

# 1999 CATIA Version 5 Workstation Benchmark

Phil Harrison

**C**ATIA Version 5 (V5) brings with it new platform support, running on the Windows NT operating system as well as the various flavors of UNIX supported in Version 4 (V4). While many of us have used Windows on our personal computers in the office or at home, the ability to run CATIA on a personal computer is new and extremely important. Reducing financial and hardware support issues, it promises to enable many more companies to use CATIA.

So how does V5 run on Windows NT and UNIX?

The best way to answer the question is to establish a benchmark and publish meaningful metrics. Many industry standard metrics measure the various facets of computer performance; SPECint, SPECfp and Viewperf measure integer performance of the processor, floating performance of the processor and graphics performance, respectively. Hardware manufacturers wax lyrical about bus speeds and disk speeds, but it is difficult to know how these parameters interact to produce a fast and reliable system.

Enter *CATIA Solutions Magazine's 1999 CATIA Version 5 Workstation Benchmark*. What we have attempted to do is to establish a benchmark that can be used to compare various systems impartially. We wanted it to be practical: this benchmark mimics both the procurement process and the design process at companies that might use V5. It was modeled after an industrial design scenario and, in much in

the same way as small companies would invite vendors to submit quotes, we invited vendors to submit systems.

## The benchmark scenarios

Realizing that CATIA users use the software in many different ways, we designed three distinct scenarios: the design of a simple plastic part, a complex casting and a production cell to machine this housing. Being subject to the functional coverage of V5 Release 1, these scenarios use much of the functionality in the Part Design, Assembly Design, Generative Part Stress (GPS), Generative Drafting and Interface modules.

- **Scenario 1: Simple part design—telephone bezel**

The first scenario models the design, analysis and documentation of a simple molded plastic part. This part uses many of the new features in V5, which give dra-



Figure 1.

matic improvements in productivity and in the capture of design intent. The bezel (Figure 1) is a single part, approximately 2 Mb in size. It uses shelling, filleting, symmetry and patterning throughout.

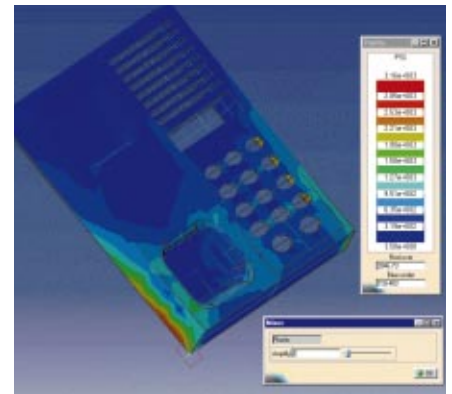


Figure 2.

We carry out a stress analysis on the part (Figure 2), then we make a major design change, altering the pocket to house the handset (Figures 3 and 4) by modifying the design intent captured as the part is being modeled. We also change draft angles on some faces following feedback from our manufacturing engineers. Now that we're happy with the part design, we produce a stereolithography file, which can be used to produce a rapid prototype. Once we're happy with the 3D definition of our part, we use the generative drafting product to automatically update the drawing of the part and export both DXF and IGES files of our design.



Figure 3.



Figure 4.

• **Scenario 2: Complex part design—bellhousing**

The second scenario models the design, analysis and documentation of a more complicated automotive transmission housing (Figure 5). This is also a single V5 part, but this model is approximately four times the size of the telephone bezel. It also takes maximum advantage of design intent capture by using solid features such

as ribs and shells and intelligent feature definitions on features such as holes with up to next and through all.

As with the first scenario, we perform a stress analysis (Figure 6). But then our friends in packaging decide that we need to make the housing a half an inch longer, so we extensively modify the design. As a consequence, you'll notice that the mounting bosses move significantly on the housing (Figures 7 and 8). CATIA copes magnificently in retaining design intent and reroutes affected geometry (see "A comparison with CATIA Version 4" on page 40). Again, once we're happy with the 3D definition we produce a rapid prototype, update our documentation (Figure 9) and export IGES and DXF files.

These two scenarios are typical for the design office. From a computational point of view, they are graphics and I/O system light, but tax the processor during the part rebuilds and analysis portions. Next, a scene (Continued on page 28.)

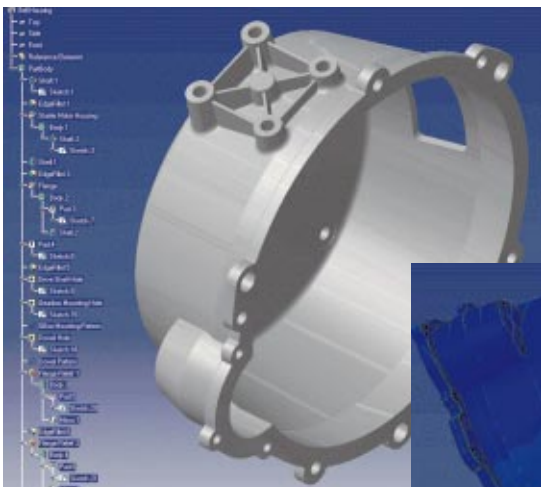


Figure 5.

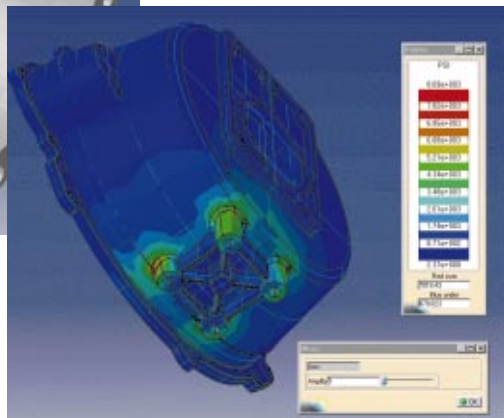


Figure 6.

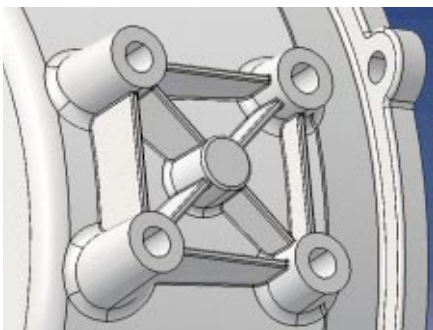


Figure 7.



Figure 8.

## Ensuring a level playing field

In order to give comparable results, certain system parameters and CATIA settings were standardized throughout the benchmark.

### System setup:

- Data was stored on the local hard disk.
- CATIA code was installed on the local hard disk.
- Systems were tested using GA Version 5 Release 1 code with Service Pack 1.
- All systems used a nodelock license for the AL2 configuration.
- NT systems were set to run at 1024 x 768 pixels with 24 bit (true color) with a refresh rate of 75 Hz or closest equivalent.
- NT systems were upgraded to Service Pack 4, if required.
- No other applications ran during each test.
- In all systems the Network Protocol TCP/IP was configured, but the machines were physically disconnected from the network after transferring data to the machines.

### CATIA settings (TOOLS OPTIONS):

- Units - inches/pounds force.
- Auto update: Yes, stop on first error.
- Performance: 3D = fix @ 0.20 2D = fixed @ 0.02 (default settings).
- Level of Detail: Static 0.5 while moving 3.0 (default settings). ●

