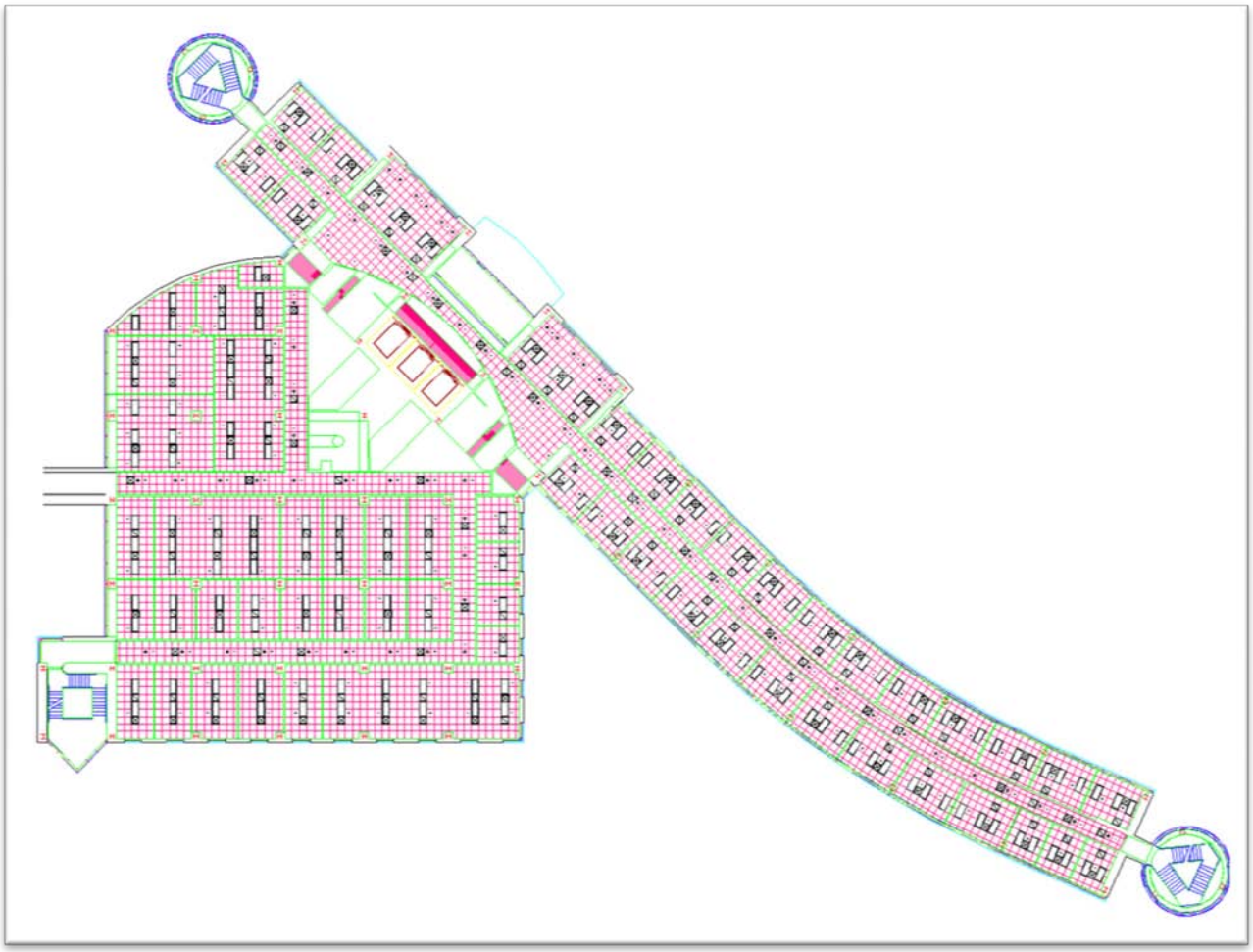
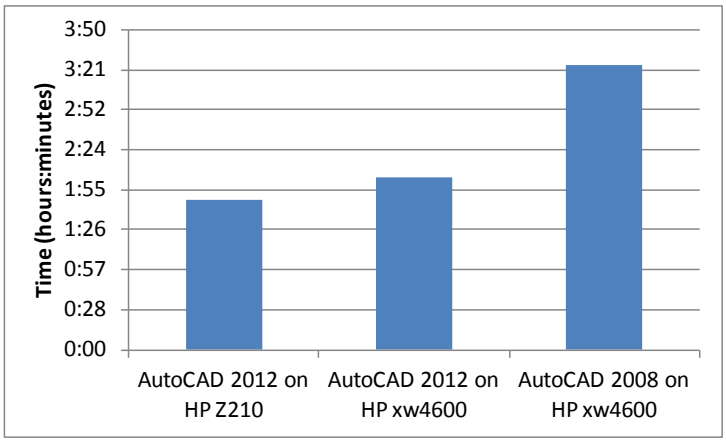


Figure 4: Completed task #4 drawing – a reflected ceiling plan of a complex office building.

This drawing took 3 hours: 25 minutes to complete using AutoCAD 2008 on the HP xw4600 Workstation. The same drawing took only 2 hours: 4 minutes to complete using AutoCAD 2012 on the same workstation, a time reduction of 40 percent. When the same drawing was created using AutoCAD 2012 on the ZP Z210 Workstation, the time required went down an additional 16 minutes or 13 percent.



Task #4: Reflected ceiling plan of a complex office building

AutoCAD 2012 was more efficient in the creation of the task #4 drawing than AutoCAD 2008. The most significant improvement was indeed both the ability to preview hatch patterns in AutoCAD 2011 and AutoCAD 2012 and also the ability to use grip editing to quickly and easily modify the angle and origin of hatch patterns after they were added to the drawing. In AutoCAD 2008, it was much more difficult to get the ceiling tiles to align properly in each room, particularly those rooms along the curved portion of the building. When the improvement due to the upgraded HP workstation was factored in, the overall time required to complete this task improved by a total of 47 percent from AutoCAD 2008, with the additional improvement largely due to improved processing speed and NVIDIA graphics performance when displaying and manipulating large areas of hatch.

Drawing Task #5

The fifth drawing task was the creation of a series of conceptual design studies for a pavilion structure. This task scenario was designed to highlight the new conceptual design and surfacing capabilities added to AutoCAD 2011. Conceptual design is a difficult process to quantify. In this task, the end results of each design iteration needed to be the same, although the tools used to achieve those results would vary in AutoCAD 2008 and AutoCAD 2012. Figure 5 shows the five different design iterations.

