
Silicon Graphics Corporate Profile

Introduction

Silicon Graphics offers a full line of graphics workstations and servers in the IRIS 4D product line which consist of basically three major product families: The Indigo RISC personal computers, the IRIS Crimson desktide systems and the IRIS POWER Series graphics supercomputers and servers. Silicon Graphics had six percent of the worldwide workstation market in 1991, according to Data Analysis Group, behind Sun (33 percent), HP (21 percent), DEC (16 percent), and Integraph (7 percent). In August of 1992, SGI formed a single point of operations for managing OEM sales. Currently OEM partners include Daikan Industries, Digital Kienzle, Siemens-Nixdorf, Tandem, and Control Data. SGI has signed an agreement with Microsoft for incorporating IRIS GL (graphics library) technology into future operating system software from Microsoft, bringing 3D capabilities to microcomputer users.

With a good portion of its market share in high-end workstation sales, recent IRIS 4D product line additions have expanded SGI's product offering into the low-end workstation market. The IRIS Indigo is part of this strategy representing a fusion of PC and workstation technologies that combines high-end processing and graphics computing features into a professional desktop environment. IRISserver systems are designed to penetrate Fortune 1000 companies with distributed computing needs, such as systems with high storage capacities and network administration tools.

IRIS 4D workstations compete primarily against UNIX-based systems from Sun and HP that offer 3D graphic capabilities. The IRIS 4D workstations are impressive more for their high-performance graphics capabilities than for the power of their general-purpose compute engines.

SGI aggressively promotes cooperation with resellers and third-party software vendors through its IRIS Partners Program.

Corporate overview

Silicon Graphics Inc. (SGI), based in Mountain View, California, with 3,500 employees was founded in 1982 and has built a reputation for

SGI Profile - Page 1

Ñ January 15, 1993

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high-end 3D graphics systems.

SGI's revenues topped \$500 million for the first nine month of the fiscal year ending June 30, 1992 -- representing an increase of nearly 40 percent over the previous year's results. Consequently, SGI's strong cash position was committed in mid-1992 to rescue MIPS Computer. SGI ended up reporting a net loss for its fiscal year of \$118 million against a meager profit the year before of \$37.5 million. Total turnover rose by 24 percent at \$866 million (the figures are drawn up on a pro forma basis to reflect the MIPS Computer Systems Inc. acquisition). SGI will continue to incur costs of \$100 million per year for the next three years as a result of the MIPS acquisition.

Key Executives

Edward R. McCracken

CEO/President

Mike Ramsay

Senior Vice-President

Thomas Jermoluk

Executive Vice-President, Chief Operating Officer

John L. Hennessy

Chief Scientist and co-founder of MIPS

Gary L. Lauer

Vice-President Marketing

Ralph Mele

Senior Vice-President Sales

Financial highlights

SGI01.HPG;4.565";3.356";HPGL

SGI02.HPG;4.565";3.356";HPGL

SGI03.HPG;4.565";3.356";HPGL

SGI Profile - Page 3

Ñ January 15, 1993

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Target Markets

Silicon Graphics is in the data visualization business. While they have made aggressive in-roads in the lower end graphics markets, they are known as the graphics heavies of the industry, targeting Scientific Visualization, Imaging, CAE, MCAD, and AEC markets. For the lower end Indigo systems they also advertise as desktop publishing, CASE, and EE markets.

Overall product strategy

SGI's focus on 3D graphics is used as an effective differentiator against other volume workstation vendors such as Sun, DEC, and IBM.

SGI has a very limited range of products and applications for general business and commercial users. With the low-end Indigo, SGI is attempting to break out of its 3D visualization market niche.

Product portfolio and positioning

Model	Power Series Crimson	Indigo R3000	Indigo R4000	
Processor	R3000 R4000	R3000	R4000	
# Processors	1,2,4 or 8	1	1	1
Packaging	-- desktop	desktop	desktop	
Markets	SciVis, MCAD, SciVis, Animation Imaging	publishing, CASE, CAD, AEC	publishing, CASE, CAD, AEC	
Base price	\$49,900 \$29,900	\$8,000	\$12,485	
Base config MB, 16"	8 MB, 16"	16 MB, 16"	16 MB, 16"	16
	diskless diskless VGX Entry	diskless Entry	diskless Entry	