# Table 1. System Specifications

Vendor	Compaq	Compaq	Dell	Dell	Hewlett Packard	Hewlett Packard	Hewlett Packard
Model Number	Professional Workstation AP500	Professional Workstation SP700	Dell Precision WorkStation 410	Dell Precision WorkStation 610	Kayak XW P-Class	Kayak XW X-Class	C3000
Phone Number	800/345-1518	800/345-1518	800/388-8542	800/388-8542	800/637-7740	800/637-7740	800/637-7740
Web site	www.compaq.com	www.compaq.com	www.dell.com	www.dell.com	www.hp.com	www.hp.com	www.hp.com
CPU Type	PIII	PIII Xeon	Intel Pentium III	Intel Pentium III Xeon	Intel Pentium III	Intel Pentium III Xeon	PA8500
CPU Speed	550 MHz	550 MHz	500 MHz	550 MHz	500 MHz	550 MHz	400 MHz
I/O Bus	100 MHz front side bus	100 MHz front side bus	PCI	PCI	PCI	PCI	PCI
Max # of CPU's	1 (2)	1 (2)	1 (2)	1 (2)	2 (2)	2 (2)	1 (2)
Chip Set	Intel	Highly Parallel System Architecture	Intel 440 BX	Intel 440 GX	Intel 440 BX	Intel 440 BX	PA-RISC
Network Card Ethernet	Integrated Compaq 10/100 Ethernet	Integrated Compaq 10/100 Ethernet	Integrated 3COM 10/100 Ethernet	Integrated 3COM 10/100 Ethernet	100 Mb	100 Mb	100 Mb
Graphics	Oxygen GMX	PowerStorm600	Diamond Fire GL1	Intense3D Wildcat 4000	Visualize FX4	Visualize FX6	Visualize FX4
Chip Set	3DLabs GLINT® GMX 2000	Intense 3D	IBM Oasis graphics accelerator	Intense3D	PA-RISC	PA-RISC	PA-RISC
Bus Type	AGP	PCI and AGP	AGP 2X & 100 MHz	AGP 2X & 100 MHz	AGP 2X & 100 MHz	AGP 2X & 100 MHz	
Video RAM	96 Mb, 16 Mb VRAM, 80 Mb EDO RAM	16 Mb frame buffer, 64 Mb texture memory	32 Mb	16 Mb frame buffer 64 Mb texture memory	18 + 16	18 + 32	
Resolution for Test	1280 x 1024	1280 x 1024	1280 X 1024	1280 X 1024	1280 x 1024	1280 x 1024	1280 x 1024
# of Colors for Test	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit
Monitor Size	19"	19"	19"	19"	21"	21"	21"
Memory	256 RAM	512 Mb	256 Mb	512 Mb	512 Mb	512 Mb	1 Gb
Memory Type	100 MHz, ECC,SDRAM	ECC SDRAM	ECC SDRAM	ECC SDRAM	DIMM	DIMM	50ns EDO
Virtual Memory	512 Mb	1024 Mb	512 Mb	523 Mb	1024 Mb	1024 Mb	1024 Mb
Disk Size/Type	9 Gb 10,000 RPM	9 Gb 10,000 RPM	9 Gb 10,000 RPM	18 Gb	2x9 Gb 10,000 RPM	2x9 Gb 10,000 RPM	2x9 Gb 10,000 RPM
Bus Type	U2W SCSI	U2W SCSI	U2W SCSI	U2W SCSI	U2W SCSI	U2W SCSI	U2W SCSI
File System Type	NTFS	NTFS	Fat 16-NTFS	Fat 16-NTFS	NTFS	NTFS	HFS or JFS
Software packaged with the machines	Compaq Diagnostics, Internet Explorer 4.01.	Compaq Diagnostics, Internet Explorer 4.01.	Dell OpenManage Client v. 4.3. Internet Explorer 4.01.	Dell OpenManage Client v. 4.3. Internet Explorer 4.01.	OpenGL, HP TopTools, HP MaxLife, HP UltraFlow, Netscape 4.06, IE 4.01.	OpenGL, HP TopTools, HP MaxLife, HP UltraFlow, Netscape 4.06, IE 4.01.	OpenGL, C/C++ Runtime, Fortran Runtime. Netscape 4.06, Netscape Fasttrack.
Technical Support	800/652-6672/ 24 x 7	800/652-6672/ 24 x 7	24x7 phone support	24x7 phone support	Consult vendor	Consult vendor	Consult vendor
OS/Software	Microsoft Windows NT 4.0 & Service Pack 4	Microsoft Windows NT 4.0 & Service Pack 4	Microsoft Windows NT 4.0 & Service Pack 4	Microsoft Windows NT 4.0 & Service Pack 4	Microsoft Windows NT 4.0 & Service Pack 4	Microsoft Windows NT 4.0 & Service Pack 4	HP-UX 10.20
Street Price w/19" Monitor	\$5,532	\$8,087	\$3,965	\$7,143	\$9,630	\$12,326	\$20,836

\*Due to the time difference in publication and when price quotes were received, manufacturing prices may vary by the time this benchmark is published. Furthermore, CATIA Solutions Magazine and its affiliates are not responsible for prices reported by the manufacturers.

Hewlett Packard	IBM	IBM	Intergraph	Siemens	SGI	Sun Microsystems	Sun Microsystems
J5000	IBM IntelliStation E Pro	IBM IntelliStation Z Pro	TDZ 2000 GXI	CELSIUS 630	SGI 320 Visual Workstation	Ultra 10 Model 440	Ultra 60 Model 1450
800/637-7740	800/426-7255	800/426-7255	800/763-0242	408/428-8314	888/400-4SGI	800/786-0404	800/786-0404
www.hp.com	www.ibm.com	www.ibm.com	www.intergraph.com/ics	www.siemens.com/computer	www.sgi.com	sun.com	sun.com
PA8500	Intel Pentium III	Intel Pentium III Xeon	Pentium III Xeon	Intel Pentium III Xeon	Intel Pentium III	UltraSPARC Ili	UltraSPARC II
440 MHz	550 MHz	550 MHz	550 MHz	500 MHz	500 MHz	440 MHz	450 MHz
PCI	100 MHz	100 MHz	PCI	100 MHz	PCI	PCI	PCI

2	1 (1)	1 (2)	1 (2)	2 (2)	1 (2)	1	1
PA-RISC	Intel 440BX AGP	Intel 440BX AGP	Intel 440GX	Intel 82440GX	Cobalt Graphics Chipset	Simba by SUN	
100 Mb	Integrated 10/100	Integrated 10/100	10/100 Base TX	Integrated Intel EtherExpress 10/10	Integrated 10/100	10/100 Ethernet SUN	10/100 Ethernet SUN
Visualize FX6	IBM FireGLT	Intense 3D Wildcat 4000	Intense 3D Wildcat 4000	Evans & Sutherland AccelGALAXY36	Integrated	Elite3D m3	Elite3D m6
PA-RISC	IBM Mirage Chip	Intense 3D	Intense 3D	REALImage 2100	Cobalt	Sun Designed ASICS	Sun Designed ASICS
	AGP	AGP	AGP 2X	AGP 2X	UMA	UPA 110 MHz	UPA 110 MHz
	32 Mb	16 Mb frame buffer, 64 Mb texture memory	16 Mb frame buffer, 64 Mb texture memory	20 Mb 3DRAM	SDRAM	15Mb 3DRAM	
1280 x 1024	1280 x 1024	1280 x 1024	1280 x 960	1280 x 1024	1280 x 1024	1280 x 1024	1280 x 1024
24-bit	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit
21"	19"	19"	21"	21"	21"	21"	21"
1.6 Gb	384 Mb	384 Mb	384 Mb	384 Mb	384Mb	512 Mb	512 Mb
50ns EDO	ECC SDRAM	ECC SDRAM	Synchronous DRAM, 8 ns	ECC SDRAM	ECC SDRAM DIMM	EDO DRAM	DSIMM
1024 Mb	465 Mb	512 Mb	500 Mb – 650 Mb	768 Mb	600 Mb	927 Mb	927 Mb
4x9 Gb 10,000 RPM	13.5 Gb	9 Gb 10,000 RPM	9 Gb 10,000 RPM	4.3 Gb SCSI	10.1 Gb, 7200 RPM Ultra ATA (IDE)	9.1 Gb, 7200 RPM	9.1 Gb, 7200 RPM
U2W SCSI	IDE	Ultra 2 SCSI	Ultra II SCSI	Ultra 2 Wide SCSI	Ultra ATA	Enhanced IDE	Ultra SCSI
HFS or JFS	FAT	FAT/NTFS	FAT	NTFS	FAT/NTFS	UNIX	UNIX
OpenGL, C/C++ Runtime, Fortran Runtime, Netscape 4.06, Netscape Fastrack.	Lotus SmartSuite, IBM ViaVoice, NetMeeting, Hummingbird Exceed/Maestro, Tivoli TME 10, Netfinity Manager, Intel LANDesk, Norton AntiVirus, ConfigSafe, Watergate PC Doctor.	Lotus SmartSuite, IBM ViaVoice, NetMeeting, Hummingbird Exceed/Maestro, Tivoli TME 10, Netfinity Manager, Intel LANDesk, Norton AntiVirus, ConfigSafe, Watergate PC Doctor.	InterSite.	MKS Toolkit, Exceed NFS Maestro, TGS 3D Space Assistant, IE 3.01.	Intel LANDesk Client Manager 3.3, McAfee VirusScan and WebScan, Netscape Communicator, Hummingbird NFS Maestro Solo, MKS File Manipulation Commands, IE4.01.	Solaris 7 3/99 (JDK 1.1.6) - Desktop Edition, PC file viewer 1.0.1, ShowMeTV 1.2.1, SunForum 1.0, Netscape Communicator 4.5, AnswerBook2.	Solaris 7 3/99 (JDK 1.1.6) - Desktop Edition, PC file viewer 1.0.1, ShowMeTV 1.2.1, SunForum 1.0, Netscape Communicator 4.5, AnswerBook2.
Consult vendor	Standard: 24x7, Worldwide	Standard: 24x7, Worldwide	800/633-7248	Consult vendor	Standard: 8-5 Local Time M-F, Year 1	Consult vendor	Consult vendor
HP-UX 10.20	Windows NT 4.0	Microsoft Windows NT 4.0 & Service Pack 4	Microsoft Windows NT 4.0 & Service Pack 4	Microsoft Windows NT 4.0 & Service Pack 3	Microsoft Windows NT 4.0 & Service Pack 4	Solaris 7	Solaris 7
\$39,800	\$4,760	\$8,215	\$7,995	\$9,700	\$6,053	\$8,135	\$17,330



