



## Executive Overview

The Albert-Battaglin Consulting Group (ABCG) investigated the 64-bit capabilities offered in Dassault Systèmes' CATIA V5 R16 product (CATIA V5) running under Microsoft's XP Professional x64 Edition operating system on an Intel® Dual-Core XEON® 64-bit based workstation. ABCG conducted a multi-day customer benchmark to capture typical production case studies to reach its conclusions.

ABCG found three important areas where PLM processes can benefit from this new capability:

- Digital Mock-Up (DMU) of large assemblies
- Generative drawing generation from very large assemblies
- Finite Element Analysis (FEA), especially involving assemblies

In all of the above areas, ABCG observed that 64-bit CATIA V5 allowed successful completion of large problems, which could not be handled using 32-bit implementations. ABCG also found significant performance increases in completing common tasks and up to 6 times faster computation solving FEA problems. These capacity and performance advantages can be used to design new processes within companies to reduce time to market and improve product quality.

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--Jean-Paul Rigg – Hydro Quebec

According to Jean-Paul Rigg, Director of Generation Engineering at Hydro Quebec “The capacity and performance benefits of 64-bit computing with CATIA V5, on cost effective Windows & Intel based workstations will help Hydro Quebec to move forward with true 3D digital processes, which are key to our engineering strategy”.

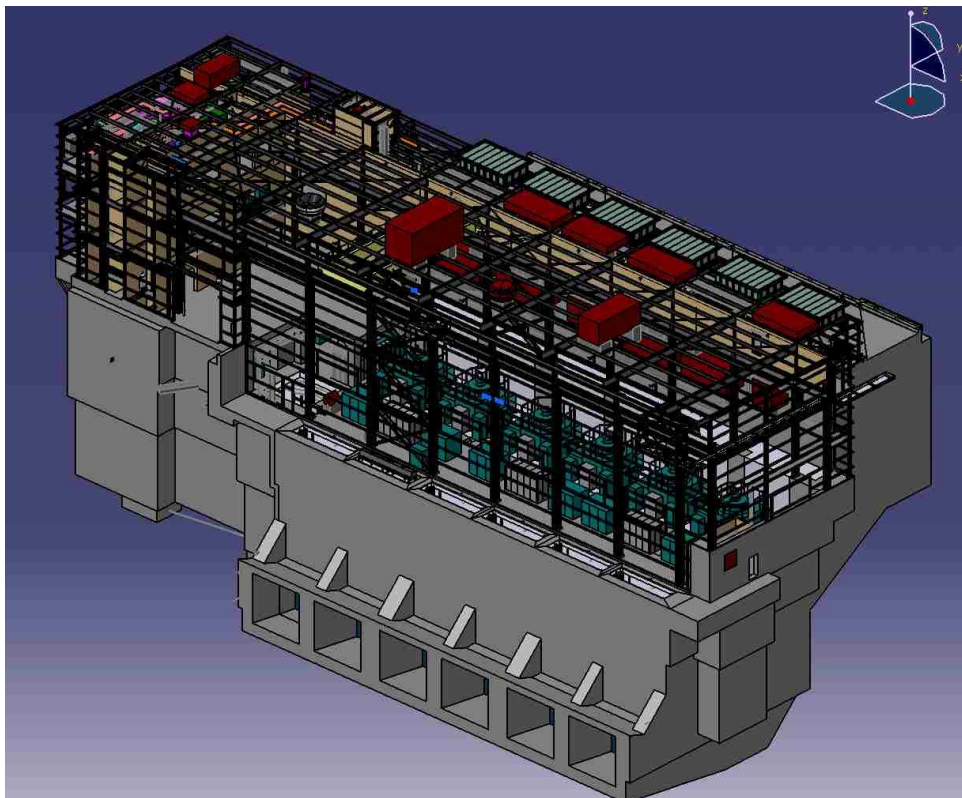
By increasing the amount of data 64-bit CATIA can handle, especially in a DMU context, the customer was able to create mockups of a complete complex installation, performing fly-throughs and clash detections. Using the entire product mockups eliminated error-prone and time-consuming work-arounds. In a similar fashion, 64-bit V5 R16 simplified the process of creating assembly drawings, allowing drawings to be automatically created of these very large, complex products not possible with 32-bit implementations. The new 64-bit support removed any hard limitation on meshing and analyzing a key design component Analysis of this critical aspect at the very high desired accuracy was not possible with 32-bit V5. The following chart summarizes some of the performance gains measured during the benchmark.