Competitive product positioning

Entry Level

SGI
HP
HP is Better
Model
Indigo
715/33
Processor
R3000
PA-7100
Clock
33 MHz

33 MHz
Graphics
Entry
CRX
Price
\$10,500*
\$7,290*
\$3,210
SPECmark89
26.3
42.8
1.6 X
MFLOPS
4.2
8.3
2.0 X
SPECint92
22.4
24.2
1.1 X
SPECfp92
24.2
45.0
1.9 X
3D Vecs/Sec
220k
600k
2.7 X
Triangles/Sec
20k

12k
0.6 X Polygons/Sec
6.6k
10k
1.5 X X11perf
N/A
7,633
1.8 X

* Configuration - 16 MB RAM, 1/2 GB disk, 16" color monitor for 3D enabled system add \$2,100 to HP configuration for PowerShade.

Color Desktop

SGI HP HP is Better

Model Indigo 715/50 Processor R4000 PA-7100 Graphics XS/24Z CRX-24Z Price \$27,995* \$24,490* \$3,505 SPECmark89 70 69 MFLOPS 16 13 SPECint92 57 36.5 SPECfp92 61 72.1
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	1.2 X 3D Vecs/Sec
	270k
	650k
	2.4 X Triangles/Sec
	80k
	150k
	1.9 X Polygons/Sec
	30k
	70k
	2.3 X X11perf
	4,223
	10,650
	2.5 X

* Configuration - 16 MB RAM, 1/2 GB disk, 19" color monitor.

High-Performance Desktop

SGI HP HP is Better
Model Crimson 735 Processor R4000

PA-7100
Clock
50 MHz
99 MHz
Graphics
XS/24Z
CRX-24Z
Price*
\$57,900
\$47,940
\$9,960
SPECmark89
70
147
2.1 X
MFLOPS
16
40
2.5 X
SPECint92
57
80.0
1.4 X
SPECfp92
61
150.6
2.5 X
3D Vecs/Sec
270k
650k

2.4 X Triangles/Sec

80k

175k

2.2 X Polygons/Sec

30k

100k

3.3 X X11perf

6,384

18,790

2.9 X

* Configuration - 32 MB RAM, 1 GB disk, 19" color monitor.

High-Performance Deskside

SGI
HP
HP is Better
Model
Crimson
735
Processor
R4000
PA-7100
Clock
50 MHz
99 MHz
Graphics
Elan
CRX-48Z
Price*
\$57,900
\$52,940
\$4,960
SPECmark89
70
147
2.1 X
MFLOPS
16
40
2.5 X
SPECint92

57
80.0
1.4 X SPECfp92
61
150.6
2.5 X 3D Vecs/Sec
1,000k
1,900k
1.9 X Triangles/Sec
270k
600k
2.2 X Polygons/Sec
68k
160k
2.4 X X11perf
6,384
19,120
3.0 X

* Configuration - 32 MB RAM, 1 GB disk, 19" color monitor.

Hardware summary

SGI's graphics solutions involve applying increasingly large amounts of exotic hardware to solve what is a straightforward problem if you have sufficient CPU power. Hardware products are based upon MIPS

Computer Systems' R3000 and R4000 microprocessors, plus SGI's proprietary Geometry Engines. These GEs are application specific integrated circuit (ASIC) add-in modules that perform graphics calculations independently of the system's CPU.

Indigo -- The Indigo is SGI's older uniprocessor model introduced in 1991. It was originally based on the R3000 processor but a newer R4000-based version was introduced in 1992. Prices for a diskless R3000 Indigo start at \$8,000 and run up to around \$22,000 with the higher end graphics options. The R4000 models currently run \$5,000 above comparably configured R3000 systems. Note that the upgrade in processor does not provide additional graphics performance. SGI is currently selling about 2000 R4000 Indigos per month.

Crimson -- Introduced in 1992, the Crimson is SGI's high-end R4000-based uniprocessor machine. The Crimson offers 4 SCSI peripheral slots and four VME slots. It supports all graphics options. Prices run from \$28,000 for a diskless server configuration to \$130,000 for the high-end Reality Engine graphics configuration.

Power Series - The Power Series is SGI's multiprocessor offering. The systems are R3000 based, supporting 1 - 8 processors at 33 or 40 MHz. Models range from the 4D/310 (33 MHz uniprocessor) to the high-end 4D/480 (40 MHz 8 processor) model. The naming scheme is 4D/xy0 where x specifies the MHz and y the number of processors. The Iris operating system supports SMP and parallelizing compilers are available from SGI. All graphics options are available on the Power Series systems. The top of the line system can run in excess of \$240,000.

