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## Create a Balanced Workstation with the Latest Intel® Xeon® Processors

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### How to Pick the Right Processor for Your Needs

By Robert Green, *Cadalyt* Contributing Expert



Buying a workstation can be a daunting task. You have to specify RAM, graphics, disk options, monitors, case sizes, power supplies, and all sorts of other issues. How do you figure out what processor you should put in your new workstation? After all, all the supporting hardware in the world won't matter if you have an underpowered processor dragging the performance of your workstation down.

#### Key Topics

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HP's line of Z Workstations makes high power Intel® Xeon® processors based on the latest Intel® architecture (code name Ivy Bridge) readily available to you in a variety of configurations from the single processor HP Z1 and Z220, to the Z420 through the monster dual-processor HP Z620 and Z820.



#### Why Intel Xeon E3?

In short, the latest Intel Xeon processor E3 family (based on Ivy Bridge microarchitecture) gives you more power. Faster cores, bigger caches, more I/O throughput, and optional powerful on-board graphics all combine to power your workstation in ways that consumer processors cannot.

The level of horsepower the new Intel Xeon processors bring to the table gives us workstations with 16 cores, 512 GB of RAM, and solid state disks (SSDs) that run rings around even three-year-old workstations. This type of power allows CAD users, analysts, simulation engineers, and rendering specialists to not only run applications faster, but to

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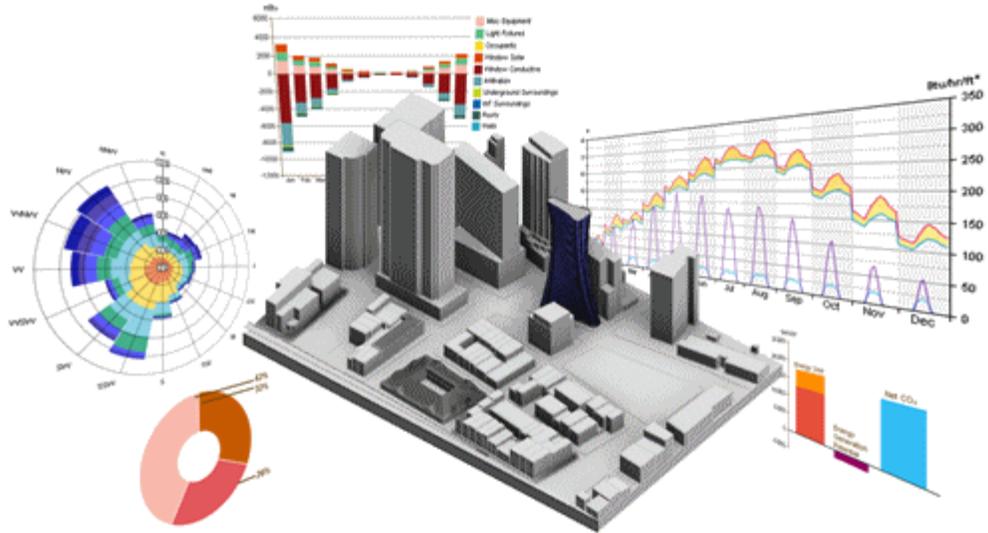


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also run more simultaneous application threads than ever before on a desktop. For example, an engineer can now finetune a 3D assembly in CAD, analyze portions of the design, render other parts of the design, plus check e-mail and fill in a spreadsheet, all at the same time without noticeable degradation in any of the processes.

Processing = Design

Design work has always taken a collection of different tools that are used concurrently, whether the tools were a drafting board and slide rule 50 years ago, or a variety of CAD tools now.



Applications such as energy analysis plug-ins for building information modeling (BIM) bring a whole new dimension to design projects, yet require more processing cores and RAM to run at the same time CAD and other applications are running. (Image courtesy of Autodesk.)

With all the processing power available, why would you want a low-end, consumer PC, when you could have a workstation that can support these powerful Xeon processors with the array of graphics, disk, and RAM resources required to get great performance? HP Z Workstations offer a great variety of platforms with varying cores, RAM, and storage (as seen below) to support all manner of design environments.

Workstation	Z220/Z1	Z420	Z620	Z820
Processor Sockets	1	1	2	2
Maximum Cores	4	8	16	16
Maximum RAM	32 GB	64 GB	96 GB ECC	512 GB ECC
Memory Modules	4	8	12	16
Maximum Disk Storage	3.2 to 6 TB	11 TB	11 TB	14 TB

The number of processors, cores, memory modules, and maximum RAM range for the HP Z Workstation line. <sup>1,2,3</sup>

As you can see from the table above, HP's Z Workstations run the gamut from solid single processor CAD performance in the Z1/Z220 series through the brute force performance of the dual processor Z820 that supports 16 cores and an astronomical 512 GB of RAM for extreme analysis and rendering.

