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Multitask Your Design

Getting More Done with an Expert Workbench

By Robert Green, *Cadalyst* Contributing Expert

We hear a lot about multitasking in today's culture of smart phones and distributed software, but we don't hear much about it within the context of design computing. With software tools that let us perform analysis, simulation, and design optimization above and beyond 2D/3D CAD, why not let engineers and architects run all these tools concurrently on a super workstation to achieve maximum design speed and efficiency?

In the past, workstations themselves have been a limiting factor — they simply could not perform all the processing required for a multitasking engineering environment.

Not anymore.

With the kind of horsepower we now have available, why aren't we performing these tasks on the same workstation at the same time? Why not let your analytical processes run in the background on two cores while performing 2D CAD annotations in the foreground? Why not render the photorealistic images for tomorrow's presentation on another two cores at the same time? Then, as soon as your analysis is complete, why not turn and make 3D changes in your CAD models as suggested by analytical results to optimize your design? And, then perform yet another analysis to confirm your changes?

When you think about the design process as a collection of processes running concurrently under the control of one engineer or architect, as opposed to a serial collection of tasks performed by many, it's easy to see how design times can be greatly compressed. The real question then becomes what kind of workstation hardware do you need to undertake this new mode of design.

Screen image courtesy of Autodesk

HP Z600 Workstation
Special deals starting at $1,499.

Screen image courtesy of Cannon Design

HP Z800 Workstation
Special deals starting at $1,799.

Screen image courtesy of Autodesk

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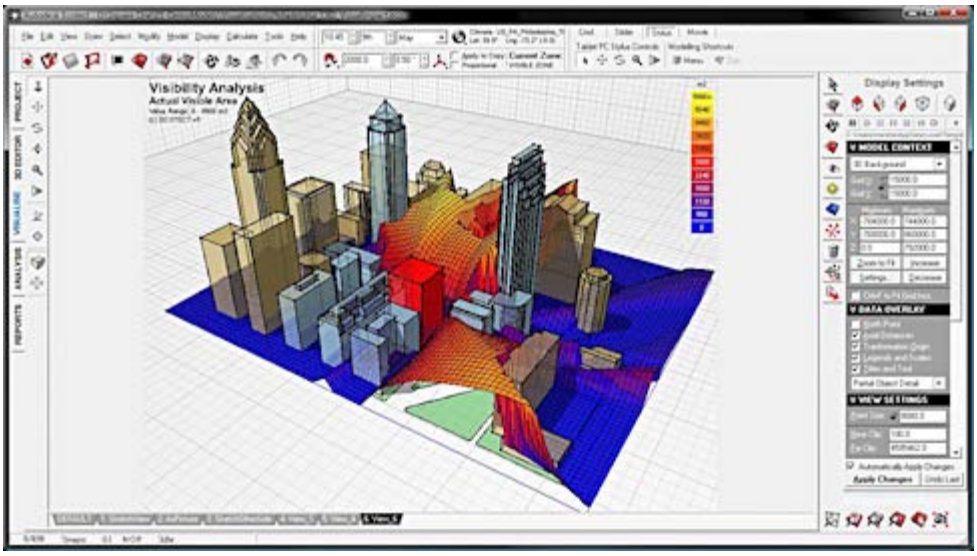
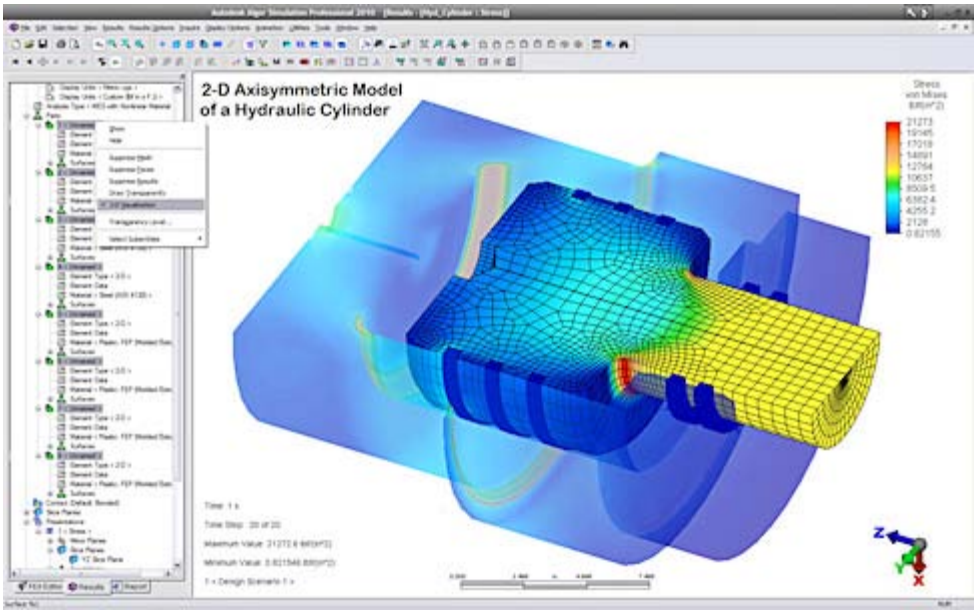