R4400 - On November 2, SGI announced the new MIPS R4400 processor as a follow-on to the R4000. The chip is available in 100 MHz, 134 MHz, and 150 MHz versions and is implemented in 0.6 micron CMOS. The new chip is binary compatible with the R3000/4000. While SGI did not announce any systems based on the new chip we expect they will come out with R4400-based Crimson systems in '93. Because of the high cost of the chip and low margin on the Indigo systems it is possible that SGI will choose not to implement an R4400 version of Indigo. Because of SGI's graphics architecture this CPU upgrade will not provide additional graphics performance.

Graphics:

Entry - The 8-plane 1024x768 entry-level graphics offering, also known as Virtual24, is of marginal use and rarely sold. It is available only with a 16" monitor. To upgrade to a 19" monitor requires upgrading to the XS graphics, a costly alternative. Entry graphics do not support Geometry Engines.

XS - The low-end XS graphics option offers 1280x1024 8-plane graphics with an optional Z buffer. On a Crimson the XS carries a \$7,000 price tag over the entry-level graphics plus a \$2,000 premium for the 19" monitor and an additional \$2,000 for Z. One Geometry Engine is supported.

XS24/XS24Z - This 1280x1024 graphics option is enhanced with 24 bitplane color. Again, Z-buffering is optional at \$2,000. The 24 planes adds an additional cost of \$2,000 above the 8-plane XS on a Crimson platform.

Elan - Elan is the next higher level graphics option. It offers 1280x1024 resolution at 24 planes with hardware Z. SGI has been using the \$58,000 Crimson Elan as a strong sales strategy against HP, dropping to the lower cost but same performance Indigo R4000 Elan at the last minute. The introduction of the new PA-7100 systems stops that gap effectively. Elan supports 4 Geometry Engines.

VGX/VGXT - VGX and VGXT are top-end graphics subsystems offering 8 Geometry Engines, 64 color planes, extremely fast polygon performance, anti-aliasing, and texture mapping. Available only on Crimson and Power Series.

Reality Engine - The Reality Engine is SGI's most advanced graphics environment offering dramatic performance increases even over the previous top-of-the-line VGXT. The Reality Engine is available only on Crimson and Power Series machines. The price tag ranges from \$100,000 to \$245,000 depending on the base system.

Software summary

IRIS - IRIS is the SGI operating System based on AT&T's System V.3 with some Berkeley extensions and enhancements for support of symmetric multiprocessing. Further enhancements support real-time applications. The current plethora of point revisions is causing a good deal of confusion to the SGI user base.

GL - GL is SGI's proprietary graphics API much like Starbase. GL is available on HP platforms as a third-party interface from Nth Graphics.

OpenGL - OpenGL is a rewritten version of GL 4.0, created in response to SGI's need for better integration with the X Windows System environment. SGI is marketing OpenGL as the alternative to PEX, the PHIGS extension on X. This is a new, untried product. It has not been through open industry review nor is it adopted by ANSI, ISO, or the majority of workstation vendors.

IRIS Inventor - An object-oriented software library package to aid development of 3D graphics applications. Based on a 3D hierarchical database, Inventor groups graphics concepts into nodes and actions. Nodes are such things as high-level primitives, properties, and database attributes. Actions include event handling, callbacks, and object manipulations. Inventor also includes several viewers.

Software positioning

Standards

The need to reduce development costs and increase portability is pressuring application developers to standardize on a single 3D graphics programming tool. The industry choice has been PEX, the PHIGS extension to X but SGI is pushing OpenGL, their rewrite of the proprietary GL API. OpenGL is an immature, untested product which lacks functionality and industry support. For current GL users it requires a full application port. Additionally, OpenGL carries a complex and expensive licensing scheme.

Specialized graphics hardware inevitably leads to application dependency on specific functionality present in the hardware. It is doubtful whether OpenGL will really be successful on any platform but Silicon Graphics because of the assumption that hardware such as stencil planes, accumulation buffers, and alpha buffers is present. On platforms without this proprietary hardware, it is necessary to use a software implementation provided by SGI, which inevitably runs much more slowly.