**Table 2. Sample System results**

System Reference System Pentium II 450 MHz 256 Mb RAM Intense3D 3400

Time To:	Bezel				Bellhousing				Production Line			
	Test 1	Test 2	Test 3	Avg.	Test 1	Test 2	Test 3	Avg.	Test 1	Test 2	Test 3	Avg.
Load CATIA	6.57	6.74	6.92	6.74	6.57	6.74	6.92	6.74	6.57	6.74	6.92	6.74
Load Part/Assembly	4.69	4.75	4.61	4.68	8.59	8.38	9.04	8.67	226.43	228.64	221.40	225.49
Perform Stress Analysis	43.36	42.43	41.73	42.51	122.94	120.19	115.92	119.68				
Modify Solid	43.01	42.10	40.80	41.97	55.86	56.48	55.55	55.96				
Modify Assembly Constraints									80.80	82.65	81.08	81.51
Export STL File	1.53	1.44	1.44	1.47	3.36	3.92	2.75	3.34				
Export IGES File	3.92	4.20	4.41	4.18	12.16	13.15	13.18	12.83				
Load & Update Print	11.11	13.58	12.78	12.49	25.34	31.34	32.53	29.74	278.04	300.81	260.78	279.88
Export DXF File	3.29	3.23	3.29	3.27	7.84	8.01	13.00	9.62	6.11	5.90	4.54	5.52
<b>VEOPERFO Graphics Test</b>												
Shading + Edge	21.92	21.89	21.97	21.93	31.03	30.92	30.77	30.90	170.63	170.89	170.80	170.78
Shading	21.95	21.79	21.72	21.82	30.79	30.86	30.76	30.80	170.54	170.40	170.22	170.38
Edges	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
First Outline	78.00	78.00	78.00	78.00	1266.00	1281.00	1281.00	1276.00	2281.00	2281.00	2281.00	2281.00
Outline	16.07	15.88	15.88	15.94	16.37	16.24	16.15	16.25	118.62	118.62	118.62	118.62
HRD	19.69	19.61	19.58	19.63	43.60	43.38	43.26	43.41	358.34	359.00	357.82	358.39

Note: Lower numbers represent faster performance.

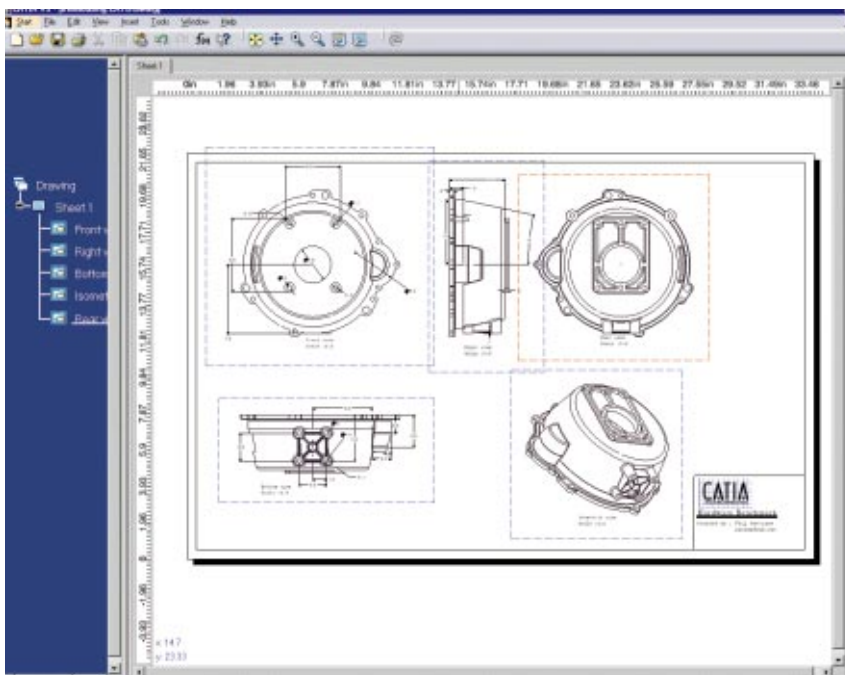


Figure 9.

(Continued from page 25.)

nario that taxes the graphics and I/O sub-systems:

• Scenario 3: Assembly design

Now that we've completed our casting, we assemble a production cell used to manufacture the part. Figure 10 shows the cell created using assembly design. It consists of more than 400 instances with a total of 60 unique parts. This assembly really stresses the hard disk and system bus during loading, while the CPU is stressed updating the assembly. Once the assembly is ready, we modify the offset between the conveyor and a floor datum (Figure 11). Because all of the other equipment is constrained to this conveyor, CATIA automatically moves the other equipment for us. Once we're happy with the new arrangement, we update our documentation and export a DXF File.

**RSVP**

The vendors were given an outline of our scenarios in terms of model size and complexity, but they were not given any models themselves. Each vendor was

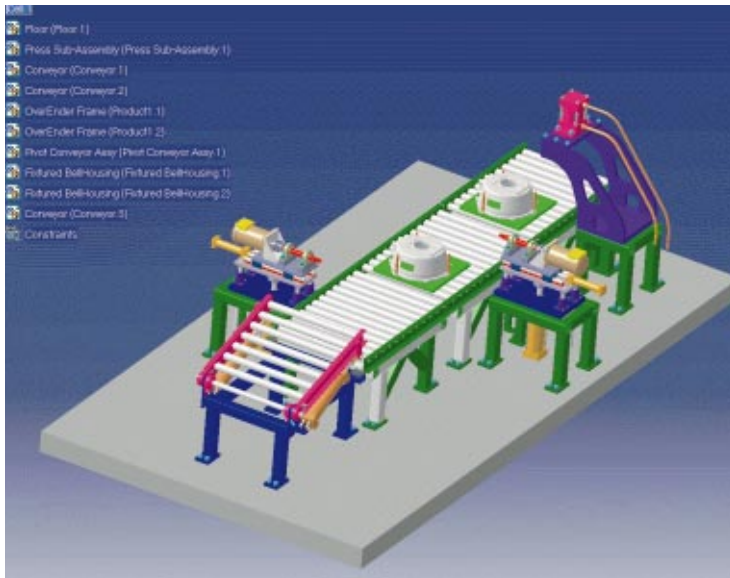


Figure 10.



Figure 11.

allowed to submit two systems of any single architecture (Intel, Alpha, UNIX). The vendors configured their systems themselves, based on basic guidelines from Dassault Systèmes and from information within our invitation.

The hardware vendors submitted the 15 systems listed in *Table 1*.<sup>\*</sup> Most vendors

submitted entry-level and high-end configurations for each architecture (for reference I've also listed the system used to create the benchmark). Interestingly, IBM and SGI declined to submit UNIX systems for benchmarking with this V5 release.

Each system was tested using the same data in an identical manner to produce a

results table such as shown in *Table 2*. This data was then weighted based on a rough estimate of how often a user might perform each operation. This is not intended to be an accurate statistical representation of the CATIA community, and indeed you might decide to use different weighting factors  
(Continued on page 31.)

