

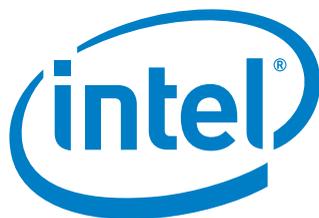
Maximize SOLIDWORKS Performance

Performance can be dramatically improved with cost effective hardware upgrades and simple configuration changes.

A Study by:



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EXECUTIVE SUMMARY

Dassault Systèmes SOLIDWORKS has helped millions of designers bring products to market, but not every user is obtaining the full benefits of the design engineering software. The problem: sub-optimal computing environments that slow down the performance of SOLIDWORKS and other design solutions, causing a drag on the productivity of valuable employees.

Running SOLIDWORKS on an optimized and correctly configured workstation allows for faster design iterations, improved productivity, greater creativity and more innovation for SOLIDWORKS users and their employers. What's more, these optimized workstations don't have to be a drain on your departmental budget. In fact, critical improvements in performance can be achieved with a relatively low investment.

The Latest Research

So how do you know what the optimal workstation configuration is for your own team of SOLIDWORKS users? SOLIDWORKS reseller Computer Aided Technology (CATI) has, through years of testing and research, come up with an answer — or answers, as it turns out, because “optimal” performance will vary by end user. For more than 20 years, CATI has provided training, installation, configuration services and support to SOLIDWORKS users. And for the past seven years, the company has embarked on a lengthy and intensive research project to determine the best hardware environment for SOLIDWORKS software in order to ensure maximum productivity.

For its most recent research, CATI designed a series of rigorous tests using typical workstation configurations and ran them using customer-supplied test models of increasing complexity and size. They then ran a standard series of SOLIDWORKS operations on those models representing commonly performed work tasks.

The Optimal Computing Environment

CATI has outlined an optimal computing environment for SOLIDWORKS that can significantly improve performance. By investing in an Intel® Core™ i7-based CAD workstation environment with sufficient RAM, a solid state drive, fast processors and robust graphics, users can increase SOLIDWORKS productivity enough to provide a return on investment in months or even weeks through accelerated design operations.

There is no single best answer for improving SOLIDWORKS performance, but CATI has developed a methodology that can point to the most practical and affordable configurations based on model size and complexity, as well as graphics operations. Using their research as a guide, users can quickly identify hardware improvements that can immediately boost design productivity.

About CATI

Computer Aided Technology (CATI) was founded in 1992 by engineering and manufacturing professionals as a one-stop, full-service provider of scalable design and manufacturing solutions, including 3D solid modeling and analysis, enterprise-wide data management, and additive manufacturing. CATI is the nation's original resource for SOLIDWORKS. The company prides itself on providing outstanding support and services through a dedicated team of professionals. CATI's two wholly-owned subsidiaries, Inflow Technology and Strategic Technology Solutions, serve customers worldwide.

DEFINING THE RESEARCH METHODOLOGY

For its most recent round of CAD workstation configuration testing, CATI took a slightly different approach than in previous tests. In those earlier tests, CATI loaded a large assembly and created a macro to run repeatable SOLIDWORKS functions against the assembly. The macro was performed on the baseline hardware configuration, and then repeated as different elements (such as the amount of RAM or the number of cores) were changed. The models were identical every time the test was run.

“Our data in the past was skewed toward people who really pushed the machines hard,” says Adrian Fanjoy, CATI's technical services director. To provide a broader range of recommendations for users with different levels of assembly complexity, CATI developed a testing program that allowed them to test seven different model assembly sizes and five different levels of image quality. Assembly sizes ranged from 94 components to more than 20,000 components. The different sized assemblies are dropped into an existing base assembly, so that the same operations can be run each time.

The application programming interface (API)/instruction set was also altered to test computational work (such as modeling, rebuilds, etc.) separately from graphics functions.

The instruction set was meant to mimic operations routinely performed by CAD users, and included:

- Opens
- Rotations
- Modeling
- Rebuilds
- Switching Sheets
- Saves
- Closes

“The benchmark runs much faster this time around,” Fanjoy says. “We're doing part modeling, adding components into the model, patterning features and parts, editing of features, and some deletion and creation of features at the part and assembly level.”