Summary Chart of Performance Benefits of the 64-bit Environment

|                                  | 32-bit environment | 64-bit environment                        |
|----------------------------------|--------------------|---|
| FEA Analysis                     | 1 (baseline)       | 4.8x – 6.5x                               |
| DMU Loading (design mode)        | 1 (baseline)       | 1.9x – 2.5x                               |
| DMU Loading (visualization mode) | 1 (baseline)       | 1.1x – 1.6x                               |
| Save 3D-XML                      | 1 (baseline)       | 2.4x – 4.0x                               |
| Generate large complex surface   | 1 (baseline)       | 4.3x                                      |
| Photo rendering                  | 1 (baseline)       | 1.8x - 6.9x (depending on number of CPUs) |

Although this testing did not seek to validate the entire PLM environment, initial testing verified that the customer’s Smarteam client implementation, including customer specific macro enhancements did work correctly with 64-bit CATIA V5. In addition, the customer CATIA Visual Basic macros tested worked on the 64-bit version without modification. These are important considerations to verify when integrating 64-bit technology in existing computing environments.

Overall, ABCG recommends using 64-bit technology in selected processes to access the performance and capacity benefits.



**Picture 1 – Power Plant DMU Model**

## Background

The power of 3D PLM is the enabling of true digital processes throughout a product's lifecycle. The effective utilization of a complete digital product definition continues to deliver faster time to market, better quality, and lower costs than conventional processes. As the capabilities of PLM systems have increased over time, so have the complexity of designs to which it is applied. Problems that were impractical a few short years ago on the fastest computers available are now tackled with desktop systems on a daily basis. Still, systems have had their limitations, and one such area of concern centers on 32-bit memory addressing. ABCG has studied the impacts and benefits of new 64-bit memory addressing capabilities available in Dassault Systèmes's CATIA V5 Release 16 in conjunction with Microsoft's XP Professional x64 Edition operating system and with Intel Dual-Core Xeon® processors 5100 Series.

Until R16, Windows versions of CATIA V5 used 32-bit memory addressing in all modules, which implied a theoretical limit of 4GB of addressable memory space. In ABCG's testing, this limit is closer to 1.9 - 2.5 GB depending on operating system and configuration. Using a 64-bit implementation the addressable memory space is 16 terabytes (TB) with a physical memory limit of 128GB. This extra memory means more capacity - the ability to load vast amounts of data into main memory - and consequently greater performance for CATIA users.

To ascertain the benefits of the new 64-bit capability for customers, ABCG spoke with other PLM specialists and worked with customers using CATIA V5 in production.

ABCG's study found three areas where the 64-bit would impact customer process the most:

- Large Assembly modeling – DMU
- Drawing generation from assembly models involving section cut and detail views
- FEA – large analysis problems use huge amounts of memory, or when memory is not available, disk space, for solving problems.

ABCG then conducted a benchmark at Hydro Quebec in Montreal using proprietary customer data to quantify and document the benefits of operating in a 64-bit environment. ABCG tested scenarios using both 32-bit and 64-bit versions of CATIA V5 R16 SP 6.

Hydro Quebec is a world leader in hydropower generation. The data sets we tested consisted of very large assemblies of parts representing power stations and generation facilities. These parts sometimes include complex surfaces, such as terrain models or spillway geometries. ABCG believes that these very complex assemblies are comparable to extremely complex design problems that might be found in other industries. Note that this testing focused on the most demanding tasks available, which require more capacity than average tasks in most industries.

## Test Machines

The following table shows the operating environments used for the testing. Both of the machines used for testing were certified for CATIA V5 by Dassault Systèmes. The 32-bit environment was selected as to represent typical workstations in use by Hydro Quebec today. All testing was run with software, licenses and data local (no network). All tests were made using CATIA V5 R16 SP6.