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The HP Z420 (left), HP Z620 (center), and Z820 (right) Workstations have the chassis size, power supplies, and disk capacity to support aggressive applications such as analysis, simulation, and rendering.

### Intel Xeon Processor Analysis

With all the configurations possible in HP Z Workstations with Intel Xeon processors, I thought it best to get some detailed feedback from Intel. I spoke with Intel's Workstation Group General Manager Frank Soqui to find out how workstation configurations can vary with workloads and how to equip your HP Z Workstation with the right Xeon processor, RAM, graphics, and disk resources to achieve maximum performance. Here's how the conversation went:

Robert Green [hereafter RG]: First off, the Ivy Bridge generation of Xeon processors gives more options and more power than an Intel<sup>®</sup> Core™ i5 or i7 chip, right?

Frank Soqui [hereafter FS]: Right, but to be clear, Ivy Bridge is a microarchitecture found in both Intel Core- and Intel Xeon-based solutions. With respect to Xeon, users can employ faster processor speeds, ISV-certified processor graphics, as well as access to error-correcting code memory (ECC) memory. These all combine to create a workstation solution that with the help of OEM's, such as HP, and are purposely built for professional users who demand performance, stability, and reliability.

RG: So, what sets the new Xeons apart from previous generations?

FS: Each year Intel introduces new processors and each year we look to process more instructions in a given cycle. Both the Intel Xeon E3 and Intel Xeon E5 processors found in the latest HP Z series workstation do just that — process more instructions in a given clock cycle than our previous generation. However, in this case it is much more than just a faster processor or enabling a user to execute more instructions in a given clock cycle — we looked at other bottlenecks and added SATA 3.0 technology which when coupled with solid-state drives (SSDs), like our Intel 520 series, helps users to potentially increase their productivity by more than 3X. We actually measured this and you can see it on [YouTube](#). My point is that it's easy to build faster, more capable processors, but sometimes when you include other technologies as part of the process some amazing things can happen.

### General User Needs

RG: For a general CAD user who's also running typical office applications, what's the "sweet spot" in terms of what Xeon processor they should use?

FS: CAD is notorious for being a single-threaded application, but I have yet to see a CAD user who is single-threaded. CAD users multitask with e-mail, Internet, spreadsheets, word processors, and more, and that doesn't even count what IT adds to a workstation, such as security, system updates, and malware monitoring. A recent study by CATi, a SolidWorks reseller, found that an ideal CAD workstation provides users with a processor between 4 and 6 cores. I would err on the high side.

If you are contemplating a new workstation, I recommend you opt for more cores because new versions of your CAD program will always task more cores as it becomes more complex. An HP Z420 Workstation with an Intel Xeon processor E5-1650 might be an ideal starting spot. It provides users a fast clock rate, 6 cores, and includes enhanced I/O technologies that are typically found in servers. These technologies help applications expedite data movement and provides for better overall performance.

RG: What about 4 core processors?

FS: You can get by with an Intel Xeon processor E3-1245 v2-based workstation. It offers a slightly faster clock, and includes processor-based graphics, but it limits the number of cores to 4 and does not include the enhanced I/O technologies found in Intel Xeon E5-1650 processor-based HP Z420 Workstations. This new processor not only gives users twice the memory bandwidth, it gives them bandwidth and I/O to support more complex work.

Graphics

RG: Besides core count, what about clock rate, cores, RAM, graphics, or other parameters? Is there a way to optimize my cost to performance ratio by specifying the best Xeon processor?

FS: The clock rate is, of course, important but core count, memory, and graphics are the more surprising parameters.

CATi found that if you skimp on memory you will probably reduce your productivity by more than 2X. So, for about \$70 of memory (2X 4GB memory sticks) you could double your current productivity. When buying memory, CATi suggests looking at how much memory your largest model requires and then purchase twice that amount, in order to get the most from your HP Z Workstation.

It's a simple rule: Do not skimp on memory.

Regarding graphics, even though we all might like to say we have the biggest, baddest graphics card that money can buy, it may not be the best investment. While there are a few users that will benefit from the ultra-high-end cards, most CAD users will be just fine with an entry-level graphics card, such as an Intel HD P4000 graphics on the Xeon E3 processor.

I'm not alone here. CATi also found that most users do *not* need the highest end graphics card. Their test found that a high-end graphics card can cost users up to 12X more and deliver only 6% more in performance 6Gb per second, potentially doubling disk throughput. Ouch!

From my point of view, if you're a typical CAD user, you should have a system that works for the whole user experience, including adequate processing speed, between 4 to 6 cores, appropriate graphics, and SSDs. With this, you'll end up with a very productive system that will help you explore more models in less time that you ever had before.