CATI also focused on specific workstation variables this time,

primarily the amount of RAM and the processor speeds, which also simplified the benchmark testing. Each assembly size was tested against these different workstation configurations to measure the amount of time it took for the API/instruction set to run.

The testing also required a flexible and scalable hardware platform that could be reconfigured easily to maintain the level of consistency needed for the study. As in the past, CATI partnered with workstation manufacturer BOXX Technologies.

BOXX Technologies provided an APEXX 2 workstation with an Intel solid state drive (SSD) and one four-core Intel Core i7-4790K series processor running at 4.06GHz (4.5GHz when overclocked). CATI tested memory up to 32GB of RAM and several graphics card configurations. Overall the workstation is faster than previous models used for testing, but with fewer cores.

In addition to simplifying the instruction set, CATI also reduced the number of hardware variables it tested against. “We have a more general knowledge now of what will affect performance,” Fanjoy says. “Everybody knows that SSD is the way to go, and we know that we don't need more than a reasonable number of cores, and we took out the very high range of graphics cards. We focused on what actually makes a difference in the environments we currently work in.”

To gauge the effect of changes in the workstation, CATI assembled a baseline configuration for the APEXX 2 workstation.



About the Hardware

CATI used a BOXX Technologies APEXX 2 workstation to run its tests.

APEXX 2 Specifications:

- Intel Core i7-4790K processor with 4 cores; 4.0GHz overclocked to 4.5GHz
- Up to 32GB of RAM
- Intel 180GB solid state drive (SSDSC2BW180A4)
- NVIDIA Quadro K2200 Graphics Card

BASELINE WORKSTATION ENVIRONMENT

WORKSTATION	OPERATING SYSTEM/ SOLIDWORKS SETTINGS	MODELING TECHNIQUES
Intel Core i7-4790K Processor with 4 cores at 2GHz	Windows 7, 64 bit	Image quality set to 25%
6GB RAM	Windows visuals at default setting	High level of detail in models
Swap managed by operating system	SOLIDWORKS 2015 SP0	Large number of top level mates in larger assemblies
SSD Hard Drive	SOLIDWORKS options set to default	External references
Files stored locally; no antivirus	SOLIDWORKS Add-Ins on: Tool- box and Toolbox Browser	Complex assembly structure that was several levels deep

CATI researchers modified this baseline workstation environment with additional RAM, different graphics, processor overclocking and various modeling techniques to gauge how those modifications would affect SOLIDWORKS performance.

THE FINDINGS

Processors: Speed Matters

Professional workstations come standard with multicore CPUs, but as CATI has found in the past adding more cores doesn't necessarily provide a big benefit to SOLIDWORKS performance. Generally speaking, four cores are enough for most users. SOLIDWORKS uses up to two cores, and the OS and other applications can use the other two. If you are engaged in simulation, rendering or other intensive applications, then additional cores may be necessary.

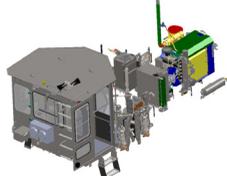
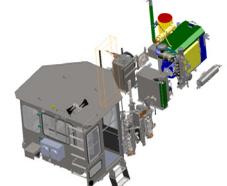
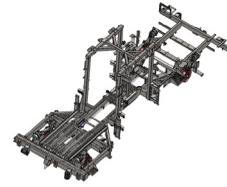
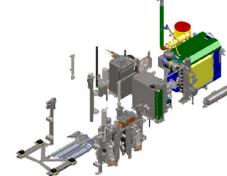
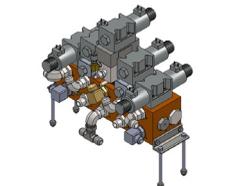
For SOLIDWORKS-only environments, using four cores instead of two will net a performance improvement of 14.4%. Research CATI performed in previous years showed that moving from two to six cores only provides a 14.8% improvement in speed. Adding more cores is most beneficial when perform-



ing simulation or photo rendering tasks, and can be helpful running simultaneous applications such as enterprise resource planning (ERP) solutions, Outlook or other office applications.