Applications such as visibility analysis bring a whole new dimension to building information modeling (BIM) design projects yet require more processing power to run in parallel with other applications. (Image courtesy of Autodesk)



Applications such as finite element analysis allow simulation of loads to run concurrently with other design applications to let you examine more "What if?" design scenarios. (Image courtesy of Autodesk)

The Expert Workbench

Intel Corporation has devised a four-tier categorization of workstations that span from basic to very high performance. The highest category of performance, called the Expert Workbench, is designed to provide maximum capacity for running multiple processes, much like the concurrent design philosophy I envisioned above.

The Expert Workbench calls for two (2) Intel® Xeon® 5600 series processors to deliver 12 total cores of computing performance to bear on compute intensive applications such as analysis, simulation, and rendering. With two processors at clock frequencies of up to 3.46 GHz, on board cache of 12MB, 3 memory channels, 8 threads, and Intel® Turbo Boost and SpeedStep® Technologies, the total 12 core machine brings power to bear that was unthinkable just three years ago.

Intel and HP have worked together to create Expert Workbench level HP Z600 and HP Z800 workstations with well matched RAM, disk, and graphics systems at a variety of pricing points. A quick trip to the HP web site showed the following standard configurations for a HP Z800 and HP Z600 on the higher and lower end of the Expert

HP Remote Graphics Software

HP Total Care

Download the HP & Autodesk Productivity Survey and The HP & Autodesk Brochure

Workstation Finder Tool

Workbench spectrum, respectively:

HP Z800 (FM017UT) - $9,629*[1,2,3]
Genuine Windows® 7 Professional 64
2 Intel® Xeon® Processor X5677 (3.46 GHz, 12 MB cache, 1333 MHz memory, Quad-Core)
16 GB 1333 MHz DDR3 ECC Unbuffered RAM
12 DIMM memory slots (maximum of 192GB DIMMs)[4]
600GB[6] 15000 rpm SAS disk[5]
1GB NVIDIA Quadro FX3800 (1GB)
1110 watt power supply

HP Z600 (FM023UT) - $3,079*[1,2,3]
Genuine Windows® 7 Professional 64
2 Intel® Xeon® Processor E5620 (2.40 GHz, 12MB cache, 1066 MHz memory, Quad-Core)
12GB 1333 MHz DDR3 ECC Unbuffered RAM
6 DIMM memory slots (maximum of 48GB, with 8GB DIMMs)[4]
500GB[6] 7200 rpm SATA NCQ[5]
2GB NVIDIA Quadro 4000
650 watt power supply

* These are Internet prices as of May 2011, please check with HP for up-to-date pricing and discounts.

(Note: To help you compute how much RAM you'll need and therefore help you decide whether the HP Z600 or HP Z800 platform is the best choice for you, we'll talk about HP's Performance Advisor below.)

The HP Z600 (left), and HP Z800 (middle) workstations have the chassis size and power supply capacities required to deliver Expert Workbench configurations to your desktop.

Expert Workbench Metrics

To get some expert advice on configuring an Expert Workbench workstation, I spoke with Intel's Workstation Product Manager Wes Shimanek about his experiences with a variety of CAD, analytical, and simulation applications on high-end Intel Xeon equipped workstations. Our conversation focused on which workstation components are the most crucial in achieving maximum performance in analysis and simulation software environments. Here are some of the highlights:

Robert Green [hereafter RG]: You told me that it's time to look beyond the processor clock rate and consider the overall performance of a workstation. Can you give me a quick rundown on what that would mean for an engineer using a workstation for analysis and simulation type tasks?

Wes Shimanek [hereafter WS]: Technical application performance is based on more than processor clock rate. You need to make sure you are looking at the entire infrastructure including the size of the last level cache (LLC), the number of memory

channels, as well as the number of available physical and logical computational cores and the availability of technologies such as Intel Turbo Boost or Intel Hyper Threading technologies. Combined, these technologies help users get data to where it's needed in order to change it into actionable information.

In an Expert Workbench, powered by two Intel Xeon 5600 series processors, users can concurrently accelerate both CAD and simulation or rendering and ray tracing applications. The result is they can experiment with more design alternatives in less time than ever before.

RG: What about the cache size of the processor and how that relates to performance?