<sup>\*</sup> A 16th system was entered in but did not complete the benchmark because of a problem that testing identified in the V5 code for alpha machines. Dassault Systèmes expected to fix the problem by the time this benchmark is published.

## Measuring performance

Dassault Systèmes provides a macro language that can be used on both UNIX and Windows NT systems. This language (VBScript) enables the user to record a series of interactions and replay the actions later. While this macro language captures selection of geometry and menu picks, it does not capture local graphic interactions such as dynamic zooming, panning and rotations.

This macro language was used to record the extensive modifications to both the telephone bezel scenario and the bellhousing scenario. To ensure repeatability and accuracy, each operation was timed three times in the same operation sequence. The results were later averaged.

The macro language can be used to replay graphic modifications made by selecting menu picks, such as moving to a named view, zoom in/out or reframe. However, running macros takes system resources, and the overhead is significant when compared to the actual

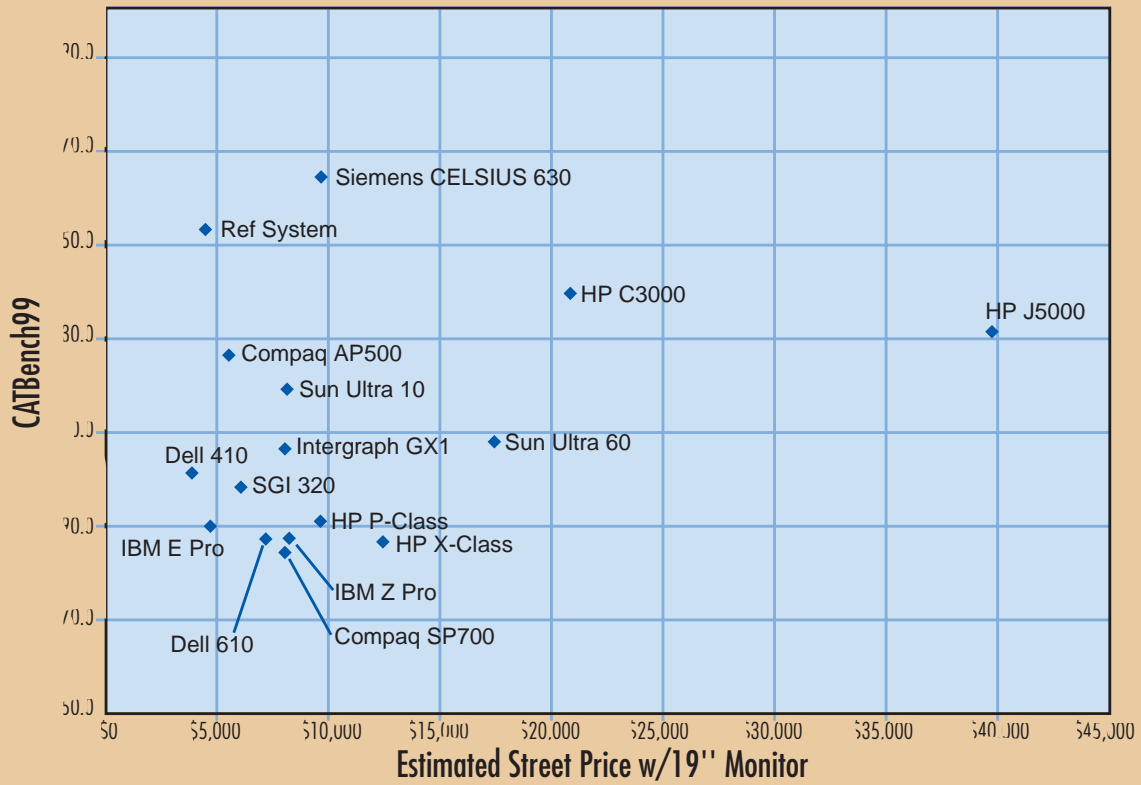
time for the graphics card to recalculate the frame. To overcome these shortcomings and get an effective measurement of graphics performance, Dassault Systèmes created a tool, "VEOPERFO," which accurately measures graphics performance.

VEOPERFO reads cgr data exported from CATIA Version 5 (V5) and allows a user to manipulate that data graphically and interactively. VEOPERFO also allows the recording of a user's local graphic interactions. These interactions can then be replayed by using a script and outputting the performance to a file. Because all the data for this benchmark was created using V5, only data associated with shaded mode was used to assess graphics performance.

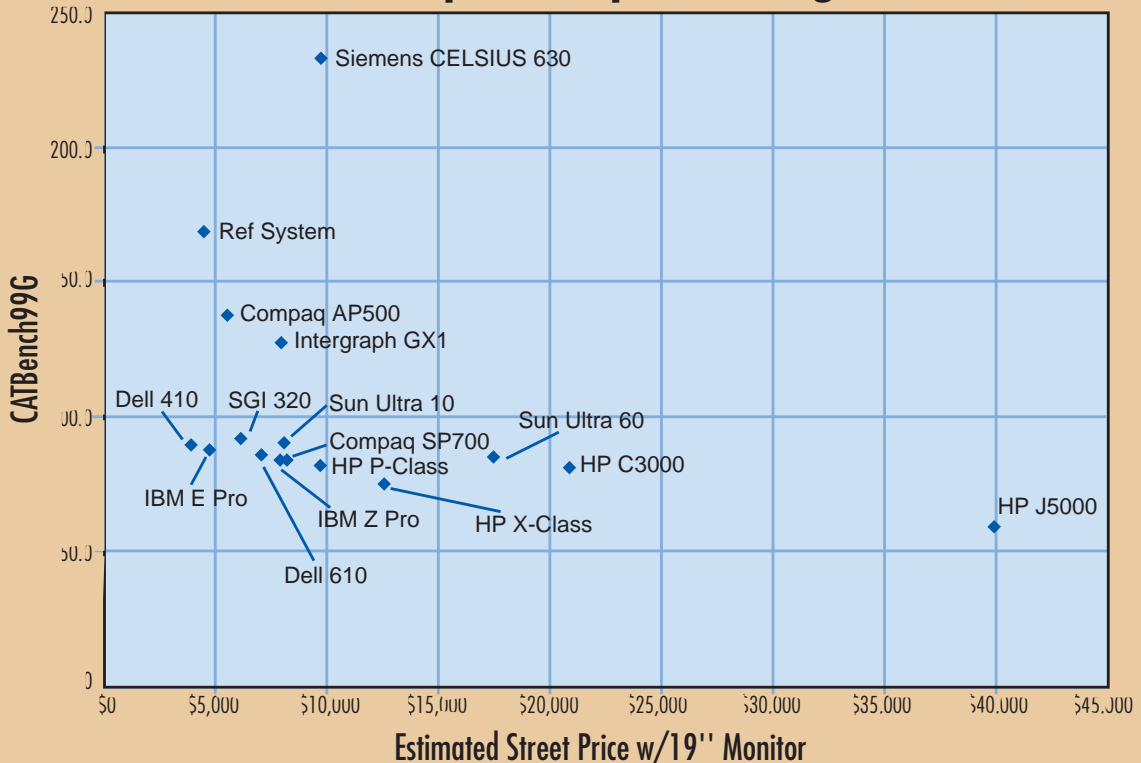
VEOPERFO needs a licensed valid V5 environment to operate. Dassault Systèmes plans to make it generally available in V5 Release 2.

— Phil Harrison

**Graph 1. Overall Rating**



**Graph 2. Graphics Rating**



Note: Lower numbers represent faster performance. The ratings are normalized: 100 represents average performance. Siemens and SGI prices include 21" monitor, as 19" monitor was not available.

(Continued from page 29.)

based on your company's usage. The results for each system were then normalized to produce the following three benchmark ratings:

- CATBench99S measures the performance of the CPU, bus and I/O subsystems.
- CATBench99G measures the graphics performance of each system.
- CATBench99 is the combination of the CATBench99G and CATBench99S, giving equal weight to both system and graphics performance.

A summary of the results for all systems is shown in Table 3. Normalizing the data makes it easier to understand. Because a value of 100 represents the average of all systems, a value of 200 means that a system took twice the time to accomplish a task as the average of all the systems. Results are also shown in Graphs 1, 2 and 3 for overall (CATBench99), graphics (CATBench99G) and system (CATBench99S) performance, respectively.