HD Graphics

RG: How can I tell if HD graphics is adequate for my needs versus a higher end graphics card?

FS: If you are typical CAD user and you don't perform simulations, renderings, or

photorealistic imaging, then an HP Z1 or HP Z220 with Intel HD P4000 graphics has the potential to be an ideal platform. The Intel HD P4000 graphics is designed to be a workhorse for the typical CAD user and it is only available on the Intel Xeon Processor E3-1200 v2 product family.

RG: Where do you see Intel HD P4000 graphics fitting in with respect to CAD tools available in the market?

FS: If you run Autodesk AutoCAD, Inventor, and Revit; Adobe® Premiere® Elements; Adobe® Photoshop®, SolidWorks and other similar volume professional software applications, then the Intel Xeon processor E3-1200v2 product family with Intel HD Graphics P4000 is a solution to consider.

RAM

RG: So, HD graphics could be a way to save a few dollars that could be put into performance enhancing RAM then?

FS: Exactly, and if you already have the RAM, then buy an SSD. When you make investments that way, you create the balance I am talking about and that balance accelerates your entire workflow.

Solid-State Drives

RG: I'm seeing more workstations using SSD technology. How do SSD devices factor into specifying the processor?

FS: Great question. Let's go back to Ivy Bridge and the introduction of the Intel Xeon processor E3 1200 v2 — the processor found in HP's Z1 and Z220 Workstations. With v2, you get what is known as SATA 3.0 technology, which supports up to a 6Gb/s transfer rate. The previous generation only supports SATA 2.0 and a transfer rate 3Gb/s.

If your applications are really I/O bound, then consider using workstations such as HP's Z620 and Z820 because they are based on the Intel Xeon processor E5 2600 product family and support an enhanced I/O infrastructure that is even more robust than the Intel Xeon processor E3 1200 product family.

RG: The impact of SATA 3.0<sup>4,5</sup> hasn't gotten much press but it has a big impact on throughput. Could you expand on this a bit?

FS: Yes, the Intel Xeon E3- and E5-based workstations all support SATA 3.0 and up to 6Gb per second, doubling disk throughput. When combined with SSD devices like the Intel 520 series we are pushing read and write performance to new heights.

These new SSDs are very fast and they are the most affordable ones to date. The CATi study suggests that users can double productivity with an SSD using SATA 3.0 technology.

## Analysis/Higher-End User Needs

RG: Now let's examine the analysis/simulation user's processor requirements. How do things change for these users?

FS: These users employ applications that use all of the resources available in a workstation — they love cores and should consider a dual processor HP Z620 or Z820 Workstation with either an Intel Xeon E5-2670 or Intel Xeon E5-2667 processor. These processors provide users the opportunity to solve fairly large and complex problems right at their desk. We use systems like these at Intel and have seen an engineer's productivity increase by as much as 4X.

Dual-Socket Support

RG: So, the dual socket (supporting two processors) really does make a big difference?

FS: In the right situation, a dual socket workstation is an ideal innovation platform,

helping users explore more ideas in less time.

RG: Do all the parameters we talked about like RAM and SSDs still hold true?

FS: Yes. Perhaps even more so as getting data to more processors becomes even more important. Many simulation codes write intermediate results. If you do this to an SSD, you see those results faster.

## Heavy-Duty Rendering Users

RG: Now we arrive at the heavy duty rendering users. What's the right workstation formula for them?

FS: No surprise here — more cores is the way to go. Typically photorealistic imaging is all about ray tracing and many of these plug-ins used by CAD applications take advantage of more cores. Some may benefit from high-end GPU technologies, but most are CPU-based. In a study by Luxology, a ray tracing ISV, it found that the performance of ray tracing that uses global illumination algorithms is slightly faster on a CPU versus a GPU. So, it is a toss up.

I want to be consistent here. I have talked a lot about the need for a balanced system — a balance between resources is what gives users the opportunity to have the best possible design experience. It's also important for a system to be flexible. Engineers and architects use an array of high-computation software. Processors now offer users more opportunity for flexible performance across a broader array of uses.

### Benchmark Debate

RG: Would it be worthwhile to benchmark workstation configurations based on the rendering tools used?

FS: To be honest, I am not a fan of benchmarks, although at times they are a necessary evil. That said, I think users and IT managers must be honest; they must make sure they need what they are buying.

If you only work with CAD, then a single-socket workstation with one processor and an entry-level graphics card is probably adequate. Sure, more cores would be better if you mega-task through an array of tools, and the best graphics would be ideal if you work with advanced features all the time. But, most people do not. The CATi study found that if users create a balanced system and have the OS and application tuned properly, users can gain a performance increase of 5X. It is all a matter of balance.