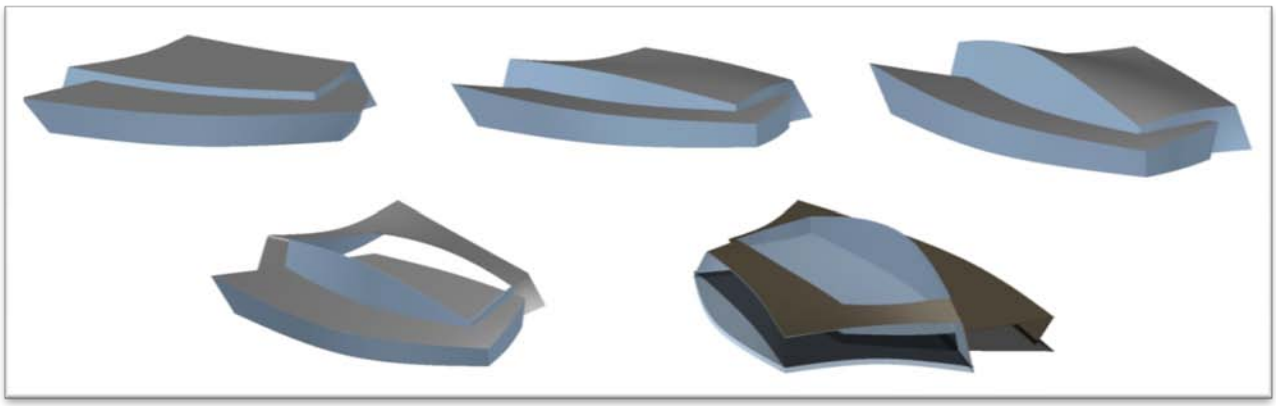


Figure 5: Completed task #5 drawing – 3D conceptual design studies for a pavilion.

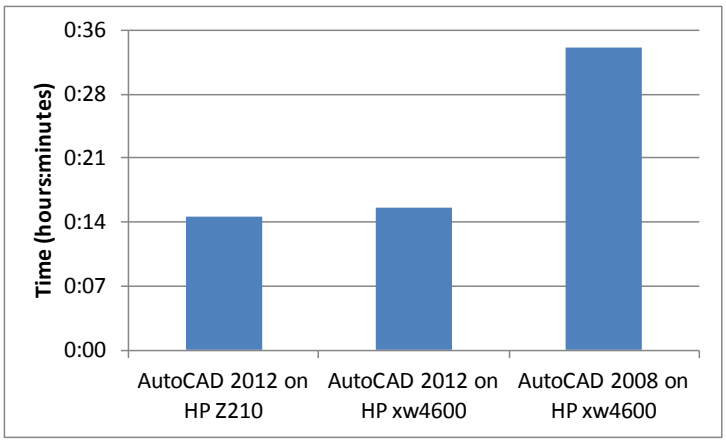
In each version of AutoCAD, this task began with a set of points that could be used as the basis for sketching the footprint of the building. Each iteration of the design required that variations be made to the curves used as a basis for creating the walls and roofs. After creating the third option, a skylight based on the footprint of the lower roof was added to the design, and then portions of the walls and upper roof were merged in order to begin studying the form of the concrete walls and roof. Then, another change was made to the roof lines to create a fifth design option that also included the skylight and the form of the concrete walls and roof. Materials were then added to the various building components in that fifth iteration.

Thanks to improved functionality in AutoCAD 2011 compared to AutoCAD 2008, I had anticipated significant improvements thanks to the ability to use completely different workflows:

- In AutoCAD 2008, the walls and roofs of the pavilion can be created by lofting to create surfaces. However, since there is no associativity between the surfaces and the guide curves, when the guide curves are modified, if the changes are minor, it is possible to also select and modify the surfaces, but in most instances, the fastest way to update the model is to delete the previous surfaces and then create new surfaces by lofting again between the modified curves. In order to create the skylight opening, you have to project a plan view of the lower roof and then use its boundaries to create a solid that can be subtracted from the upper roof. When additional changes are subsequently made in the fifth design iteration, this process must be repeated again.
- In AutoCAD 2011, the walls of the pavilion can be created by lofting (as in 2008) and the roofs created as either network or patch surfaces. Thanks to the associativity between the surfaces and the guide curves, when the guide curves are modified to create the subsequent design iterations, the surfaces immediately update to reflect those changes. The skylight can be created by projecting curves onto the roof surface and then those curves can be used to trim the opening. When further changes are made in the fifth design iteration, the associativity again causes the surfaces to immediately reflect the changes to the underlying curves.

I expected to see these same types of improvements when comparing AutoCAD 2008 to AutoCAD 2012, but did not expect to see significant additional improvements.

This drawing took 34 minutes to complete using AutoCAD 2008 on the HP xw4600 Workstation. The same drawing took only 16 minutes to complete using AutoCAD 2012 on the same workstation, a time reduction of 53 percent. When the same drawing was created using AutoCAD 2012 on the HP Z210 Workstation, the time required went down an additional minute or 6 percent.



Task #5: 3D conceptual design study

Using AutoCAD 2012 was twice as fast in the creation of the task #5 drawing as AutoCAD 2008. The most significant improvement was the improved workflow. Instead of having to delete and re-create surfaces each time

the shape of the pavilion was modified, curve associativity in AutoCAD 2011 and AutoCAD 2012 enabled the surfaces to immediately update to reflect those changes. When the improvement due to the upgraded HP workstation and NVIDIA graphics was factored in, the overall time required to complete this task improved by a total of 56 percent from AutoCAD 2008.

Drawing Task #6

The sixth drawing task was to create a finished site plan that incorporated information provided in two separate PDF files as well as new utility lines from the street to the house. One PDF contained the existing site plan, including contours, property lines, street right-of-way, and utilities. The other PDF contained the floor plan of the existing house. Figure 6 shows the completed task #6 drawing.