### System features and results

- ★★★★★ = Excellent
- ★★★★ = Good
- ★★★ = Average
- ★★ = Below average
- ★ = Poor

### Compaq AP500



This is Compaq's entry-level machine priced at \$5,532, but it uses the same attractive and huge deep chassis as its higher-level brethren. Graphics rating was below par, as it uses an older Oxygen GMX graphics card. System performance was acceptable. This system has network

activity and hard disk access lights on the front of the case, which gives a good indication of system activity during read/write operations.

★★★

### Compaq SP700



Higher up in the Compaq product line and still using the Intel architecture is the SP700 machine. Priced at \$8,087, this machine uses Intergraph's impressive Intense3D Wildcat 4000 graphics card, which Compaq renamed Powerstorm 600. The SP700 uses the same chassis as the AP500 and shares Compaq's excellent on-line help and diagnostic tools. The SP700 had the best system performance of all the

systems tested, thanks to a fast CPU, a fast SCSI hard drive, plenty of memory and Compaq's proprietary highly parallel system bus.

All around, this is a well-balanced, high-value system. It is highly recommended.

★★★★★

### Dell Precision 410



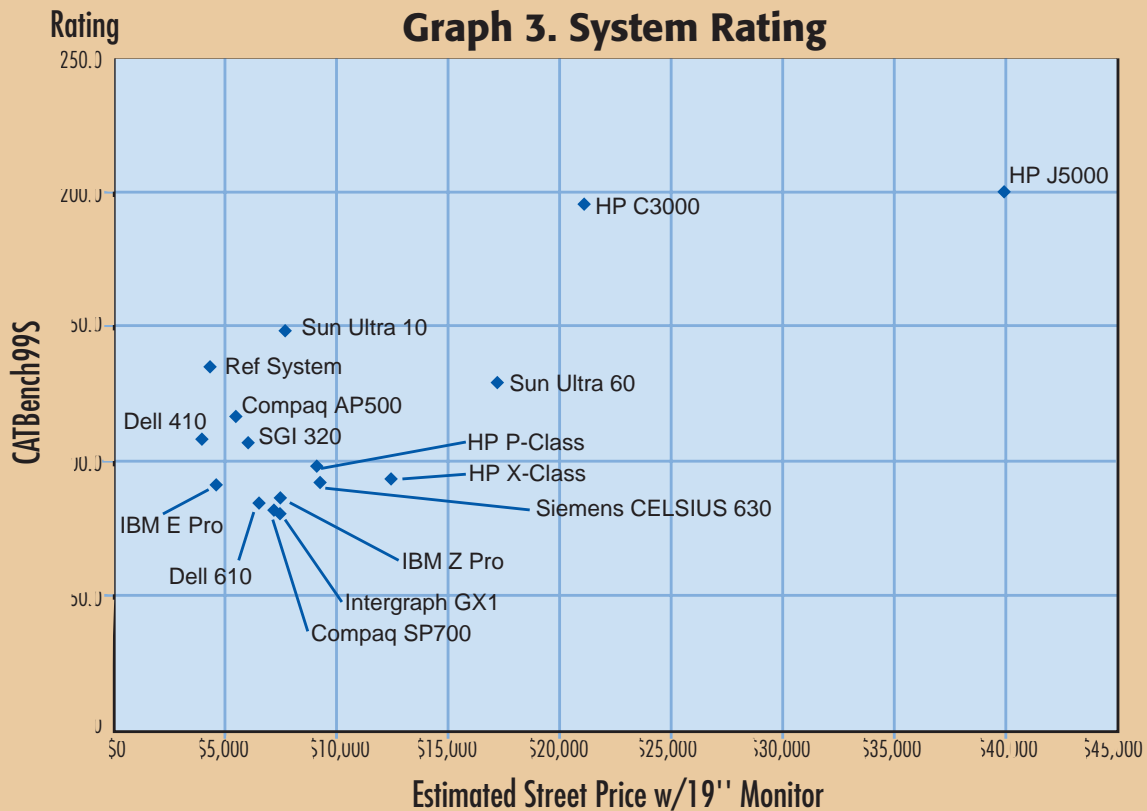
Dell entered the workstation market during 1998 and has worked rapidly with Dassault Systèmes to certify its 410 and 610 machines.

Both the 410 and 610 are housed in a mid-size tower chassis that offers a remarkable amount of space inside; access to com- (Continued on page 34.)

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# 1/3 Page Square





Note: Lower numbers represent faster performance. The ratings are normalized: 100 represents average performance. Siemens and SGI prices include 21" monitor, as 19" monitor was not available.

(Continued from page 31.)

ponents is simply a matter of pressing a button and swiveling the side panel off. As with all other systems tested in the benchmark, the cover on the systems are lockable. A novel feature in the Dell systems is that after the cover has been removed, a warning is given when the system next reboots to tell you that the system has been opened.

One problem was found on both Dell systems tested. Dell has programmed the middle mouse button to enable scrolling within a document. This may be useful in applications such as word processing and spreadsheet analysis, but it breaks CATIA's dynamic rotation and zoom interactions with the mouse. The middle mouse button can be reprogrammed easily in control panel settings for the mouse by setting it as "middle button."

The Dell 410 submitted for the benchmark used a 500 MHz processor that showed average performance. Surprisingly given the \$3,965 price, this system was configured with the more expensive SCSI controller and SCSI disk drives. The system used Diamond's FireGL1 graphics adapter, which showed blazing performance for the telephone and bellhousing scenarios. Its performance on the production line scenario was also good.

Given this machine is packaged with Dell's superb P990 monitor (which just won an independent review as the best value 19" monitor) and costs less than \$4,000, this is an excellent system for meeting the entry-level and mid-level requirements of budget-conscious buyers.

★★★★★

#### Dell Precision 610



The 410's big brother is the 610, which upgrades the CPU to Intel's 550 MHz Pentium III Xeon processor and came equipped with 512 Mb of memory. Thanks to these upgrades, this \$7,143 machine demonstrated 25 percent better system performance than the 410 to be among the best performers in the benchmark.

Graphics performance of the Intense3D adapter was very good on the production cell scenario, but slower on the other two scenarios than the FireGL1 adapter. Like the 410, this machine would be improved by adding a network activity light on the front of the system.

Overall, the Dell the machine is well balanced and comes with Dell's excellent P990 monitor. This system is excellent for mid- to high-level use at a good price.

★★★★★

#### Hewlett Packard Kayak XW P-Class



Both the P-Class and X-Class machines tested in the benchmark are part of HP's new Visualize professional workstation range. This machine was configured with

2 Pentium III 500 MHz processors. Yet its performance was average, demonstrating that a second processor is of negligible value in systems at this moment.

The P-Class machine comes in a very attractive mid-size tower that is tightly packed. It uses HP's own Visualize FX4 graphics, which performed below average on the small scenarios but extremely well on the production cell. The tower includes both hard disk and LAN activity lights on the front, as well as an LCD readout. This system also suffered from overzealous mouse programming and had to have the mouse reprogrammed to enable correct mouse interactions within CATIA.

At \$9,630 this system is expensive compared with its competitors. Removing the second processor would reduce the price substantially without sacrificing performance.

★★★★★

### Hewlett Packard Kayak XW X-Class



The X-Class machine comes in a full-size tower and was equipped with two 550 MHz Xeon processors and 512 Mb of memory. System performance was slightly better than the P-Class machine, but still unremarkable.

The graphics card in the machine, HP's Visualize FX-6, was blazingly fast on the larger scenario and performed best of all the Intel-based machines.

Like HP's P-Class workstation, this machine came with an excellent complement of software, including web browsers, anti-virus software and HP's excellent on-line documentation and diagnostics.

Priced at \$12,326, it is an excellent high-end machine and can be recommended.

★★★★★

### Hewlett Packard C3000

HP's C3000 machine comes in a very attractive deep case with lots of expansion space. The system featured HP's PA8500



processor running at 400 MHz and included two hot swappable disk drives that are removed from the front of the machine. The machine can have a second CPU added. Remove the cover, and the system immediately powers down—you only do that once!

The system came with HP's HP-UX 10.20 operating system, which includes a graphical tool called SAM that is used to administer the system easily.

System performance gave a disappointing score of 200 on CATBench99S. Results were particularly poor loading the large assembly and updating the print of the assembly. The Visualize FX4 graphics card gave excellent results (particularly for the production cell) to return an overall rating of 140.

At nearly \$21,000, this machine is expensive, while offering below-par performance.