### Cooling Technology

RG: What about thermal management or liquid cooling systems in multiple processor workstations? At what point should I start considering these options?

FS: Processor speed and thermals go hand-in-hand — the higher the clock frequency, the hotter the chip. The new HP Z Workstation processors all support Intel Turbo Boost Technology 2.0. This technology automatically allows processor cores to run faster than the base operating frequency, if they're operating below power, current, and temperature specification limits. Hardware developers spend a great deal of design time and investment around the infrastructure of the system to manage how it moves air through the system to achieve the lowest possible temperatures. In some very high power, high clock-rate systems with lots of heat producing components, liquid cooling might become necessary.



The HP Z820's internal air guides move cooling air through the chassis to achieve optimum cooling allowing processors to run faster.

#### Processor Cache

RG: I notice that the processor caches are getting larger. How much does the larger onboard caching boost performance?

FS: I have been around workstations and CAD for the better part of 32 years, and I have always heard from engineers that cache is king with CAD. To be honest, I have never asked for a benchmark to support this claim, but I have heard it enough to believe that cache probably IS king, although I suspect other investments such as memory, SSDs, and more cores are potentially more important in delivering best overall user experience.

#### The Five Main Specs

RG: If you had to sum it all up into a concise recommendation, what would you tell users to consider when specifying processors for new workstations?

FS: That's simple — it's all about balance. To address that concept, here are five areas Intel looks at when analyzing workstation needs.

##### 1. Processing Capacity

- Does your application use multiple cores<sup>3,6</sup>? If it does, buy a system that allows you to maximize your Intel Xeon based cores.
- If your application has limited scalability, then focus on frequency. Or do what we do — at Intel we run multiple instances of the same software to increase the number of iterations we can explore in the same time period. When we work that way, our engineers can increase their productivity by over 4X.

##### 2. Memory Capacity

- As CATi suggests, don't skimp on memory! The \$70 you save might cost you more than double productivity.

##### 3. I/O Capability

- Do your models take a long time to load? If they do, explore two things: the impact of an SSD and the impact of faster network interface controllers (NICs).

##### 4. Graphics

- It is not always to your advantage to over buy on graphics. Yes, industry

standard benchmarks may lead you to the conclusion that more is better, but as the CATi study suggests your typical user may be able to benefit more from other investments.

5. Never Use Default Settings

- o It is always dangerous to use default settings when designing a workstation. Test the system using a variety of settings and see what gains are possible — you will be surprised.

### Cost Justification

Now, everyone who uses CAD would obviously love an HP Z820 workstation with 16 cores, tons of RAM, and a huge solid state disk but the trick is getting your company to actually buy that sort of machine. And, even for modest upgrades like a processor with more cores, additional RAM, or an SSD, you have to quantify how much time savings a faster machine can generate and then convert the time savings into dollar savings.<sup>7</sup>

Here we see a chart that converts minutes saved per day into dollars per year depending on labor rate. This chart assumes 240 work days per year (48 weeks at 5 days/week).

		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)					

Let's imagine an example like this:

An employee who does detailed rendering work for a variety of clients requires an average of 9 hours per day to complete their tasks. If purchasing them an \$8,000 workstation (sounds like a lot, right?) saves 45 minutes per day and the full labor rate of the employee averages to \$60/hour, then here are some of the conclusions we can readily arrive at:

- The chart shows \$14,400 in savings is generated per year.
- The faster workstation will be used for at least two years — we see that the cost savings is actually at least \$28,800 over the span of two years.
- Purchasing the employee an \$8,000 workstation returns \$28,800 in savings over two years for a total profit of \$20,800.

So now the question becomes, will we invest \$8,000 to get \$20,800 over the next two years? I can tell you from experience that the answer to this question will be a resounding YES when management understands the payback.

Of course there are other intangibles in our example case that are harder to quantify, like:

- Can we get better quality renderings in addition to faster delivery?
- Can we process more iterations of a rendering?
- Can we do more projects in a "same day" timeframe to respond to clients faster?

Can we make our clients happier with our new, faster/better rendering services?

What are these benefits of faster computing worth to you?

## Wrapping Up

With new HP Z Workstations, based on the latest Intel Xeon processors a whole new level of speed, throughput and productivity are possible. For those who make their living doing CAD, analysis, simulation and rendering tasks isn't the performance worth it? The more you consider it, the more you'll realize that budget computers don't save you money, they cost you productivity. High-end processor equipped workstations don't cost you, they pay you back in time savings.

It is my hope that our exploration of the expanded capabilities of the latest Intel Xeon processor family can maximize the performance of your HP Z workstation and how to make configuration choices based on the type of work you do.

**Author's Note:** *I'd like to thank Intel's Frank Soqui for agreeing to our interview.*

## About the Author

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