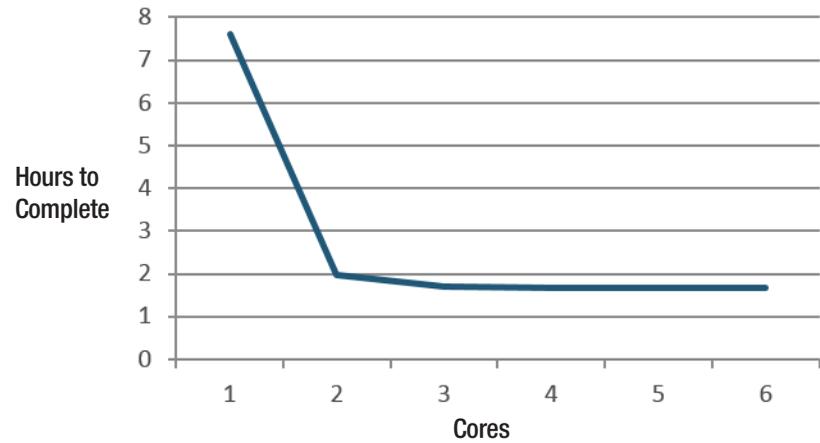
What is more important for SOLIDWORKS is the speed of the processors. CATI tested processor speeds ranging from 2GHz to 4.7GHz across all seven assembly sizes

THE MODELS

MODEL	COMPONENTS	UNIQUE COMPONENTS	NUMBER OF BODIES
#1 	20,960	2,440	29,978
#2 	10,479	2,440	14,989
#3 	8,067	1,916	9,935
#4 	5,468	1,530	10,356
#5 	1,585	736	6,475
#6 	1,854	569	1,684
#7 	94	34	90

CATI tested seven models of various sizes provided by Racine Railroad Products.

Compare Cores



Moving from two to six cores only provides a 0.4% improvement in SOLIDWORKS compared to moving from two to four cores. However, multi-tasking, performing rendering and simulation can all benefit from additional cores.

using 32GB of RAM and no graphics manipulation. “What we found was that, regardless of assembly size, the processor gave you a compelling performance boost with each increase in speed,” Fanjoy says.

That improvement ranged from 7.5% to 9% per each 0.5GHz bump in speed. There was no discernable difference in this improvement among the small and large assemblies.

The “practical zone” for processor speed is between 3.5 to 4.5GHz. This zone allowed the system to run the largest assembly 18% faster than the baseline, and the smallest assembly ran 19% faster than the baseline.

While having more than four cores provides a negligible improvement in terms of SOLIDWORKS

performance, adding cores can have a big impact when it comes to simulation and rendering. According to CATTI’s previous research, simulation flow improved by 17% when moving from four to six cores, while moving up to 16 cores provided a 29% improvement. For photo rendering, going from four to six cores again provided a 17% improvement in speed. Moving to 16 cores provided a 74% improvement.

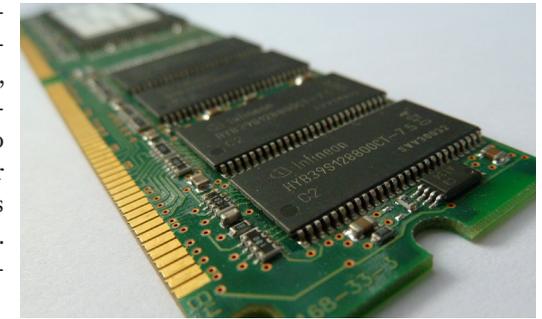


Image: Laserlicht, Wikimedia Commons

RAM: Get All You Need (and a little more)