★★★

### Hewlett Packard J5000



HP's J5000 machine comes in a large desktide chassis and looks like what it is: a server. Having said that, I was disappointed to see that the network activity light is on the back of the machine.

This \$39,800 machine comes with two HP PA8500 processors running at 440 MHz, 1.6 Gb of RAM and four hot swappable 9 Gb disk drives for a total of 36 Gb of storage.

In spite of a faster clock speed than the C3000 machine, the system performance was almost identical to that of the C3000 machine, again with the loading of larger

assemblies and drawing updates causing problems.

The Visualize FX6 graphics card in the machine performed better than any other graphics card. Its performance was stunning. With the high cost of \$9,500 just for the graphics card—more than most of the machines in the benchmark—it should be!

I think this machine is ill suited to run CATIA interactively. Given its graphics performance, memory and storage capacity, it would probably make an excellent CATWeb server or data/license server. The machine even comes with Netscape's Fastrack web server software ready to configure.

★

### IBM Intellistation E Pro



A CATIA-capable workstation from IBM for less than \$5,000! Can this be a typo?

This \$4,760 E Pro is IBM's entry-level workstation, with the Intellistation M Pro and Z Pro higher up the price range. The E Pro comes in a desktop case that has to be used horizontally with a somewhat flimsy cover. Frankly, I'd prefer a mini-tower case that takes up less space. Like the rest of IBM's Intellistation family, the case, display and all peripherals come in stylish stealth black.

In order to keep the cost down, the motherboard in the E Pro can only use a single processor and the system uses IDE disk drives. The front of the bezel includes both hard disk and network activity lights.

The E Pro submitted came with a single 550 MHz Pentium III CPU, 384 Mb of memory and a 13.5 Gb hard disk, fully configured with IBM's excellent P92 monitor. IBM even includes a suite of diagnostic, anti-virus and web browsing software, and both Intellistations in the benchmark come with a mail-in certificate for a free copy of IBM's productivity suite, Lotus SmartSuite. Even if you don't use SmartSuite, you can use the package to get a cheaper competitive upgrade to your office suite. Either way you win!

**Table 3. Results Summary**

	Reference System	Compaq AP500	Compaq SP700	Sun Ultra 60	Dell Precision 410	Dell Precision 610	Hewlett Packard Kayak XW P-Class	Hewlett Packard Kayak XW X-Class
<b>GRAPHICS</b>								
Bezel	154.0	192.0	109.4	76.2	43.6	114.4	122.6	115.2
Bellhousing	159.2	168.4	85.8	82.5	63.4	88.9	106.9	101.0
Production Cell	172.2	120.9	81.1	86.7	102.6	83.1	70.9	67.2
CATBench99G	168.4	135.4	84.8	85.0	90.6	87.3	81.7	77.2
<b>SYSTEM</b>								
Bezel	115.4	94.7	87.5	141.6	100.6	87.5	100.8	97.2
Bellhousing	120.6	100.2	88.3	142.5	102.8	90.1	103.5	97.6
Production Cell	151.3	131.6	81.9	130.3	118.3	85.1	98.0	93.8
CATbench99S	137.4	117.3	84.5	130.3	111.4	86.8	99.9	95.4
CATBench99	152.9	126.4	84.7	107.6	101.0	87.1	90.8	86.3
Cost	\$4,516	\$5,532	\$8,087	\$17,330	\$3,965	\$7,143	\$9,630	\$12,326

Note: Lower numbers represent faster performance.

System performance was very good throughout with no bottlenecks. This system used Diamond's FireGL1 graphics, which were developed by IBM and Diamond and incorporates IBM's Silicon. Performance on the telephone and bellhousing scenarios was stunning. Performance on the larger production cell scenario was excellent.

Given this machine is packaged with IBM's P92 monitor and costs so little, this is an excellent system for meeting entry and mid-level requirements of budget-conscious buyers.

★★★★★

### IBM Intellistation Z Pro



IBM's Z Pro comes in a full tower case and was configured with a single 550 MHz processor, 384 Mb of memory and Intergraph's new Intense 3D Wildcat 4000 graphics card. System performance was approximately 4 percent better than the E Pro, thanks to SCSI devices and the faster

processor. Overall, the system performance was within 3 percent of the fastest system.

Graphics performance of the Wildcat card was average on the two smaller scenarios, but excellent on the production cell scenario. The price is \$8,215. Overall, this is a well-balanced, high-value system. It is highly recommended.

★★★★★

### Intergraph TDZ2000 GX1



Intergraph abandoned its Clipper architecture to work with Intel on NT workstations some years ago and has taken a leadership role in Wintel-based graphics workstations. The benchmarked TDZ2000 GX1 is housed in an attractively styled purple case. It incorporated a single 550 MHz Pentium III Xeon CPU and 256 Mb RAM. The keyboard on Intergraph systems cleverly incorporates speakers and a microphone. This causes somewhat of a rat's nest of wires in back, where no less than four separate wires plug into the machine.

System performance on the Intergraph machine was superb; graphics performance was disappointing. This is very surprising since this machine used the same graphics card as in the Compaq SP700, Dell 610 and IBM Intellistation Z Pro machines—and Intergraph developed and manufactures the card!

Should Intergraph improve the graphics performance of this system to where it should be with its Intense3D Wildcat 4000 card, this system will be right up there with the best systems in the benchmark and at \$7,995 an excellent buy.

★★★

### Siemens Celsius 630



Siemens is not known for its workstations in the United States, but has a large presence in Europe. The Celsius 630 system submitted for the test is housed in a dark metallic case and looks quite industrial.

Hewlett Packard C3000	Hewlett Packard J5000	IBM Intellistation E Pro	IBM Intellistation Z Pro	Intergraph TDZ2000 GX1	Siemens Celsius 630	SGI Visual Workstation 320	Sun Ultra 10
109.4	66.0	49.6	110.5	111.1	110.0	92.1	77.7
97.2	64.6	61.9	85.7	102.3	198.6	107.4	85.4
76.0	58.1	99.2	80.8	134.7	257.4	88.7	92.6
82.7	59.9	88.5	84.7	127.4	233.0	91.8	90.0
209.1	203.4	93.8	89.2	87.3	93.5	103.0	165.1
193.0	200.3	95.2	88.6	88.2	93.5	104.9	157.1
194.5	199.4	89.3	88.6	83.4	95.8	107.4	139.8
196.4	200.3	91.6	88.7	85.3	94.8	106.0	148.4
139.6	130.1	90.0	86.7	106.4	163.9	98.9	119.2
\$20,836	\$39,800	\$4,760	\$8,215	\$7,995	\$9,700	\$6,053	\$8,135

The \$9,700 system included twin 500 MHz Pentium III processors and 384 Mb of memory. The hard disk installed in the system was a mere 4.3 Gb, so look to upgrade the hard disk. System performance of this configuration was very good with a CATBench99S of 94.8.

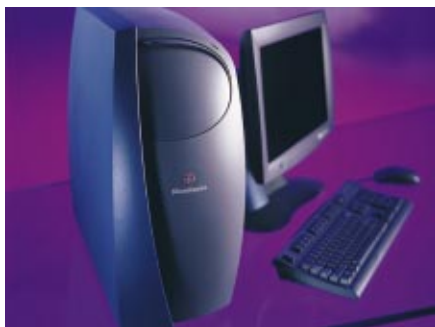
Unfortunately, this system came with a comparatively old and outdated graphics card: Evans and Sutherland's Accel GALAXY36, which performed worse as the dataset increased in size to give a graphics benchmark score of 233. Manipulation of models was decidedly jumpy compared to all the other benchmark systems.

The software supplied with the system is also outdated, as it comes with Service Pack 3 on Windows NT and Internet Explorer Version 3.

I would not recommend the Siemens system until the graphics adapter is updated.



### SGI Visual Workstation 320



(Continued on page 38.)

## Certified configurations

CATIA runs on Windows NT and the four major brands of UNIX. Shouldn't it, therefore, run on any hardware that is compatible with the operating system? From a theoretical point of view that should be true, but the issue is far more involved than that.

CATIA is certified by Dassault Systèmes to run on certain selected combinations of UNIX and NT operating systems and patches, processors, graphics cards, drivers, network cards and motherboards. Note that Dassault Systèmes certifies a particular system, not a vendor. It has a certification process in place to test systems. This ensures that systems selected from the certified configuration list (visit [www.catia.ibm.com/hardware/hwv5nt.html](http://www.catia.ibm.com/hardware/hwv5nt.html)) can be used reliably in production at your facility.