|              | 32-bit environment                | 64-bit environment                        |
|--------------|-----------------------------------|---|
| Make & Model | IBM IntelliStation M Pro 6230-39U | HP xw8400                                 |
| OS           | Windows XP Pro                    | Windows XP Pro x64                        |
| CPU(s)       | 1x Intel® Pentium® 4<br>3.0 GHz   | 2x Dual-Core Intel® Xeon® 5150<br>2.66GHz |
| L2 Cache     | 512K                              | 4MB                                       |
| RAM          | 3GB 333MHz SDRAM                  | 16GB 667Mhz DDR                           |
| System Bus   | 800Mhz                            | 1333Mhz                                   |
| Graphics     | NVIDIA Quadro FX 3000             | NVIDIA Quadro FX 3500                     |
| Disk         | 36.4GB (10K rpm) Ultra320 SCSI    | 160GB (7200rpm) SATA 3Gb/s                |

## Results

### *General*

The 64-bit CATIAV5 implementation affects only how parts, assembly or FEA models are loaded into memory at run-time. There is no change to how these items are stored on disk. This means that data can be transparently shared between 32-bit and 64-bit implementations as long as run-time memory limits are not exceeded in the 32-bit environment. Because of the way that V5 manages memory, there are cases where performing construction operations or having long design sessions with a part or assembly uses more memory than simply viewing or even measuring the same item.

### *FEA analysis*

The 64-bit CATIA V5 R16 SP6 implementation on Windows XP Professional x64 Edition allows computation of more complex analysis problems than with 32-bit versions. In addition, ABCG measured performance gains of up to 650% in some computations. The ability to solve more complex analysis problems can have an immediate and significant impact on a company's design process. In our testing, we were not able to complete a problem involving 1.4M degrees of freedom (DOF) on the 32-bit system, while the 64-bit machine completed the test in about 14 minutes. It must be noted that the 32-bit failure occurred after more than 1 hour of computation, thus wasting much valuable time. In addition, failures of this type discourage analysts from even attempting complex problems.

ABCG observed another example at a customer site in the aerospace sector. This customer found it impossible to mesh and solve a critical sub-assembly using the desired parabolic tetrahedral elements and mesh size. To work around this limitation, the customer was forced to perform multiple runs of the assembly concentrating each run on a specific component of the assembly that was meshed using tet-10 elements while other components were meshed using tet-4 elements. The results of all of these runs had to be stored and interpreted separately, wasting time and disk space. Using 64-bit CATIA V5, the customer was able to make the entire run using tet-10 elements, creating just one set of results. Not only is this new process faster, but also potentially more accurate as all components are being simultaneously evaluated using the desired tet-10 elements.

Even when the 32-bit system was able to complete the task, the 64-bit machine was an average of 5.8 times faster than the 32-bit system. ABCG testing found that most of this gain was due to the additional memory capacity on the 64-bit machine.

### ***DMU – Large Assembly Modeling***

64-bit CATIA V5/DMU running under Windows XP x64 OS & Intel® Dual-Core Xeon® processors enables V5 users to work with huge assemblies containing thousands or even tens of thousands of components in both visualization and design modes. In testing at Hydro Quebec we were able to open and manipulate complete power station and sub-station designs. This was not possible using CATIA in a 32-bit environment. Even when assemblies could be loaded on the 32-bit system, we found that the 64-bit system was typically 1.5 to 2.5 times faster loading and displaying a CGR or design mode assembly than a 32-bit system. This applied also to opening 3DXML files where we found the 64-bit implementation to be up to 1.8 times faster depending on the assembly.

Loading of complete assemblies has clear process advantages for customers. The primary benefit comes in the area of component collision detection and visualization. Invariably huge DMU assemblies are created by a large number of individuals working in different groups, companies and countries. It is essential that new or redesigned components be checked for inference with the current versions of other components within the total product. In the visualization case fly-throughs, design reviews and presentations are enhanced when the most complete and accurate depiction of a product can be shown. When memory limitations prohibit loading of the total assembly, the customer is forced to pick and choose the components to use for the reviews and presentations. In the case of interference analysis, customers often make multiple interference runs of a specific component against each sub-assembly of the total product. In addition to being time consuming, these approaches can lead to errors or misinterpretations if important components or sub-assemblies are left out.

Most customers work using cache mode for large assemblies. Cache mode uses “CGR” representations to insure optimal performance. In some cases, such as cable and harness routing, or when creating or editing assembly constraints, it is desirable to work in “design mode”. When using design mode, additional model information is loaded into memory, in order to maintain performance. In ABCG’s testing, design mode representations typically required 3 to 7.5 times the memory required for cache mode representations. The new 64-bit V5 implementation allows even the largest assemblies to be used in “CGR” or “Design” modes depending on what is more appropriate for the task at hand, giving the user access instant access to all required data for their design task

In our testing we also measured 3D clash and interference detection on large assemblies. In our testing the 64-bit CATIA system was 1.8 times faster then the 32-bit configuration.