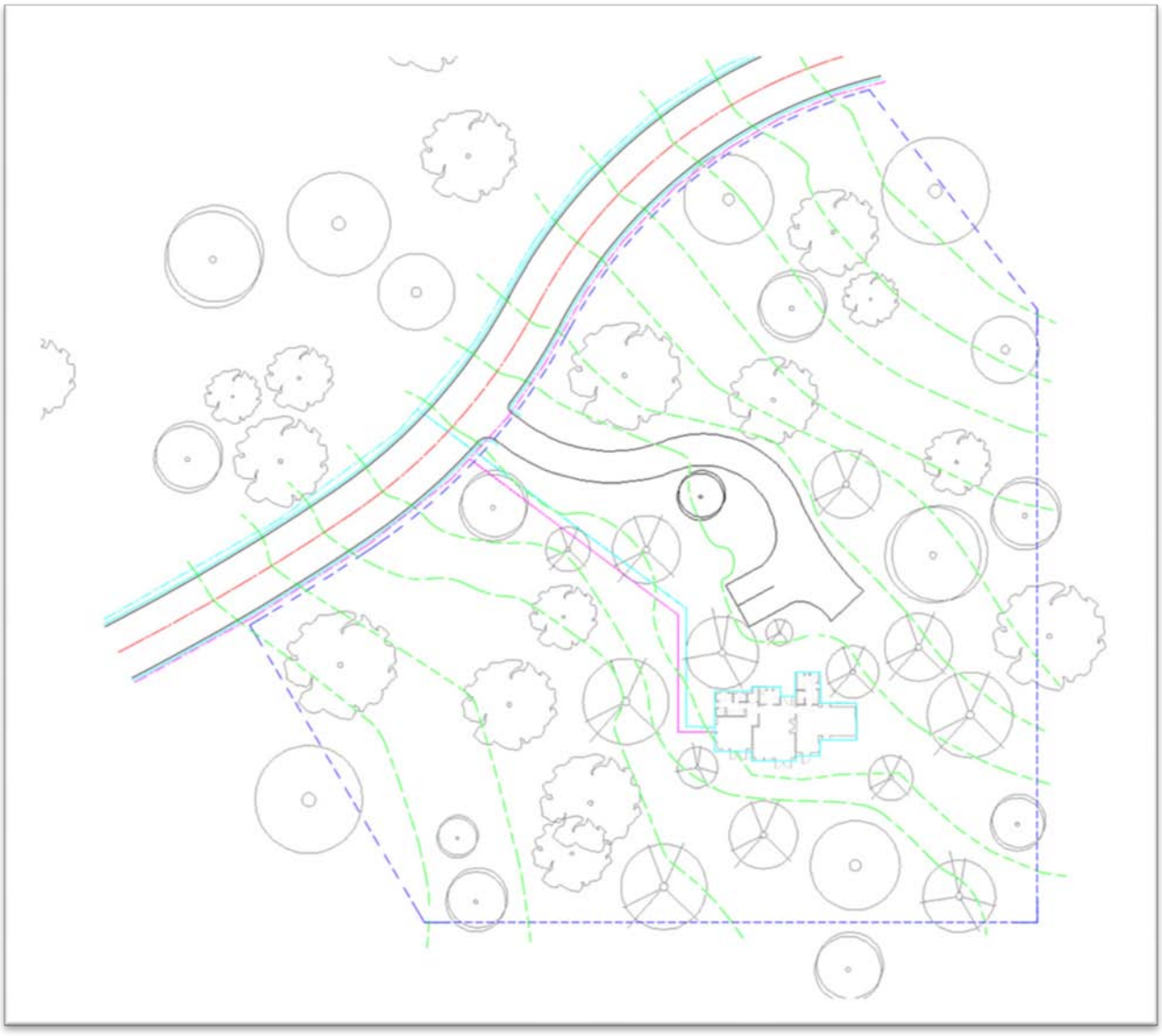


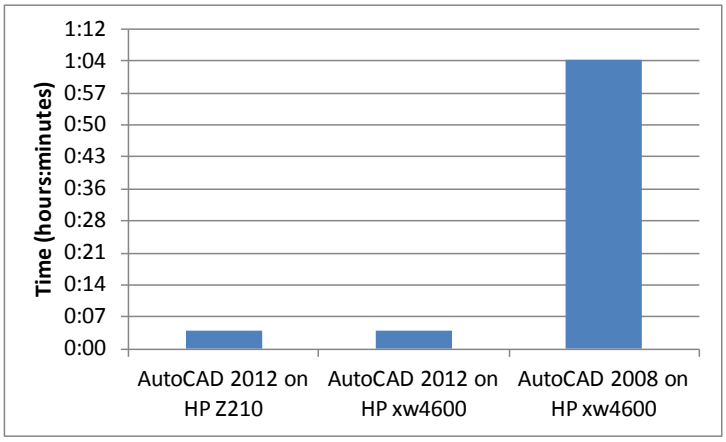
Figure 6: Completed task #6 drawing – a site plan based on several existing PDF files.

Again, thanks to improved functionality in AutoCAD 2011 compared to AutoCAD 2008, I had anticipated a significant improvement in the time required to complete this task thanks to the ability to use completely different workflows:

- In AutoCAD 2008, in order to utilize the PDF files, the user would have to first open each PDF file in the free Adobe Acrobat Reader software, perform a screen capture to grab the line work in the PDF file, save the result as an image file, and then attach each image to the AutoCAD drawing as an underlay. Once visible in AutoCAD, each image could be scaled so that it was at approximately the correct size. The user would then have to trace over the line work in the image file using standard AutoCAD commands.
- In AutoCAD 2011, each PDF file could be attached directly to the drawing as an underlay. The PDF file could then be scaled to the correct size. A clip boundary could then be applied if necessary to remove extraneous information in the PDF file and the PDF frame hidden so that it was not visible in the drawing.
- The utility lines were created using complex linetypes that incorporated symbols and text. If care was not taken to always draw these lines from left to right, the resulting text would appear upside-down. In AutoCAD 2008, this would require the lines to be erased and redrawn. In AutoCAD 2011, any upside-down lines could simply be reversed, or if the complex linetype was defined with the new "upright" orientation option, complex linetypes would always be right-reading regardless of the direction in which they were originally created.

I expected to see these same types of improvements when comparing AutoCAD 2008 to AutoCAD 2012, but did not expect to see significant additional improvements.

This task took 1 hour: 5 minutes to complete using AutoCAD 2008 on the HP xw4600 Workstation, compared to just 4 minutes using AutoCAD 2012 on the same workstation, a time savings of 94 percent. There was no measurable improvement when the same drawing was created using AutoCAD 2012 on the HP Z210 Workstation.



Task #6: Site plan based on several provided PDF files

AutoCAD 2012 was significantly more efficient in the creation of the task #6 drawing than AutoCAD 2008, the most dramatic productivity improvement in the study. The capabilities demonstrated by this particular task have wide-ranging applications. It is quite common to obtain PDF files of existing conditions. The ability to incorporate a PDF file as an underlay in an AutoCAD drawing and to then crop out unwanted portions of that PDF file can significantly reduce unnecessary drafting, particularly when working on revisions or additions to existing work.

Drawing Task #7

The seventh drawing task was to model the eight major components of a machine vise. Once the individual parts were modeled, they were positioned to create the finished machine vice assembly shown in Figure 7.

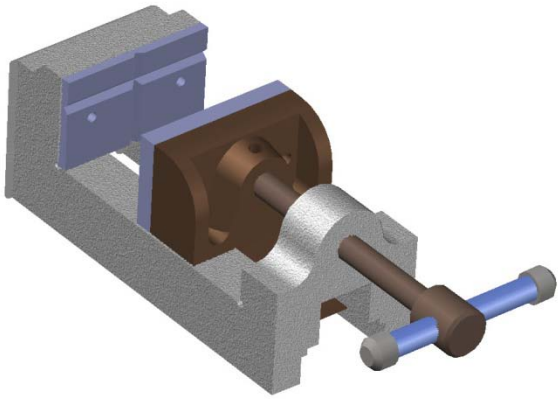


Figure 7: Completed machine vice assembly.

After modeling the complete assembly, nine separate layouts were created. A custom border and title block was created and saved as a block, with appropriate attributes to fill in the title block with data such as scale, part number, and sheet number. This title block was inserted onto each layout, and then appropriate views were created for each of the eight major components. The first layout showed an isometric view of the completed assembly with each part labeled, as well as a bill of materials showing the part number, quantity, and part name. Each of the remaining eight layouts showed 2D orthographic views of an individual part at an appropriate scale, complete with dimensions. Several of these sheets are shown in Figure 8.