WS: There is an old saying cash is king. It's the same with computer architectures — it's just a different kind of cash. This time it's about cache memory, memory that is built into the processor. All else being equal, cache is so effective in system performance that two computers running at the same CPU frequency with different cache sizes can exhibit different benchmark results. As an example, an Intel Xeon E3-1245-based workstation with a 3.3 GHz clock and an 8MB cache is 1.9X faster than a 3.3 GHz Intel Core i3-2120 processor that only supports a 3MB cache. Another contributing factor to this performance advantage is the availability of Intel Turbo Boost 2.0 Technology, which is not available on an Intel Core i3-based processor.

RG: Is RAM architecture important or is it just the amount of RAM that is important?

WS: There are many contributing factors to performance:

- Cache size
- Memory capacity and speed
- Number of physical and logical computational cores
- System level bandwidth

Another contributor to performance is memory capacity and the number of memory channels that are available. Obviously, the more memory channels, the greater the potential to quickly access data. So that the machine works most efficiently, you should keep memory channels and DIMM slots evenly populated. As an example, an entry-level workstation based on the Intel Xeon E3 1200 family supports only two memory channels. Users should be thinking 4-, 8-, 16-, and 32GB memory configurations with 2-, 4-, or 8GB memory sticks respectively. With Expert Workbench, you have access to 6 memory channels — 3 for each processor. In this case, memory sweet spots will be 6-, 12-, 18-, 24-, 48GB, and the like.

Another memory technology to consider is whether or not you want to invest in error correction code (ECC) memory or not. Because users invest in an Expert Workbench to help explore more "What-if?" scenarios in less time, you should be using all of its available cycles around the clock. With that in mind, the slight premium for ECC memory is a low-cost insurance policy to make sure you really get actionable results — not losing your hours of hard work to a blue screen.

RG: Do you have a rule of thumb for how much RAM to install?

WS: Good question. The simple answer is that more is better — to a point.

I researched online and found 2GB 1333 ECC memory DIMM slots this morning (5/15/2011) and the price ranged from $42 to $50.

- In the case of entry-level workstations with two memory channels I suggest opting for an 8GB memory configuration, such as four 2GB DIMM.
- For an Expert Workbench with 2 processors, I would opt for a minimum configuration of 12GB

In each case, I kept the memory channels and DIMM slots evenly populated to achieve the best memory performance. As you know, many workstation applications

support 64-bit versions. Recently, I was part of a workstation pilot program with a North American trucking company. The company regularly worked with large data files that took up to 20 minutes to open — they were thrashing against the 32-bit limit.

With a slightly newer workstation with 6GB of memory (this workstation had 3 memory channels) and a 64-bit version of their CAD application, users opened large files in less than 2 minutes. I think the move to 64-bit applications and 6GB memory configuration is justifiable.

RG: I'm making the assumption that your workstation metrics are based on 64-bit Windows 7 operating systems, correct?

WS: That is generally the case, but many large enterprise organizations still need to support 32-bit requirements. To answer your specific question, all of our measures are done with Windows 7 and 64-bit.

However, taking advantage of an Intel technology known as Intel® Virtualization Technology for direct i/o (Intel VTd i/o) we help organizations deliver near native application performance to both 32-bit legacy environments, while allowing engineering users to increase their agility via 64-bit design applications. This helps engineering organizations realize the productivity gains offered by the example above and still meet their 32-bit legacy needs as they continue to migrate to a complete 64-bit environment.

RG: As far as graphics are concerned what is the impact on performance when considering a graphics processor (GPU) in high-end workstations?

WS: With respect to graphics, I see a number of high-end workstations being configured with ultra high-end GPUs that cost between $1,800 and $2,000. They almost always come with 2.5GB of GGDR memory. I agree, some users may need them to support high-end graphics or imaging applications, but many CAD users may be fine with midrange graphics cards that cost as little $500 and support for 1GB of GDDR memory. Even more users may actually be just as creative with an entry card that cost $170, again with 1GB of GDDR memory.

Before making a decision, I ask:

- What technology do you need to create the most productive and creative platform for your users
- What percent of your day are you opening and closing large files? Opening and closing applications?
    - Might you benefit more from an investment such as Solid State Drives, which accelerates this process?
- What percentage of your day are you using ultra-high end visualization techniques? If this is your primary role, then you should invest in the best graphics processing subsystem you can.

RG: Let's discuss the importance of disk speed. Do you recommend any particular disk technology?

WS: Good question. No surprise here — faster is always better. Let's look at few opportunities to improve performance. If your simulation software on your Expert Workbench is reading and writing intermediate results with a great deal of frequency, then consider a Solid State Drive (SSD) investment. This can offer some dramatic opportunities to gain access to actionable information. The next consideration is the speed of the hard disk drive (HDD) rotation speed. Again higher is better, a fast rotation speed equates to higher data transfer rates and faster transfer rates that can help shorten the time to decision.