### ***Drawing generation***

Automatic multi-view drawing generation is an important process in most companies. 64-bit CATIA V5 allows creation of drawings previously impossible using 32-bit implementations. When memory limitations prevent drawing creation customers are forced to use slow and error-prone work-arounds to complete these tasks. These procedures generally require the creation of several isolated views from subsets of the desired data. These isolated views must be then superimposed upon one another and interactively edited to create a correct drawing. While this is a tedious process, the real problems arise when something in the assembly changes. At this point all of the previous steps must be repeated because no associativity is maintained between the isolated views and the defining geometry.

64-bit CATIA V5 makes this entire process automatic. In our case studies we were able to create multi-view drawings from assemblies which were previously impossible. In one case we created a five view drawing of an entire power station. According to Sylvie Robichaud, project engineer for Tecsuit Inc., creating a single view of one their key assemblies took four

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hours because of 32-bit system limitations and the resulting work-arounds and rework. We were able to create the identical view in less than two minutes using 64-bit CATIA. Ms. Robichaud feels that this technology is a huge benefit because "We want our engineers time spent on complex design optimization, so generating views and drawings rapidly is of the outmost importance".

### ***Other performance points***

Usability is an important factor when working with any PLM tool. Our testing showed that system performance suffers when systems are pushed to their memory limits. This effect was significantly worse when using the 32-bit configuration. As an example, opening the "Desktop" after loading a large model took 15 seconds on the 64-bit system compared with 25 on the 32-bit configuration. Closing the same panel was instantaneous in the 64-bit environment, but took 8 seconds in the 32-bit environment. In a dramatic example, opening and closing the "Options" dialog took only 1 second on our 64-bit workstation compared with 1 minute on the 32-bit station. While these absolute times may not seem like a lot, ABCG believes that their overall impact on productivity is substantial. When a system is sluggish, engineers can lose their train of thought or become frustrated using the tool. This can lead to situations where engineers are reluctant to use the CAD system themselves, preferring to leave that to "CAD operators". This naturally reduces overall productivity and increases the possibility for communication related mis-understandings and errors. In a similar vein, some work still needs to be done in CATIA on progress indication, function interruptability, and responsiveness. Some functions can take many minutes on these very large data sets and the user needs to know that the program is working, about when the operation will be completed, and have the option to terminate the operation without loss of data if this time is not appropriate.

### ***Multi-core support***

The 64-bit hardware used for this testing was built on Intel® Dual-Core Xeon® processors, newly based on the latest Intel® Core™ microarchitecture. This technology is designed to deliver a higher performance, greater energy efficiency and a more responsive multitasking environment.

In our testing we found two key workbenches, Photo Realistic Rendering and Generative Analysis that benefited from this new Intel microarchitecture.

Testing showed that rendering a complex animated scene, an aerial fly-through, took about 4, 2 and 1 hours respectively using 1, 2 and all 4 CPUs. Note additionally that even with only 1 Dual-Core Xeon® processor, the 64-bit configuration outperformed the 32-bit one by 80%. We also measured some improvement in the FEA code using multiple cores. On a test with 765K DOF, our FEA test measured that compared with using 1 CPU, using 2 CPUs improved performance by 18% and using 4 CPUs improved performance by 37%.

The multi-core architecture might have other advantages that were not evaluated in this study. Some operations on CATIA can be quite long, but multiple cores could allow an engineer to effectively use other applications, such as web-browsers, spreadsheets, word processors, emailing, Voice over IP (VoIP), backup, antivirus etc. while CATIA is “thinking”.

## Conclusions

ABCG’s testing at Hydro Quebec documented significant performance and capacity benefits of using a 64-bit operating environment versus their existing 32-bit environment. While some of the performance benefits measured can undoubtedly be attributed to 64-bit machine’s superior specifications, most of these gains are attributable to the increased real memory addressing capability afforded by 64-bit hardware, operating system and software. The multi-core Intel® Xeon processors, delivered significant performance benefits when using the Photo Realistic Rendering and Generative Analysis workbenches of CATIA V5.