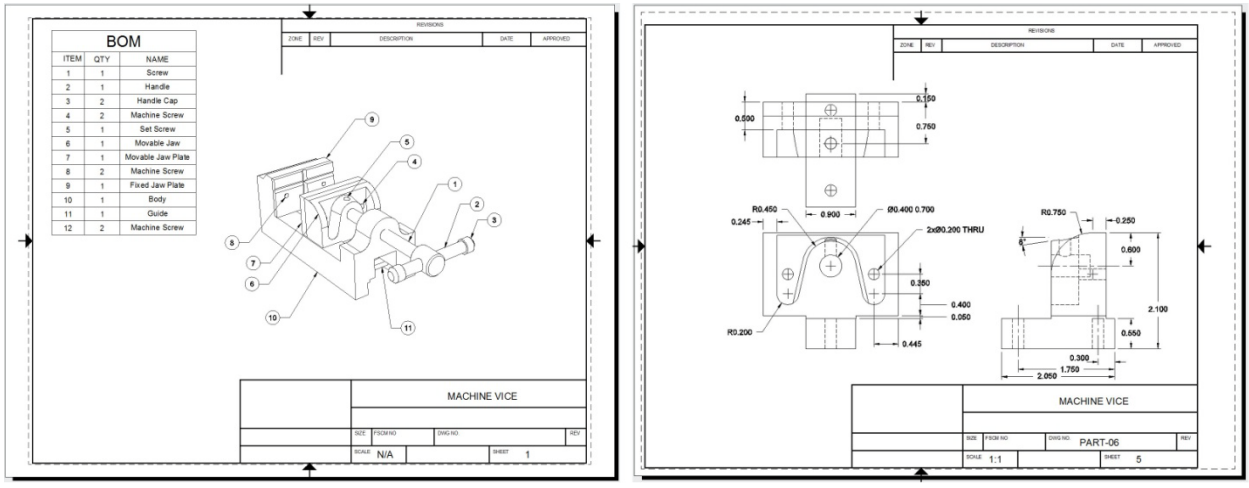


Figure 8: Completed task #7 drawing – a 3D machine vice assembly with separate sheets for each part.

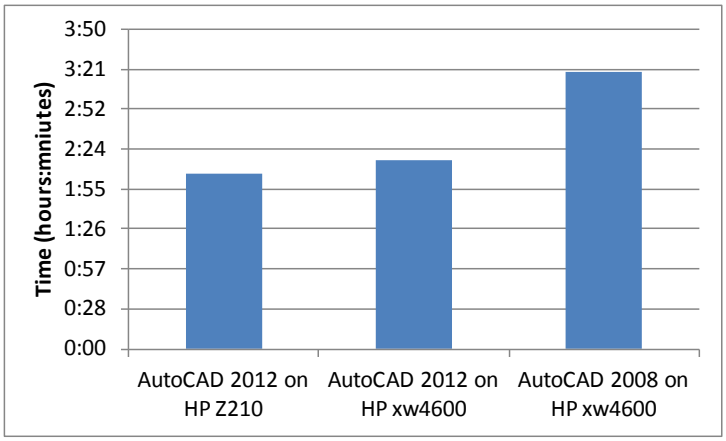
In the previous study comparing AutoCAD 2008 to AutoCAD 2011, I had anticipated productivity improvements in a number of areas:

- The non-modal Layer Properties Manager palette in AutoCAD 2011 would make it easier to create and control layers for each part.
- Actual drawing and editing tasks would be faster thanks to the more intuitive ribbon interface in AutoCAD 2011.
- Navigating within the 3D model would be faster and easier in AutoCAD 2011 thanks to the ViewCube.
- Manipulating the various 3D objects both during their creation and later, when moving them into the proper position within the assembly, would be easier thanks to the enhanced 3D gizmos in AutoCAD 2011.
- Enhancements to visual styles in AutoCAD 2011 would make it easier to see the various objects used to create the individual 3D parts.
- Selecting overlapping objects would be much easier in AutoCAD 2011 thanks to the new selection cycling functionality.

I expected to see these same types of improvements when comparing AutoCAD 2008 to AutoCAD 2012, but did not expect to see significant additional improvements.

While all of my assumptions proved to be true, the improvement between AutoCAD 2011 and AutoCAD 2012 turned out to be quite significant as well because a regression that had been present in AutoCAD 2011, which required section planes to be repositioned before creating each view, had been eliminated in AutoCAD 2012, making view creation much faster compared to the previous release. This task took 3 hours: 20 minutes to complete using AutoCAD 2008 on the HP xw4600 Workstation compared to 2 hours: 16 minutes using AutoCAD 2012 on the same workstation, a time reduction of 32 percent. There was a significant improvement in the time required to model the 3D parts in AutoCAD 2012 compared to AutoCAD 2008, and an equally significant improvement in the time required to create 2D orthographic views of the individual parts.

When the same drawing was created using AutoCAD 2012 on the HP Z210 Workstation, the time required went down an additional 7 percent.



Task #7: A 3D machine vice assembly with separate sheets for each part

AutoCAD 2012 was more efficient in the completion of this task than AutoCAD 2008. When the improvement due to the upgraded HP workstation was factored in, the overall time required to complete this task improved by a total of 37 percent from AutoCAD 2008, with the additional improvement largely due to improved system and NVIDIA graphics performance when working in 3D.

Drawing Task #8

In the eighth and final drawing task, standard AutoCAD commands were used to model two variations of a pulley assembly, including all of the dimensions and the calculated length of each pulley belt. First, each pulley wheel size was modeled as a separate block. Then, the appropriate blocks were inserted and positioned. Finally, the pulley belt was created and then text added along with a field that reported the length of the belt. Figure 9 shows the completed task #8 drawing with both variations of the pulley assembly.