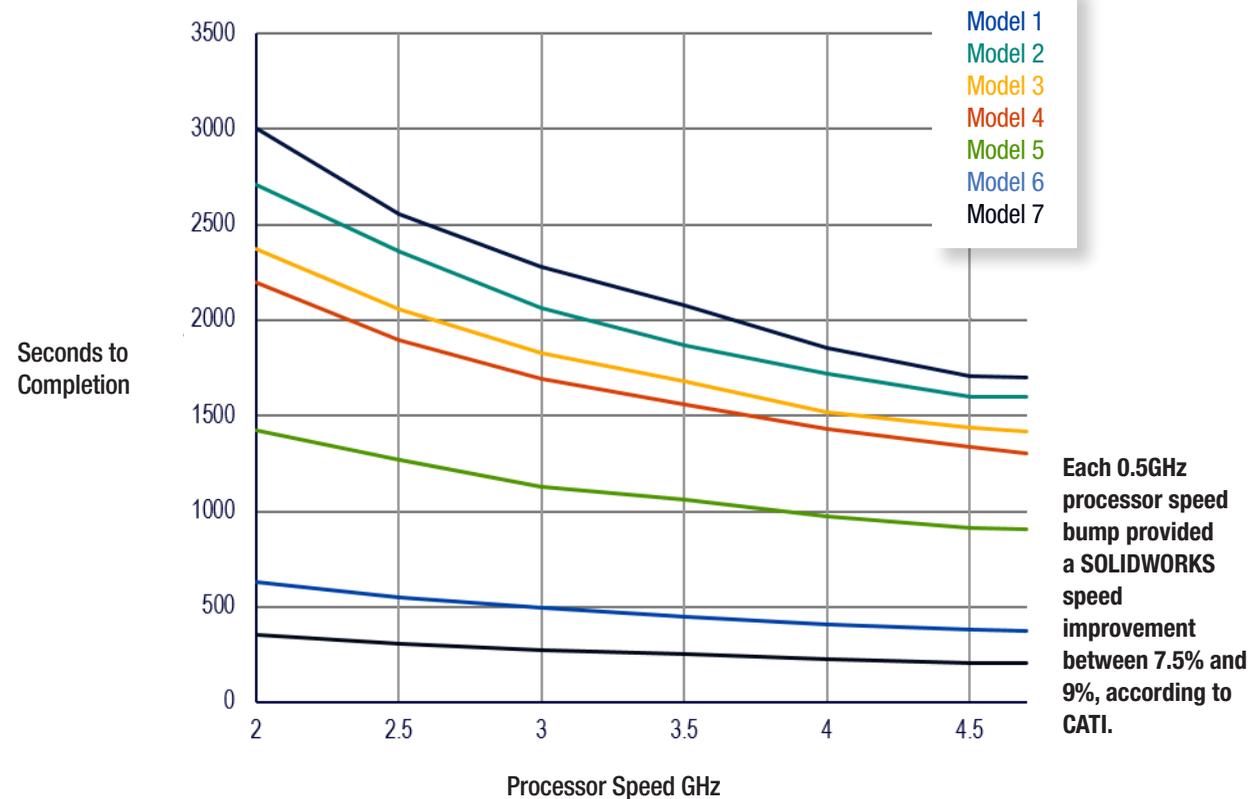
Even having a fast processor doesn’t guarantee optimal performance if you don’t have enough RAM (random access memory). As it turns out, the workstation element that can have the biggest impact on performance also happens to be the least expensive to upgrade.

As a general rule, have enough RAM to avoid swapping — the borrowing of a segment

of hard drive space to store and retrieve active data when there isn’t enough RAM. Swap operations cause system slowdowns, particularly if you don’t have enough RAM to accommodate very large assemblies.