The third consideration is the use of RAID (*Redundant Array of Inexpensive Disks*) technology that you can use to accelerate the performance and reliability of your workstations data storage solution. A RAID 0 or RAID 10 system consists of two or

more disks working in parallel. These disks can be hard discs but there is a trend to also use the technology for solid state drives.

Author's note: I'd like to personally thank Wes Shimanek from Intel for taking the time to share his expertise with us.

Productivity Tuning with HP Performance Advisor

Purchasing a workstation with the correct complement of cores, memory, drives, and graphics is the starting point for your multitasking platform, but why stop there? Why not tune your workstation to use its resources in a way that will support your precise computing needs, rather than just hoping for maximum performance? HP's Performance Advisor is exactly the tool that allows this optimized tuning to be performed, saving you time and enhancing your workstation investment.

HP Performance Advisor assists you with maintaining your HP Workstation by keeping track of the latest hardware and graphics drivers and software specific drivers for popular CAD applications (see figure below) but it also helps you maximize the performance of your application's memory and processor use.

Performance Advisor provides guidance on the proper settings for each CAD application so each can be optimized to get maximum performance. A graphical display (see graphic) shows how your applications and processes use memory to help you understand how to optimally tune your machine. If your software applications require more RAM to operate at peak efficiency, Performance Advisor can help you arrive at the optimal value since you'll know how much memory is actually required.

With as many as 12 cores on board (using dual configurations, with six cores each) with 24GB or more of RAM and Performance Advisor to help you get the most from all of it your workstation can power through multitasking operations that would have been unthinkable just a few years ago.

Performance Advisor's simplified console shows memory use to help you understand application requirements so you can allocate system resources such as RAM or even processor cores for optimal performance.

Justify Your Cost

Everyone who uses CAD would obviously love a workstation with 12 cores and 24GB of RAM that could run all their applications concurrently, but not everyone has management that sees the value and is willing to pay for them. To make the case for a truly multitasking workstation, a little financial legwork is in order.

To begin, let's agree that getting a task done in less time leads to savings. The next step is to realize that the savings you generate could pay for the beefier workstations required. The equation is simple: Time = Money.

		Labor Rate ($/hr)					
		40	50	60	70	80	90
Time Saved (min/day)	5	800	1000	1200	1400	1600	1800
	10	1600	2000	2400	2800	3200	3600
	15	2400	3000	3600	4200	4800	5400
	20	3200	4000	4800	5600	6400	7200
	25	4000	5000	6000	7000	8000	9000
	30	4800	6000	7200	8400	9600	10800
	45	7200	9000	10800	12600	14400	16200
	60	9600	12000	14400	16800	19200	21600

Savings ($/year)

The table I developed above demonstrates how saving a few minutes per day adds up over the course of a year (or two, or three). A quick example of saving an $80/hour engineer 30 minutes per day for two years would yield $19,200 in labor savings, right? *(Simply intersect the 30 minute per day line to the 80 $/hour column for $9600/year times 2 years).* Given this understanding of savings, you can now see that even a $10,000 workstation can pay for itself in a single year and can continue generating savings for years after you purchase it.

In addition, if we also stop to consider that not only will the engineer save time but the engineer's client will get a better design (because more simulations and scenarios can be run) sooner (due to faster performance), that client will be happier and more likely to do repeat business with the company. Now, what is *that* worth?

Wrapping Up

With the kind of workstation, software, and design optimization tools available to engineers and architects now, shouldn't we all be thinking about ways to speed our designs along using the concepts of concurrent computing on our own expert workbenches? Just consider the possibilities.

About the Author

Robert Green
Robert provides CAD implementation, consulting, and programming services for a variety of companies throughout the United States and Canada. He holds a degree in mechanical engineering from the Georgia Institute of Technology and is the author of *Expert CAD Management: The Complete Guide*. Reach him via his web site at www.cad-manager.com.

DISCLAIMERS

(1) Quad- and six-core technologies are designed to improve performance of multithreaded software products and hardware-aware multitasking operating systems and may require appropriate operating system software for full benefits; check with software provider to determine suitability; Not all customers or software applications will necessarily benefit from use of these technologies.

(2) 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. See http://www.intel.com/info/em64t for more information.

(3) Intel's numbering is not a measurement of higher performance.

(4) Each processor supports up to 3 channels of DDR3 memory. To realize full performance at least 1 DIMM must be inserted into each channel. To get full 6 channel support, 2 processors MUST be installed.

(5) SATA hardware RAID is not supported on Linux systems. The Linux kernel, with built-in software RAID, provides excellent functionality and performance. It is a good alternative to hardware-based RAID. Please visit http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00060684/c00060684.pdf for RAID capabilities with Linux.

(6) For hard drives, 1 GB = 1 billion bytes. 1 TB = 1 trillion bytes. Actual formatted capacity is less. Up to 20 GB of hard drive (or system disk) is reserved for the system recovery software for Windows 7.