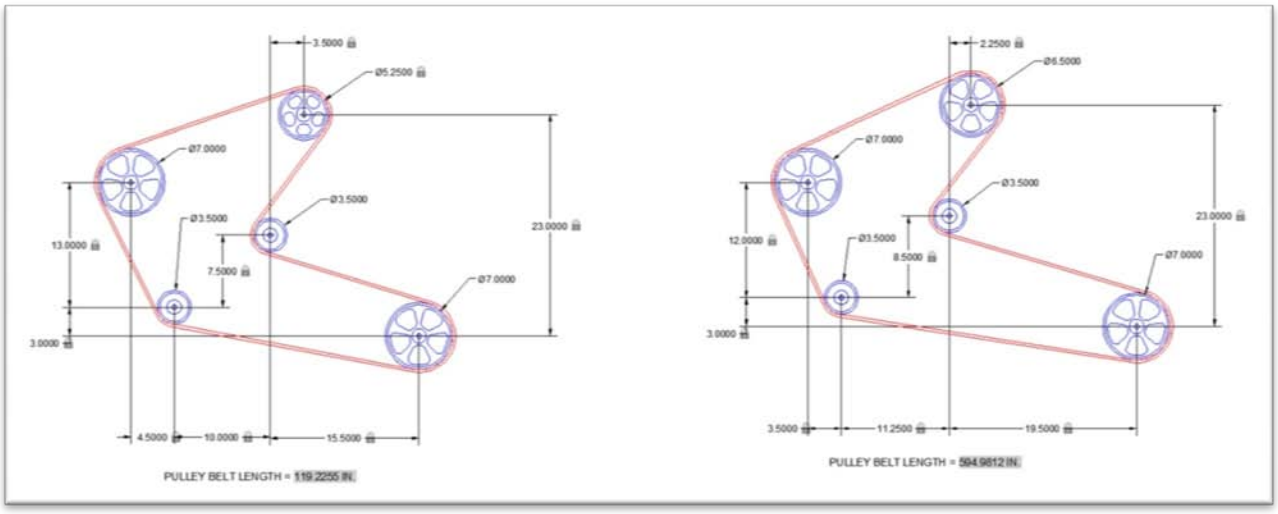


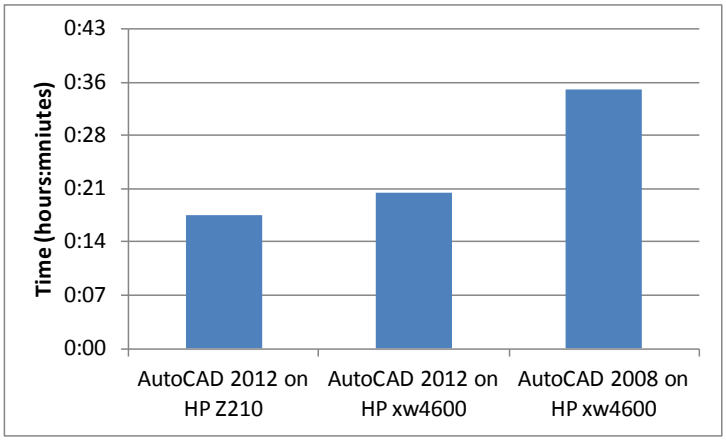
Figure 9: Completed task #8 drawing – two variations of a pulley assembly.

Because of the new parametric features introduced in AutoCAD 2011, I anticipated significant productivity improvements:

- In AutoCAD 2008, the various pulley wheels must be inserted at or moved into the precise position as the drawing is created, and then dimensions added. Then, to create the second variation, the first pulley arrangement can be copied, the necessary blocks replaced, and then each of the pulley wheels moved to its new position.
- In AutoCAD 2011, the various pulley wheels can be inserted at their approximate positions and then dimensional constraints created between each wheel. By specifying the correct dimension when these constraints are created, the wheels automatically move into their correct position. By creating these dimensional constraints as annotational constraints, there is no need to add dimensions; the constraints serve a dual purpose. Then, to create the second variation, the first pulley arrangement can be copied, the necessary blocks replaced, and the dimensional constraints modified to move the wheels into their new positions.

I expected to see these same types of improvements when comparing AutoCAD 2008 to AutoCAD 2012, but did not expect to see significant additional improvements.

This task took 35 minutes to complete using AutoCAD 2008 on the HP xw4600 Workstation compared to 21 minutes using AutoCAD 2012 on the same workstation, a time savings of 40 percent. When the same drawing was created using AutoCAD 2012 on the HP Z210 Workstation, the time required went down an additional 3 minutes or 14 percent.



Task #8: Create two variations of a pulley assembly

AutoCAD 2012 was more efficient in the completion of this task than AutoCAD 2008 thanks to the ability to use parameters and constraints to modify the drawing. This task scenario is actually a relatively simple but common example. Many AutoCAD users typically create much more complex drawings that could greatly benefit from the use of constraints. In actual use, many customers could expect to achieve even larger productivity gains in situations that can incorporate these parametric tools.

When the improvement due to the upgraded workstation was factored in, the overall time required to complete this task improved by a total of 49 percent compared to AutoCAD 2008, with the additional improvement largely due to improved HP workstation and NVIDIA graphics performance.

About the Systems Used for Testing

The eight task drawing scenarios were completed on the same computer platform, using both AutoCAD 2008 and AutoCAD 2012:

- An HP xw4600 Workstation equipped with an Intel® Core™ 2 Duo 3.16GHz CPU, 4GB of RAM, a 7200rpm SATA hard drive, and an NVIDIA® Quadro® FX570 graphics accelerator, running Windows® XP 32-bit. This workstation did not become available until 2008; nearly a year after AutoCAD 2008 was released. At the time of its release, this system sold for approximately $2,080.

The AutoCAD 2012 tests were then repeated on a more modern computer platform:

- An HP Z210 Workstation equipped with an Intel® Xeon® E3-1245 quad-core 3.36GHz CPU, 8GB of RAM, a 7200rpm SATA hard drive, and an NVIDIA® Quadro® 2000 graphic accelerator, running Windows® 7 64-bit. This is a relatively new workstation released shortly before AutoCAD 2012 began shipping and targeted at the entry-level to mid-range CAD market. At the time this report was prepared, this system sold for $2,801.

Figure 10: The tests were repeated on an HP Z210 Workstation (left) equipped with an NVIDIA Quadro 2000 graphics accelerator (right).

In every test scenario except task #6, the time required to complete the drawing was reduced when AutoCAD 2012 was run on the newer platform compared to AutoCAD 2012 on the older workstation. The time required to complete task #6 remained the same on both computers. Those times are summarized in the following table.

	AutoCAD 2008 on HP xw4600 w/ NVIDIA Quadro FX 570 (Windows XP)	AutoCAD 2012 on HP xw4600 w/ NVIDIA Quadro FX 570 (Windows XP)	AutoCAD 2012 on HP Z210 w/ NVIDIA Quadro 2000 (Windows 7)	Time reduction ACAD2008 to ACAD2012 on (both on HP xw4600)	Time reduction ACAD2008 on xw4600 to ACAD2012 on HP Z210
Task 1	1 hr: 5 min	52 minutes	39 minutes	20%	40%
Task 2	3 hr: 5 min	2 hr: 27 min	2 hr: 0 min	21%	35%
Task 3	15 minutes	12 minutes	10 minutes	20%	33%
Task 4	3 hr: 25 min	2 hr: 4 min	1 hr: 48 min	40%	47%
Task 5	34 minutes	16 minutes	15 minutes	53%	56%
Task 6	1 hr: 5 min	4 minutes	4 minutes	94%	94%
Task 7	3 hr: 20 min	2 hr: 16 min	2 hr: 6 min	32%	37%
Task 8	35 minutes	21 minutes	18 minutes	40%	49%
TOTAL	13 hr: 24 min	8 hr: 32 min	7 hr: 20 min	36%	45%

We recorded these time savings in spite of the fact that all of the task scenarios consist of drawing and editing typical AutoCAD models rather than compute-bound operations such as rendering or analysis. The reduction in the time required to complete the same tasks when running AutoCAD 2012 on the newer workstation under Windows 7 compared to the older workstation under Windows XP is likely the result of several factors:

- The faster CPU and NVIDIA graphics accelerator likely resulted in faster manipulation of three-dimensional models and large solid filled and hatched areas. This enabled the user to pan, zoom, and orbit more quickly. Over a typical work session, this can save a considerable amount of time.
- AutoCAD 2012 seemed more responsive on the Z210 Workstation running Windows 7 than AutoCAD 2012 on the xw4600 running Windows XP, most likely thanks to Windows 7's use of Direct3D®.
- The video driver used in AutoCAD 2012 takes advantage of advanced capabilities of the NVIDIA graphics card, whereas the native video driver in AutoCAD 2008 does not.