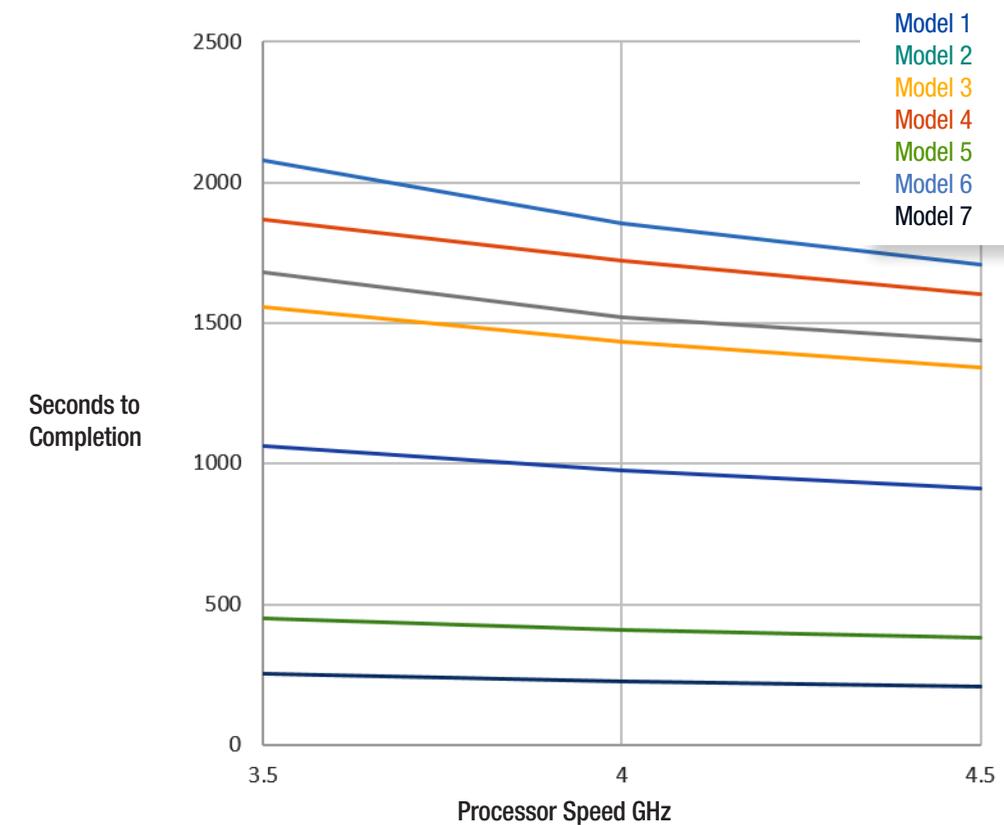
If your workstation is using swap for RAM, it will slow down the workstation, and can create OS and stability issues as well. RAM is critical for performance, and every size assembly has a different requirement.

Processor Speed Improvements



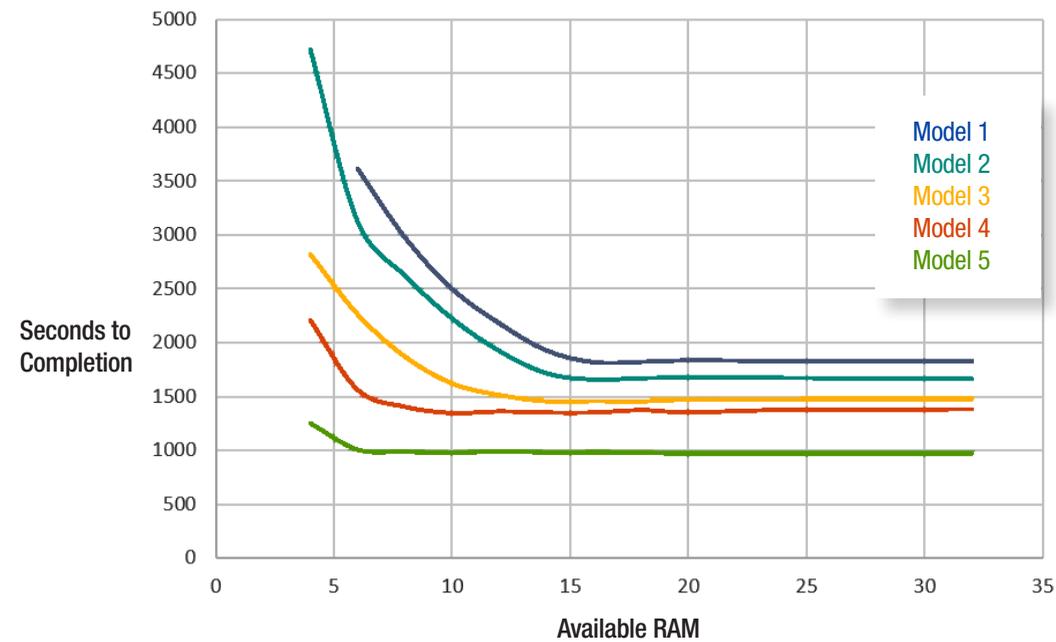
Each 0.5GHz processor speed bump provided a SOLIDWORKS speed improvement between 7.5% and 9%, according to CATTI.