Certification introduces a problem due to the delay of the certification process itself. New processors are released every four to six months, Moore's Law\* shows no evidence of saturation. Looking at the certified hardware list in late May, we saw no 500 or 550 MHz systems: At the time of the benchmark, none of the top-performing graphic adapters in this test (IBM FireGL1 or Intergraph Intense 3D 4000) were listed in the certified configurations. However, they may be certified by the time you read this article.

What do you risk by purchasing a configuration not certified by Dassault Systèmes to run V5? Basically, you have no guarantee that the application will run. If you experience a problem (defect in IBM/Dassault Systèmes parlance), your local defect support structure will attempt to reproduce the problem on a certified system. If the problem cannot be reproduced, you will be asked to refer the problem to your hardware/software driver supplier.

You have been warned!

— Phil Harrison

### \* Moore's Law

Gordon Moore, one of the co-founders of Intel, observed in 1965 that the number of transistors on a manufactured die would double every year. This later was dubbed Moore's Law and is generally interpreted as holding that hardware performance will double every 12 to 18 months.



## Windows NT or UNIX, or both?

The issue of whether to select NT or Windows on which to run CATIA (or any other application for that matter) is a complex one, clouded by preaching from some of the self-interested vendors. Each of the choices has its strengths and weaknesses. Understanding these will guide you to a better, more informed decision.

UNIX systems come from a background of proprietary hardware, and each vendor has tended to have its own proprietary version of the operating system. They have also been around for more than 25 years and have stability that the makers of NT systems can only dream about. Powerful scripting languages and a multiple-user operating system team to enable automation of many system activities. Recent standards activity has led to use of standard peripheral devices (USB or PCI) and a common user interface (Common Desktop Environment). As an illustration of how far standardization of the user interface has occurred, the author managed to install and operate CATIA Version 5 (V5) on both Sun Solaris and Hewlett Packard's HP-UX systems with no experience of installing V5 on any UNIX systems at all.

Windows NT systems come from a background of standardized generic hardware using one vendor's (Intel) processors. Stability of NT is improving, but it is still too easy to corrupt a registry file and have to totally re-install a system. The major advantage of NT is application support. We can give a designer or engineer a single system on which to do his engineering work and run standard office applications, such as word processing, spreadsheet analysis and e-mail. Remote control, scripting and automation of tasks on NT systems are currently minimal, but leading vendors such as Hewlett Packard and IBM are working to address areas of deficiency.

Indeed, Hewlett Packard, IBM and SGI all field UNIX and NT workstations. They realize that they can bring value to their customers by specifying whichever system architecture is more appropriate. The choice of whether to run on UNIX or Windows NT also depends on whether you need to operate CATIA Version 4 on the same hardware.

All of the UNIX vendors are working to enable their systems to share file resources and print services in a networked environment. Because of competition from Windows NT-based hardware, UNIX systems have dropped remarkably in price. Witness the \$8,200 Sun Ultra 10 system.

Choosing between NT and UNIX is not easy. Examine your particular needs and circumstances. One thing is for sure: As users we all benefit from the ability to choose and the fierce competition taking place in the marketplace!

— Phil Harrison

(Continued from page 37.)

And now for something totally different: Not only does the system look different in its curvaceous case, but the motherboard and bus have been completely re-architected to improve performance while keeping a very low price.

Access inside the case is very easy and reveals a tremendous amount of space inside. SGI provides excellent on-line documentation and software called the Interoperability Toolkit to enable communication with both UNIX and Apple machines.

The benchmark workstation was configured with 44 Mb of its 384 Mb of RAM used for graphics, an inexpensive ATA (IDE) disk drive and a 500 MHz Intel Pentium III processor, which gave a CATBench99S rating of 106.

Graphics performance of the Cobalt Chipset integrated with the motherboard was a very impressive CATBench99G of 91.8. The graphics performed well—not only on the smaller scenarios, but also on the production line scenario.

Overall, the SGI Visual Workstation is an excellent value for \$6,053 and is recommended.



### Sun Microsystems Ultra 10 Model 440



The Ultra 10 Model 440 is an inexpensive machine (\$8,135) aimed at entry- and mid-level users and comes in an attractive mini-tower case. The two Sun systems submitted for the benchmark ran Solaris 7 and incorporated the common desktop environment. Sun has taken a UNIX-only attitude to operating systems, although its Solaris operating system also supports Intel architecture. Sun's one concession to interoperability is to market an optional SUNPCi card for its machines. This costs \$495 and is effectively a PC-on-a-card to allow running of Windows applications.

The Ultra 10 tested included Sun's new 440 MHz processor, 512 Mb of memory and a 9 Gb EIDE disk drives, all for \$8,135. All Sun machines come with a suite of applications to aid in collaboration, including a web browser, ShowMeTV and PC file viewer.

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System performance was disappointing, especially on the smaller models. However, graphics performance with Sun's Elite3D m3 was very good with a CATBench99G rating of 90.

The Ultra 10 model 440 represents the best value for the money of the UNIX hardware entries.



### Sun Microsystems ULTRA 60 Model 1450



Big brother to the Ultra 10, the Ultra 60 comes in a large, deep case allowing for plenty of expansion. The system submitted for the benchmark was configured with Sun's new 450 MHz UltraSPARC II chip and 512 Mb of memory.

System performance improved some 10 percent over the Ultra 10 machine, while graphics performance of the Elite3D m6 improved 5 percent, giving an excellent graphics rating of 85.

Overall, the Ultra 60 scores a CATBench99 rating of 107.6, disappointing considering its purchase price of over \$17,000.



### Future benchmark enhancements

This is the first independent CATIA hardware benchmark published, and it is based on V5 R1. Future benchmarks will be improved in a number of ways:

- Expansion to include other scenarios as the V5 product portfolio is expanded (for example, to cover some manufacturing scenarios).
- Expansion of the graphics benchmark to include V4 data.
- Inclusion of model conversion scenarios from V4 to V5.

### Conclusion

Despite variations in performance, all of the systems in *CATIA Solutions Magazine's* 1999 CATIA Version 5 Workstation Benchmark performed the tasks flawlessly. Any

of these systems would be usable for small or medium part and assembly design. The benchmark also demonstrated five important points:

1. The UNIX and NT user interfaces for V5 are virtually identical, so users will be able to move between systems without a loss of productivity.
2. Data can be moved or shared between UNIX and NT systems without problems.
3. Gordon Moore's observation from 1965 is still true. [See page 37.] The 12-to-18-month-old systems that were originally priced at the same level as today's top performing machines performed 50 to 70 percent slower than the new machines.
4. CATIA V5 offers major productivity improvements when compared to V4.
5. The price/performance competition between UNIX and NT hardware vendors benefit customers whether or not they decide to implement CATIA on NT, because the price of both platforms has decreased.

In general, the UNIX systems' performance was disappointing compared to the NT systems. This was true of all systems tested. Perhaps Dassault Systèmes' V5 code has not been optimized to run on UNIX yet. However, performance was still more than acceptable, offering a choice of platforms on which to run CATIA.

Computer hardware is developing at an incredibly rapid pace. Today's systems offer greater performance for less money than ever before. This benchmark has demonstrated that systems costing as little as \$5,000 can now be used to run CATIA in a highly productive manner. However, in 12 months' time this benchmark's fastest system will appear a slouch compared with newer systems. We'll be sure to keep you updated with any CATIA-related hardware platform issues here in *CATIA Solutions Magazine*.

*Phil Harrison is principal of Lionheart Solutions Inc., a consulting firm specializing in CATIA and CATWeb implementation and use that is based in Cold Spring Harbor, N.Y. He is president of the CATIA Operators Exchange (COE), has ten years' experience installing and using CATIA on UNIX and mainframe systems and participated in IBM's advanced testing program for CATIA V5. He may be reached by phone at 516/652-8602 or by e-mail at pphsmp@ibm.net. ●*

## A comparison with CATIA Version 4

This benchmark was modeled entirely with CATIA Version 5 (V5). While creating the benchmark and during testing, I couldn't help but contrast the product, modeling methodology and dramatic improvements in productivity that V5 brings versus CATIA Version 4 (V4).