Productivity Improvement

For each of the eight task scenarios, I measured the time required to complete the drawings using the three different workstation configurations. The results in the report are then explained in terms of the amount of time saved as a result of:

- Upgrading from AutoCAD 2008 to AutoCAD 2012 while continuing to run the software on the same HP xw4600 Workstation with an NVIDIA Quadro FX 570 graphics accelerator running Windows XP 32-bit.
- Additionally upgrading to an HP Z210 Workstation with an NVIDIA Quadro 2000 graphics accelerator, running Windows 7 64-bit.

In addition to looking at the results in terms of the time savings, they can also be expressed in terms of productivity or measured output. A reduction of 20 percent in the amount of time required to complete a task equals a 25 percent improvement in user output.

$$\text{Percent time saved ACAD2008 to ACAD 2012} = \frac{\text{ACAD 2008 time} - \text{ACAD 2012 time}}{\text{ACAD2008 time}}$$

$$\text{Productivity improvement ACAD2008 to ACAD2012} = \frac{\text{ACAD2008 time} - \text{ACAD2012 time}}{\text{ACAD2012 time}}$$

For example, on task #5, the time required to complete the drawing decreased from 34 minutes using AutoCAD 2008 to 16 minutes using AutoCAD 2012, a reduction of 56 percent. Using the formula above, that represents a productivity improvement when using AutoCAD 2012 of 113 percent, or better than 2 times the output compared to AutoCAD 2008. The respective productivity improvements are summarized in the following table.

	AutoCAD 2008 on HP xw4600 w/ NVIDIA Quadro FX 570 (Windows XP)	AutoCAD 2012 on HP xw4600 w/ NVIDIA Quadro FX 570 (Windows XP)	AutoCAD 2012 on HP Z210 w/ NVIDIA Quadro 2000 (Windows 7)	Productivity improvement AutoCAD 2011 vs. AutoCAD 2008 (both on HP xw4600)	Productivity improvement AutoCAD 2012 on HP Z210 vs. AutoCAD 2008 on HP xw4600
Task 1	1 hr: 5 min	52 minutes	39 minutes	25%	67%
Task 2	3 hr: 5 min	2 hr: 27 min	2 hr: 0 min	26%	54%
Task 3	15 minutes	12 minutes	10 minutes	25%	50%
Task 4	3 hr: 25 min	2 hr: 4 min	1 hr: 48 min	65%	90%
Task 5	34 minutes	16 minutes	15 minutes	113%	127%
Task 6	1 hr: 5 min	4 minutes	4 minutes	1525%	1525%
Task 7	3 hr: 20 min	2 hr: 16 min	2 hr: 06 min	47%	59%
Task 8	35 minutes	21 minutes	18 minutes	67%	94%
TOTAL	13 hr: 24 min	8 hr: 32 min	7 hr: 20 min	57%	83%

Therefore, when expressed as productivity improvement, the test results show that users can improve their current output by 57 percent (or 1.57 times) as a result of upgrading from AutoCAD 2008 to AutoCAD 2012 without any change in the computer on which AutoCAD is run. When they also invest in a new workstation with more a modern graphics accelerator, they can achieve a productivity improvement of 83 percent or 1.83 times their current output.

Benchmark Results

In addition to the user productivity analysis performed using the eight drawing task scenarios, we also performed more traditional quantitative analysis of the computer hardware using a number of different benchmarks, including the SPEC viewperf 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 workstations used in this productivity study.

We performed a total of six different benchmark tests:

- The CADalyst benchmark
- SPEC viewperf
- An AutoCAD rendering benchmark
- An AutoCAD script to measure performance when working with very large drawing files
- A test to determine system boot time
- A test to determine AutoCAD load time

Since the two workstations used in the productivity study were available with various graphics accelerator options, we not only performed the tests multiple times, we also tested using two different graphic card combinations. When testing the HP xw4600 Workstation, we performed the tests using both an NVIDIA Quadro FX 570 graphics accelerator and a more powerful NVIDIA Quadro FX 1700 graphics card. When testing the HP Z210 Workstation, we performed the tests using an NVIDIA Quadro 2000 graphics accelerator. The difference in graphics cards had a significant impact on the results of the SPEC viewperf and CADalyst benchmarks.

In the case of the HP xw4600, we also looked at differences in the benchmark results afforded by upgrading the graphics card driver software. Graphics card developers such as NVIDIA often release updated driver software, which can be downloaded free of charge. While a user might choose to not purchase newer hardware, the performance of their older workstation could be improved by installing a newer version of the driver for their graphics card. We therefore included this analysis in our testing procedures. Upgrading to the newer driver only yielded significant results on the SPEC viewperf benchmark. The newer driver made no measurable impact on any of the other tests we performed.

CADalyst Benchmark

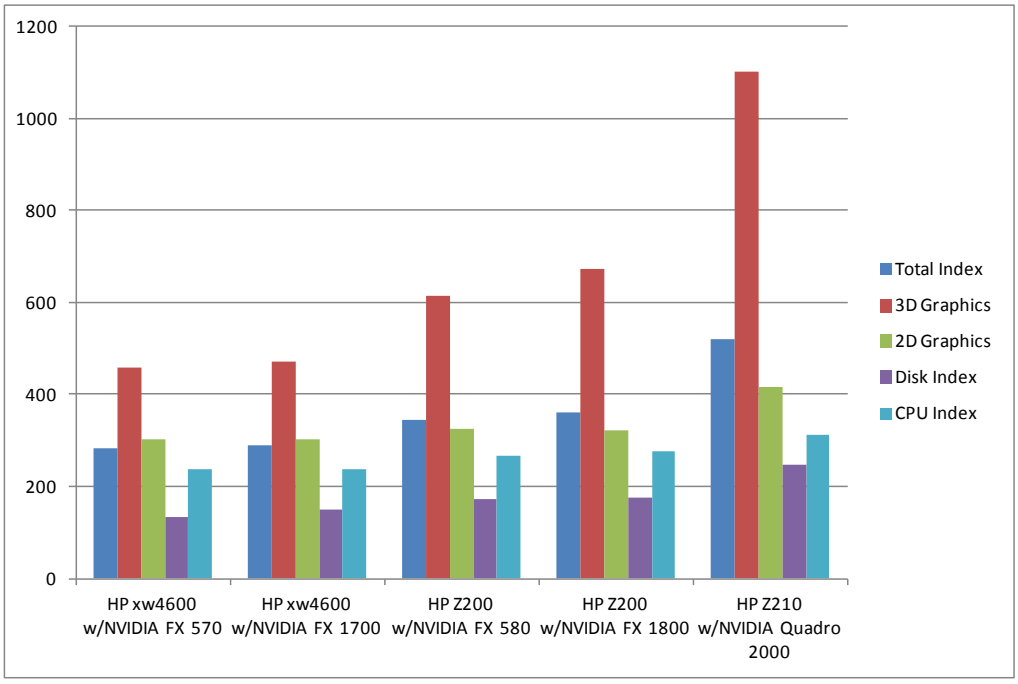
The CADalyst benchmark is designed to test and compare the performance of systems running AutoCAD. The benchmark compares the test times of the system with a set of base times, and computes an index number. An index score of 135, for example, means that the system being tested is 135 times faster than 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. The latest version of the benchmark available at the time of this study was v5.3, which is not compatible with AutoCAD 2012. For that reason, the benchmark was run on each computer using AutoCAD 2010 and the results are provided here as a quantitative measure of the performance of the workstation and graphics card combination only. All tests were run at a resolution of 1280x1024, a resolution often used by others utilizing this same benchmark.