Processor Practical Zone



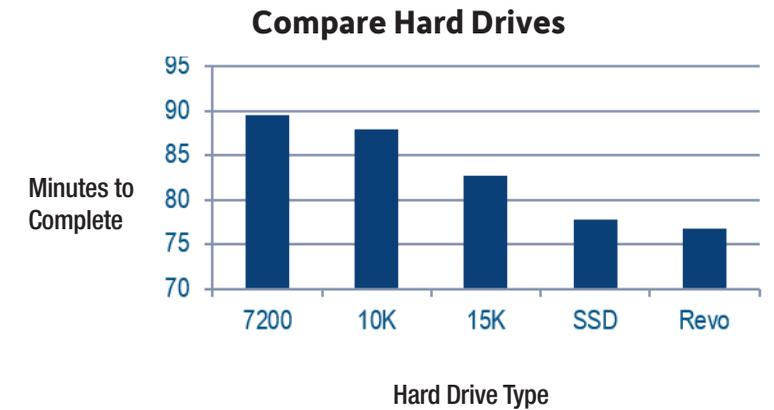
CATTI’s research showed that processor speeds between 3.5 and 4.5GHz allowed the system to run the smallest assembly to run 19% faster and the largest assembly to run 18% faster than the baseline.

RAM Configurations



CATI's research shows anything beyond 16GB of RAM is not necessary to improve SOLIDWORKS performance. However, RAM is inexpensive and moving to 32GB of RAM to help other computing processes.

Hard Drive Comparison



The price to performance ratio of solid state drives (SSDs) make them a no-brainer for engineering workstations.

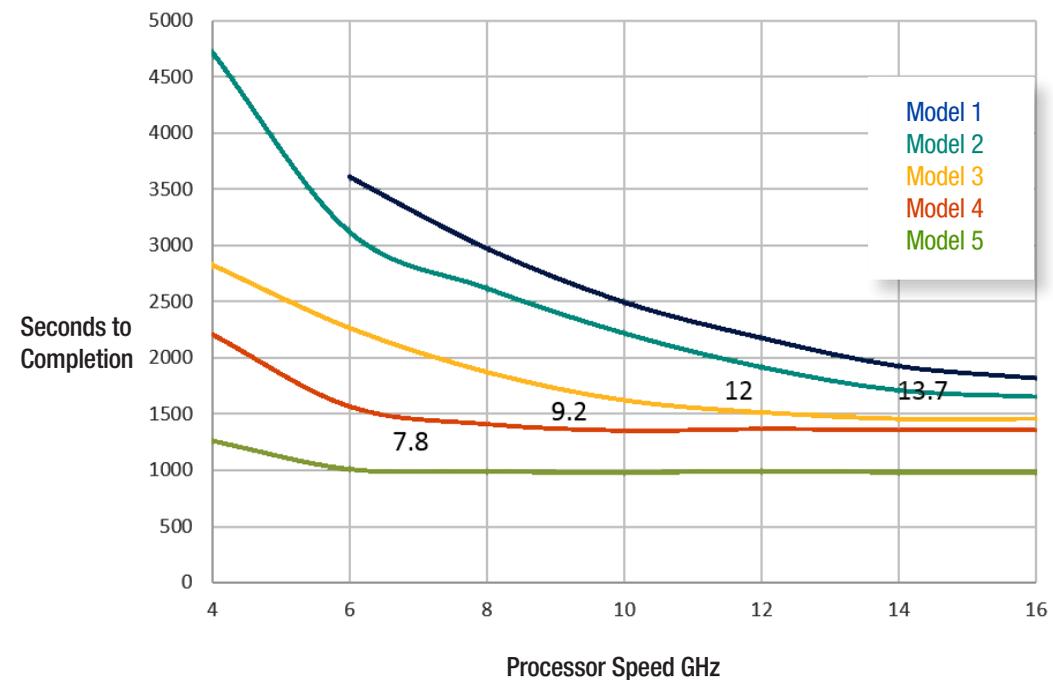
CATI's benchmark was run with five different assemblies, 11 different RAM configurations, no graphics manipulation, four cores running at 4.5GHz, and using the SSD for operation and storage.