Starting with the creation of the basic parts, a fundamental change has occurred. As we model the parts, we create sketches. As we sketch, conditions such as tangency, horizontal, vertical, in line, perpendicular or vertical are automatically captured. We can then constrain extremely quickly, generally adding dimensional constraints. Note that we parameterize only what we want to control; this is our design intent. Features such as bosses, holes, ribs and cutouts are defined in the context of the part, such that if the underlying geometry is modified, the feature is modified in respect of that change.

Contrast this with V4, where isolated geometric elements such as lines and curves are created and then used to create primitives. Design intent is later added using the PARAM3D function. V4 has added quite a few of the in-context features now in V5 (up to next, etc.), but the user interface is less efficient and the learning curve far steeper.

Creating assemblies in V5 is very easy and is similar to using

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## Version4

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the File Based Assembly product recently introduced in V4. Compared to Model/Session in V4, V5 allows us to manage our assemblies and capture constraints between parts and subassemblies. Imagine making the change in position of the conveyor belt in the production cell in V4!

Generative Part Stress was introduced as a product in V4. The V5 product is similar and just as easy to use, allowing stress analysis to become a normal part of the design process carried out by the design engineer rather than a specialist activity.

Generative Drafting takes a completely fresh view of drafting. Using wizards, the user is able to create standard layout drawings and then customize the layout. Dimensions constraining geometry and, thus, design intent can be projected into the drawing of a single icon. Tolerances can then be added and put into the correct position. Performance is dramatically improved over the V4 AUXVIEW2 and DIMENS2 functions.

Exporting geometry and drawings from V5 is much easier than from V4, because no data modification (such as dropping external details, creating wire-frame geometry, etc.) is required before translating data. All of these seem to be problematic, causing delays and error.

While each of these improvements is impressive on its own, adding them together dramatically improves our productivity.

— Phil Harrison

# Getting the most for your money

Phil Harrison

**M**ost of us operate on a limited budget. Given that constraint, how do we maximize our system's performance and where should the tradeoffs be made? Use the following as a guide (system components are listed in order of effect on system performance):

- **CPU Speed**

Given no other bottlenecks (such as I/O, memory or graphics), system performance is proportional to processor speed. Therefore, the first thing we need to do is select our system's processor.

Intel's CPUs, marketed as Pentium II, Pentium III and Pentium III Xeon, range in speed from 400 MHz to 550 MHz. The premium upgrading from a processor speed of 400 MHz is currently:

400 MHz to	
450 MHz Pentium II .....	\$.150
400 MHz to	
450 MHz Pentium III .....	\$.200
400 MHz to	
500 MHz Pentium III .....	\$.400
400 MHz to	
550 MHz Pentium III Xeon .....	\$.647

Note the large financial premium that is usually charged for Intel's latest and fastest CPU. For a high-end system, I'd recommend selecting the fastest CPU possible; for value-based systems, select the fastest, less expensive one.

Sun and Hewlett Packard UNIX machines use their own proprietary CPUs. The machines tested vary in CPU speed from 400 MHz to 450 MHz, but don't compare the speed of the processors to the speed of the Intel processors. Both Sun and HP use RISC

architecture, and many instructions may be run on these machines for one on the Intel architecture.

Another option with many machines is to add a second CPU. This is usually an expensive option (currently \$1,000 for a second 550 MHz Xeon), and running CATIA interactively offers no noticeable gains. For a second CPU to improve application performance, the application needs to be multithreaded. CATIA is not currently multithreaded. Several of the hardware vendors submitted dual-processor machines for the benchmark. They did not outperform similar-speed, single-processor machines.

A second processor may be useful on both Intel and UNIX machines, if the user wants to perform another task on the machine. However, other system resources, such as memory and I/O, would be shared by that second processor. Thus, I believe it's a waste of money to buy a second processor in a machine used to run CATIA interactively. That being said, I recommend buying a machine that is dual-processor capable. That will enable you to add the second processor when CATIA is multithreaded and the CPU is cheaper.

- **Graphics Card**

The second most-important component to select is the graphics card. An inadequate graphics card leads to jumpy screen behavior, which leads to distractions for the operator. CATIA demands that the card support OpenGL. Price of the card used to be a good indication of the amount of memory on the graphics card and its relative performance. The Intergraph Intense3D Wildcat 4000 graphics adapter showed outstanding performance in all

## Benchmark Presentation

Phil Harrison will give a presentation at the Fall 1999 CATIA Operator's Exchange (COE) Conference on the making of CATIA Solutions Magazine's 1999 CATIA Version 5 Workstation Benchmark. His talk will include a live demonstration. See pages 50-52, 60-61 for conference information.

**Table 4. Generic System Specifications**

	Entry Level	High End
Processor	500 MHz Pentium III	550 MHz Pentium III Xeon
CPUs (max)	1	1, capable of 2
Motherboard Chipset	Intel 440 BX	Intel 440 GX
Memory (RAM)	256 Mb	512 Mb
Hard Disk	9.1 Gb EIDE or SCSI	2 x 9 Gb UW SCSI 2
Graphics Card	IBM/Diamond FireGL1	Intergraph Intense3D Wildcat 4000
Monitor	19" .28" dp or better	21" .28" dp or better
Network Card	Integrated 10/100 Ethernet	Integrated 10/100 Ethernet
Expect to Pay	Approx. \$4,500	Approx. \$8,000

scenarios. This is a mid-priced adapter and was included in the higher-end Compaq, Dell, IBM and Intergraph machines. The new (and inexpensive) IBM/Diamond FireGL1 adapter was absolutely amazing and even outperformed the Intense 3D card on the telephone and bellhousing scenarios. However, the adapter's performance was average on the production cell scenario.

The Hewlett Packard J5000 UNIX machine returned the best graphics performance with its FX6 graphics card. The performance was stunning. The card is a \$9,500 option, however, costing more than nine of the complete systems submitted.

Also critical here is the bus between the graphics card and CPU. While Intel used to use the PCI bus to communicate with the graphics card, all of the Intel-based workstations submitted for the benchmark use the newer Advanced Graphics Port (AGP) or AGP 2x bus to speed graphics performance.

SGI and its Integrated Visual Computing architecture is due a special mention here. SGI has a long history of graphics leadership and has taken a novel route to produce a high-performance system at relatively low cost. System memory is shared between the CPU and graphics subsystems, which reduces system cost, while the integrated Cobalt graphics chip set communicates on a dedicated bus with the CPU.

I would recommend the IBM FireGL1 card for entry-level and mid-range applications and Intergraph's Intense3D Wildcat 4000 for high-end work.

• **Random Access Memory (RAM)**

CATIA is a memory-intensive application, and there is nothing worse for CATIA than to run out of real memory and start to page. When this happens, users notice a dramatic drop-off in performance, as hard disk access times are orders of magnitude worse than memory access times. The minimum recommended memory for CATIA from Dassault Systèmes is 256 Mb. However, the amount required depends very much on the datasets to be loaded and what other programs are run at the same time as CATIA.

A Windows NT system running e-mail, standard network protocols and an anti-virus program will deduct 50 Mb away from your total memory immediately. Therefore, a machine with 256 Mb will only have 200 Mb of real memory available for CATIA to load the program and the dataset. *Remember when Bill Gates said that he couldn't imagine an application requiring more than 1 Mb of addressable memory?*

Memory is now extremely cheap, running at about \$2/Mb. I would recommend 256 Mb for lower-end machines

and a minimum of 512 Mb for larger assemblies. That being said, you should run a test on your datasets and then check to see if you're paging. If you are, then you should invest in more memory. UNIX machines tend to allow the installation of more memory than Intel machines; most of the Intel machines allowed a maximum of 1 Gb of memory. The UNIX machines from Sun and Hewlett Packard allowed between 2 Gb and 4 Gb to be installed and would be more suitable for very large digital mockup work.

• **Hard Disk/Controller**

Fast read and write times are desirable to improve the speed at which CATIA is read into memory and to optimize the read and write of data. Ninety percent of the benchmark systems submitted for testing used Seagate's new 9 Gb ST39102 Cheetah SCSI disk, which operates at 10,000 RPM and is very fast. It is also noisy!

SCSI is preferable over EIDE disk drives, as it is generally more reliable and allows more devices to be controlled from a single controller. However, SCSI is more expensive, so buyers of budget systems may want to consider EIDE disk drives.

Table 4 summarizes these recommendations for an entry/mid-level and a high-end workstation. ●