As expected, the benchmark results showed a marked improvement when upgrading from the HP xw4600 to the newer HP Z210. Within each of those workstations, the benchmark results also improved when we upgraded the graphics accelerator. Switching from an HP xw4600 with an NVIDIA Quadro FX 570 graphics accelerator (the combination used for the AutoCAD 2008 portion of the user productivity study) to an HP Z210 Workstation with an

NVIDIA Quadro 2000 graphics accelerator produced a very significant improvement in the Total CADalyst benchmark index of 83 percent.

We also looked at the CADalyst benchmark data from last year's study, which compared the HP Xw4600 workstation to an HP Z200 workstation equipped with an NVIDIA Quadro FX 580 and a Quadro FX 1800. The HP Z210 workstation equipped with the NVIDIA Quadro 2000 GPU was significantly faster than even the relatively new HP Z200 workstation, with a 44 percent improvement over the Z200.



CADalyst v5.3 Benchmark Results Using AutoCAD 2010

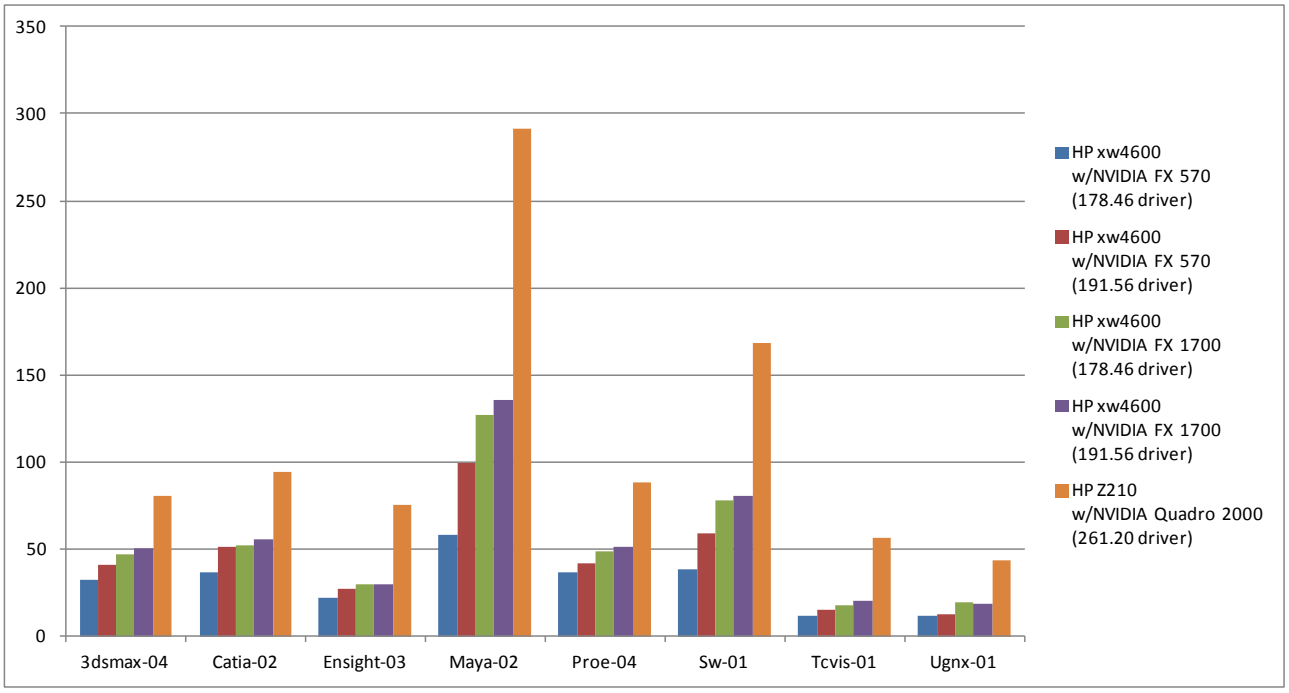
SPEC viewperf

The SPEC viewperf benchmark measures the 3D rendering 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. During the time that this productivity study was being conducted, SPEC.org released its newest version, viewperf 11. However, we were unable to get that new version to run under Windows XP. For that reason, we used viewperf 10. This actually has the benefit of enabling some additional comparisons to other published results. Had we used the newer version, which is based on totally new viewsets, the results would not be comparable to any previously published results. However, since viewperf 10 and viewperf 9 are based on the same viewsets, the results obtained with both versions of the benchmark are directly comparable.

The SPEC viewperf benchmark can also 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 1280x1024 as a single thread.

As expected, the results improved significantly when upgrading from the HP xw4600 to the newer HP Z210 with the NVIDIA Quadro 2000 GPU. Within each of those workstations, the benchmark results also improved when we upgraded the graphics accelerator. On the HP xw4600, the results also improved when we upgraded to the newer version of the graphics driver software.



SPEC viewperf 10 Benchmark Results

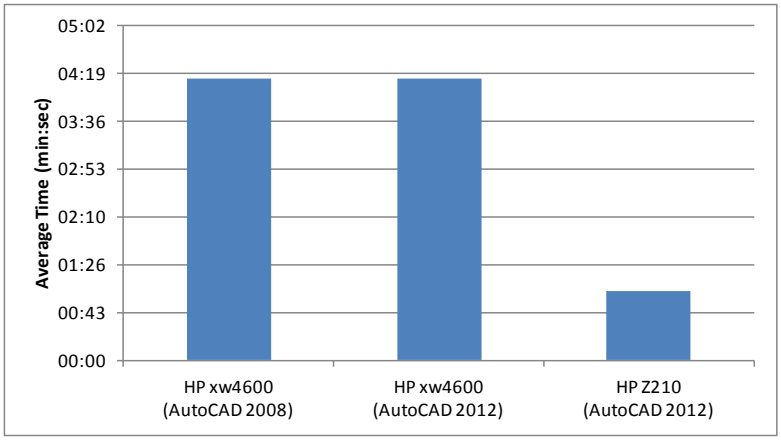
Depending on the viewset, the SPEC viewperf results improved up to 69 percent simply by upgrading the driver software for the older graphics card, with an average improvement of 33 percent. For each of the systems tested, the more powerful version of the graphics card was on average 30 percent faster. Comparing the two system configurations used in the productivity study—the HP xw4600 Workstation equipped with an NVIDIA Quadro FX 570 graphics card versus the HP Z210 Workstation equipped with an NVIDIA Quadro 2000 graphics card—the SPEC viewperf results improved anywhere from 84 to 283 percent depending on the viewset, with an average improvement of 173 percent.

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 1280x1024. 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 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 Z210 was able to complete the rendering much faster than the HP xw4600—1 minutes: 2 seconds versus 4 minutes: 15 seconds—an improvement of 309 percent. There was no difference in rendering time on the HP xw4600 when comparing the two different versions of AutoCAD.