When rolled out, the increased capacity enabled by using 64-bit technology will allow Hydro Quebec and its partners to complete important parts of their design process faster and with higher quality. ABCG does not feel that the benefits measured at Hydro Quebec are industry or product specific. Any CATIA V5 user working with very large complex assemblies or doing FEA analysis should benefit from this technology. On a subjective note, users were certainly enamored with the performance of the 64-bit workstation, they all wanted one for their own work.

## Recommendations

- Test 64-bit CATIA V5 in your operating environment – Our testing focused on using 64-bit CATIA V5 in a stand-alone mode. You will need to verify that other applications, utilities, drivers, etc. in your PLM environment work correctly with Windows XP x64 and 64-bit CATIA V5.
- Start evaluating 64-bit CATIA V5 now - ABCG recommends that CATIA and DMU users begin working with 64-bit CATIA for large memory intensive tasks. The Windows Task Manager Performance tab can be used to monitor the memory requirements of your CATIA V5 activities. If any failures occur when Total Commit Charge values are in the 1.9+ Gb range, you definitely need to try a 64-bit environment.
- Get enough memory - For FEA, where performance is important, we recommend 8GB - 16GB of memory or more. The size of the factorized matrix of problems you typically work on is a good indication of the amount of memory you can use to optimize performance. For DMU users we would expect 4GB – 6GB to be sufficient for nearly all work. Drawing generation is another area that can consume large amounts of memory. A DMU assembly that requires 700MB of memory to load can use 6GB – 8GB+ of memory to create a drawing. Naturally you can substitute disk swap space for memory, but you will certainly pay a performance penalty. Note that using 64-bit CATIA can require somewhat more memory than running the same task using 32-bit CATIA.
- Ensure sufficient disk space - we used 20GB of “/tmp” space and 10 GB of swap space for some of our testing.
- Fast network - Big jobs inevitably mean lots of data. Since most people don’t have the luxury of having data locally at all times, this means moving it across the network.

The assemblies we worked with take 100's of MB space in CGR form and 10 times that in native format. A slow network can therefore hurt the overall system performance.

- Integrate incrementally - Add 64-bit CATIA V5 to your existing environment first for processes where the benefits will be greatest. Recent Intel® Pentium 4, and all Xeon® processor-based workstations are 64-bit ready. This means that you may be able to take advantage of 64-bit technology without buying new hardware. Keep in mind that 32-bit and 64-bit environments can be used together, this allows for gradual, pay-as-you-go migration to 64-bit technology as appropriate.

## About the author

Bernard H. Battaglin, BS ME/CS has specialized in the application of computer technology to solve design and manufacturing problems since 1980, when he evaluated and selected CAD systems for the Buick Motor Division of General Motors. He specified and developed design and analysis software both for the RCA Astro Electronics Company and for Storage Technology Corporation. He joined a CAD/CAM startup, Vulcan Software, in 1985 and went on to Daisy as marketing Product Manager. In Europe, Mr. Battaglin served as International Project Manager for a EU multi-country consortium developing and deploying an electronic market place. He was also co-founder of the SKIL project, an international consortium of CATIA V5 PLM users working together to adopt KnowledgeWare solutions. Mr Battaglin is a partner and principle consultant in the Albert-Battaglin Consulting Group, [www.abcg.com](http://www.abcg.com). Mr. Battaglin has developed and directed TAGITT CATIA performance benchmarks since 1989.

## Thanks!

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## About Dassault Systèmes

As a world leader in 3D and Product Lifecycle Management (PLM) solutions, Dassault Systèmes brings value to more than 90,000 customers in 80 countries. A pioneer in the 3D software market since 1981, Dassault Systèmes develops and markets PLM application software and services that support industrial processes and provide a 3D vision of the entire lifecycle of products from conception to maintenance.

CATIA, the company flagship and WW leading CAD solution, brings product excellence to manufacturing companies, enabling users to simulate the entire range of industrial design processes, from initial concept to product design, analysis, and assembly..

Thanks to Dassault Systèmes' open, component-based architecture (CAA V5), the CATIA product line covers all types of design and engineering needs, as well as integrating seamlessly with other Dassault Systèmes' brands DELMIA, ENOVIA, and SMARTEAM or Microsoft's new VISTA environment and Office system applications.

## **About Intel**

At Intel, we constantly push the boundaries of innovation in order to make people's lives more exciting, more fulfilling, and easier to manage. Our unwavering commitment to moving technology forward has transformed the world by leaps and bounds.

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