CATI found that each size assembly eventually reached a "flatline" beyond which adding more RAM made very little impact on performance. According to Fanjoy, 16GB of RAM will be sufficient for almost all assemblies. Each assembly tested flatlined at a specific amount of required RAM, meaning that adding more RAM beyond the required amount achieved no discernable performance benefit. None of the tested assemblies, even the 20,000-component assembly, required more than 16GB to perform optimally.

"You need to have some pretty gigantic assemblies to require more than 16GB of RAM," he says. "Even when we doubled the number of components in an assembly, we didn't need more than 16GB of RAM."

Because RAM is now so inexpensive, overbuying is still a better bet than underbuying. Just keep in mind that while moving from 16GB to 32GB of RAM is relatively inexpensive, doing so will not necessarily net a significant performance improvement in SOLIDWORKS.

Model Methodology



The size of your SOLIDWORKS model largely determines the optimal amount of RAM, up to 16GB.

Solid State Drives Are a Given

A solid state drive is largely the default state of professional workstations at this point, and CATI has opted not to test traditional spinning hard drives any longer. All of the models in the current round were tested on an SSD, in fact.

The reason: An SSD provides a significant performance improvement over a traditional drive at relatively little cost. In previous tests, CATI found that moving from a 7200 RPM hard drive to an Intel SSD improved performance by as much as 15%. Using an SSD for local file storage netted a 68% improvement. That saves hours of run time, at a cost of less than a few hundred dollars.



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GRAPPLING WITH GRAPHICS

The most recent CATI study separated graphics from computational functions during testing. Measuring performance of a graphics card in a CAD environment is difficult to do. The criteria are subjective and hard to isolate. In reality the “feel” of the model as it rotates and the quality of the image are the aspects of the deliverable that matter. Fortunately quality is easy to adjust with the Level of Detail option in SOLIDWORKS. However, the “feel” has to be inferred relative to the frames per second (fps) that are being displayed by the graphics card.

The challenge is determining how many frames per second are required to allow the user to experience a smooth transition while spinning the model with a quality level that is comfortable — a highly subjective measure. Generally, users want a refresh rate of 15 to 20 fps to maintain image quality and a comfortable “feel.” There are also some boundaries CATI had to keep in mind during testing, the most pronounced being the frequency limit of the monitor being used to display the model. A typical monitor refreshes at 60GHz, implying that any frame rate over 60 would be superfluous.

CATI tested NVIDIA Quadro K620, K2200 and K4200 graphics cards, but there were a number of variables that ultimately affected performance, including assembly size, amount of RAM, level of model detail, image quality and SOLIDWORKS settings. They tested a single part and ran the image quality up in steps from 25% to 100%. They then measured graphics performance in terms of frames per second (fps) of the image quality while in motion. What fps performance the graphics card can provide beyond the refresh rate of the monitor is, in CATI’s terms, overkill.

Where graphics cards make a difference are in single parts with complex geometries and a large amount of tessellation. For the cards tested, moving from the K620 to K2200 provided 69% more fps on average, while shifting from the K2200 to the K4200 provided a 22% fps improvement. However, most of that improvement occurs beyond the monitor’s ability to display it.

For large assemblies, the difference between the three cards was fairly small.

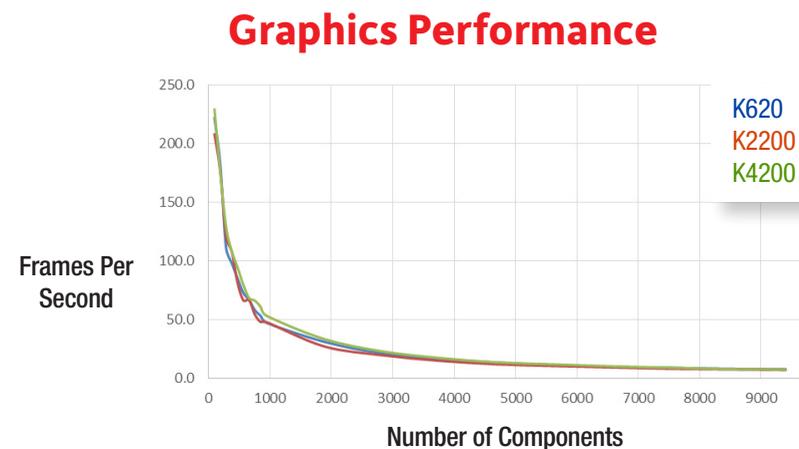
“In the past, we believed that SOLIDWORKS changed its method for managing display data when assemblies reached larger sizes,” Fanjoy says. “We developed a test to determine where this point of change might be and found some pretty interesting data. It doesn’t look to us like the mechanism is changing. It looks like the capabilities change in an unexpected yet extremely predictable fashion.” The graph below shows how predictable the performance is, as well as how closely the different cards performance compares.