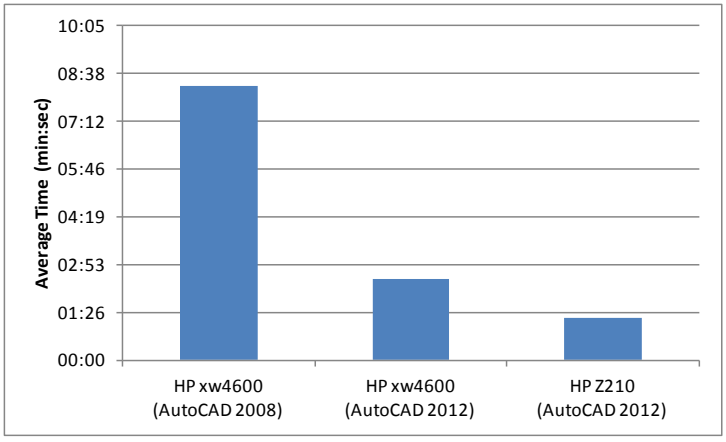


AutoCAD Rendering Benchmark Results

AutoCAD Large Drawing Benchmark

This benchmark is meant to gauge the performance of the workstation running AutoCAD when working on large models. The test records the time it takes to load a large AutoCAD drawing file (28MB) 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.

As expected, AutoCAD 2012 outperformed AutoCAD 2008 on this test. It took 8 minutes: 15 seconds to complete this test on the HP xw4600 running AutoCAD 2008 compared to 2 minutes: 26 seconds on the same system running AutoCAD 2012, a performance improvement of 239 percent. When we ran the same test on the HP Z210 running AutoCAD 2012, the time required to complete the test dropped to 1 minute: 16 seconds, an additional 92 percent improvement over the xw4600 running the same version of AutoCAD 2012 and a 551 percent improvement compared to the HP xw4600 running AutoCAD 2008.



AutoCAD Large Drawing Benchmark Results

Basic Computer Operations

The time required for HP Z210 to boot up was considerably shorter than for the HP Xw4600. The HP xw4600 Workstation running Windows XP was ready to start programs approximately 50 seconds after pressing the power button. The HP Z210 Workstation running Windows 7 was ready to start programs approximately 38 seconds after power-up, 32% faster.

AutoCAD 2008 actually loaded faster, however, taking approximately 4 seconds to load on the HP xw4600 Workstation running Windows XP compared to approximately 8 seconds to load AutoCAD 2012 on the HP Z210 Workstation running Windows 7. The longer load time is largely due to the ribbon interface in AutoCAD 2012.

Once AutoCAD was up and running on the respective systems, AutoCAD 2012 seemed more responsive on the Z210 Workstation running Windows 7 than AutoCAD 2008 on the xw4600 under Windows XP.

Other Considerations

Although the tests did not take into consideration any of the other differences between the operating systems, one should also note several other features and functions available when running Windows 7. AutoCAD 2012 leverages the Live Taskbar Preview functionality in Windows 7. With the Windows 7 Live Taskbar Preview, when you move the cursor over the AutoCAD icon on the Windows taskbar, you see a preview image of each drawing currently open in AutoCAD 2012 (as shown in Figure 10). You can click on a preview image to quickly work on that drawing or even close the drawing using the preview image. If AutoCAD 2012 appears in the list of recent programs in the Start menu, it also stores a "jump list" of most recently opened files. You can then load one of those files (or start AutoCAD 2012 and load the file) by simply clicking on it in the list. You can also pin files so that they remain in this list. The jump list also appears when you right-click on the taskbar icon. These jump lists are shown in Figure 11. This additional functionality when running Windows 7 could further improve overall productivity.

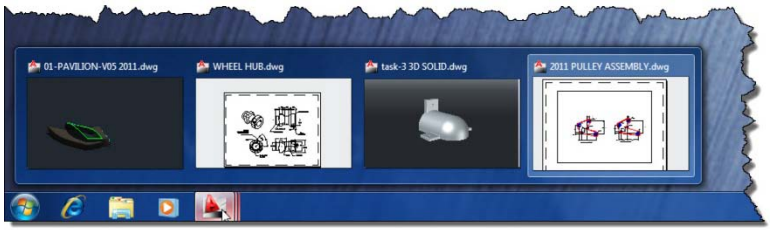


Figure 10: The Windows 7 Live Taskbar Preview lets you preview and switch to an open drawing.

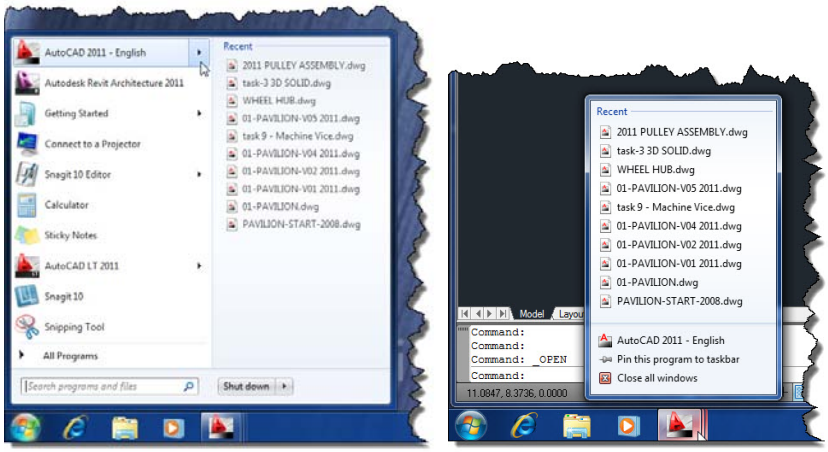


Figure 11: Windows 7 "jump lists" enable you to quickly load recently accessed drawings.

Conclusions

The results of this productivity study were both dramatic and conclusive—AutoCAD 2012 is significantly more productive than AutoCAD 2008. What's more, upgrading one's workstation, graphics card, and operating system as well as upgrading from AutoCAD 2008 to AutoCAD 2012 results in an average overall productivity improvement of more than 80 percent.

When creating typical drawings, the ease of access afforded by the ribbon interface as well as the use of new features and functionality introduced in AutoCAD 2009, 2010, and 2011, results in time savings ranging from 20 to 94 percent, with an average time savings of 36 percent. This equates to individual productivity gains ranging from 25 to 1525 percent, with an average overall productivity improvement of 57 percent.

Upgrading one's workstation and operating system as well as upgrading from AutoCAD 2008 to AutoCAD 2012 results in time savings ranging from 33 to 94 percent, with an average time savings of 45 percent. This equates to individual productivity gains ranging from 50 to 1525 percent, with an average overall productivity improvement of 83 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. Enhancements to the user interface in both AutoCAD and Windows 7 also yield a more satisfying user experience.

Most users will be able to get more work done faster as a result of moving from AutoCAD 2008 to AutoCAD 2012. The amount of improvement likely to be recognized is so significant that most users will conclude that it easily justifies the cost of upgrading.

The additional improvement in user productivity resulting from also upgrading the computer workstation and graphics card is also so significant that most users should recognize a very fast return on their investment, easily justifying the cost of upgrading their hardware as well as their AutoCAD software.

About the Author

David Cohn has more than 25 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 both Autodesk University and AUGI® CAD Camps.

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