For the test, CATI created 19 different assemblies. Each assembly was made from the same base assembly (94 components, 34 unique components, ~127K graphics triangles). CATI used SOLIDWORKS’ Pack and Go functionality to save many different replicas of this assembly with different file names to ensure that SOLIDWORKS would view each identical assembly as unique. CATI then used these assemblies to create

different sized assemblies for testing.

CATI found that as the number of graphics triangles exceeds 1 million, the fps rate drops dramatically for all of the graphics cards tested. For very large assemblies, there was almost no difference between the different cards.

Additionally, researchers tested the impact of the CPU speed on video performance. They documented a 38% improvement in frame rate by moving from a 2GHz processor to 4GHz.



For the cards CATI tested, researchers saw a surprisingly predictable drop in graphics performance as assembly sizes grew.

CONCLUSIONS

CATI’s research findings provide a guide for the changes you can make to your CAD workstation configuration to improve SOLIDWORKS performance. Each user’s requirements are unique depending on their application environment, model complexity, modeling methods and other factors that impact workstation performance.

Guidelines

Taking into account the effect model sizes have on performance, CATI found that most SOLIDWORKS users could improve performance and productivity by using the following guidelines:

- **Hard Drive:** SSD
- **Memory:** 16GB RAM (More for extremely large and complex assemblies)
- **Graphics:** NVIDIA K2200 Graphics Card
- **Processor:** Single 4-core processor (more cores if you are performing simulation/rendering), with a clock speed as fast as you can afford
- **Software Settings:** A local working directory usually managed by a product data management system like SOLIDWORKS PDM and optimizing SOLIDWORKS options will complete the package.

Optimal vs. Practical

A key distinction CATI made in the current research was the difference between an optimal machine and a practical configuration. The configuration that may give you the very best possible performance may only provide a marginal improvement over a less costly machine that still runs SOLIDWORKS efficiently. The key is to find the configuration that is optimal for your specific environment and application requirements, without purchasing an overpriced unit that will not provide sufficient performance improvements to justify the additional cost. Take a balanced approach to get the most productivity for your investment.

“For example, with processor speed you basically get around a 10% improvement for every half gigahertz you buy,” Fanjoy says. “At some point, there’s a cliff where the cost of the processor goes up exponentially compared to the performance improvement. You have to decide if it’s worth going off that cliff in terms of price. That can become a very complex conversation involving a lot of other factors.”

SOLIDWORKS users also have a myriad of options available now that allow them to balance different types of workstation technologies for different tasks. While the deskside workstation still serves as the “workhorse” for day-to-day design functions, mobile workstations with less horsepower can be used for CAD in the field and on the go by different end users with different levels of skill and computational requirements. Finally, cloud-based solutions can allow designers to tap into more power on an as-needed basis for simulation, rendering and final design without a capital investment in new hardware or software licenses.

Finding Balance

Whatever your needs, there is an optimal, balanced workstation solution available for you. By following the guidelines found in this paper, you can configure a productive, affordable CAD workstation suited for your specific environment.

APPENDIX

Intel Workstation Information:

intel.com/workstation

Intel Workstation Configurator:

intel.com/content/www/us/en/workstations/workstation-configurator-tool.html

Maximize SOLIDWORKS' Performance, June 2012:

deskeng.com/de/maximize-SOLIDWORKS-performance-white-paper/

CATI Tech Notes:

blog.cati.com/SOLIDWORKS/