SGI does not offer a native implementation of PHIGS on their platform. Instead they refer to a third-party product called Figaro PHIGS. Figaro PHIGS is layered on top of GL and thus doesn't give full performance such as HP PHIGS. Recently SGI agreed to participate in the efforts to define a single protocol for distributed 3D graphics.

X Integration

Before IRIS 4.0, GL applications were forced to build their own widgets because they could not easily integrate GL rendering with the native window system and its available widget sets, if any. Now the preferred model is to do "mixed model" applications which use X and its widget sets (e.g. Motif) for the basic user interface, but render in GL. This method is unsatisfactory because input handling and color-map sharing require tight integration between the 3D graphics library and the X Window System.

The SGI Raster Engine (REX) ASIC chip is a pipelined line drawing and pixel filling engine on a single chip. The only facilities provided for support of X11 is that "it considers the upper left corner of the screen to be the origin, which supports X11 protocol screen addressing," and "a programmable length pattern register." The remaining functions are intended to support the proprietary IRIS GL library functions. The entry-level graphics subsystems give such poor performance that the X Windows benchmark (x11perf) performance numbers are not published.

The Series 700 is well known for its superior X11 and vector performance. In fact, there is currently no device available from other vendors that can even beat a Model 715 (not to mention a Model 735 CRX) in X11 performance.

HP 9000 versus SGI

Parity
HP Strengths
SGI Strengths
-Corporate strength
-Industry perception as graphics leader
-Investment protection
-PA-7100 Architecture
-Ultra high-end systems
-High functionality/entry cost graphics
-Multiprocessor systems
-Integrated Multimedia

The HP strengths reflect areas that HP should discuss and sell as being critical to the prospect's success. Being in the account first and discussing the importance of these items may set the criteria for an HP win.

SGI strengths reflect what they will discuss. These may be HP's perceived weaknesses and HP can expect to be challenged on these issues. The Handling objections section discusses tactics to discount or turn these issues into an HP strength.

HP's strengths against SGI/criteria for HP win

Corporate strength

HP is a much more stable company. HP's total turnover in its FY'92 was over \$16 billion, and its net profit is equivalent to SGI's and MIPS's total turnover. HP's financial strength assures long-term stability as a business partner. The diversity of our business and product segments enables HP to be more financially stable than strictly computer-oriented companies such as SGI.

Product range

HP has a broad homogeneous product portfolio based on leadership RISC technology, from the desktop Model 715 up to data center systems (e.g., 890/400). Moreover, HP can provide a customer with complete solutions, since HP is also a leading vendor of peripherals and office automation.

SGI has concentrated very much on the high-end 3D graphics niche. With the lower cost Indigo systems they are trying to widen their focus. However, lack of standards support combined with poor X performance cripples the Indigo in applications with X Windows-based user interfaces. Since this is often the primary use for low-end graphics workstations, applications in the commercial, system administration, software development, and personal productivity environments may be severely handicapped. Add in the R3000's poor floating-point performance and low-end technical applications are affected as well.

Additionally, SGI offers no monochrome or grayscale entry-level systems. Their Entry graphics subsystem supports only a 16" monitor. In order to use the 19" monitor which most technical customers demand, it requires an upgrade to the XS graphics at a \$3,500 premium plus an additional \$2,000 for the monitor upgrade.

Investment protection

HP's hardware architecture of the Series 700 result in faster graphics and CPU performance when upgrading to a newer PA-RISC chip. This is achieved by integrating graphics instructions into the PA-RISC chip.

SGI requires the customer to purchase two upgrades, CPU and graphics processor, to achieve the same balance as HP achieves with just a CPU upgrade.

Support

HP has excellent quality of their products and support, and offers a wide range of maintenance, support, and consulting services worldwide. SGI has only a thin support network, and hence, customers often depend on help from other SGI users. Moreover, SGI's support contracts are more expensive than HP's.

Superior price/performance

HP systems outperform SGI product line in almost every category at every price point. Price/performance is an important reason for choosing a computer system. When choosing an HP system the customer has the benefit of getting the most performance for his money.

PA-7100 RISC

The PA-7100 RISC processor is a clear price/performance leader over the MIPS architecture. The PA-7100 architecture offers 2X superscalar instruction execution, superior floating-point performance and graphics support instructions all of which are important in delivering performance to 3D graphics applications.

After the ACE consortium fell apart, only a few computer companies stayed with the MIPS processor. DEC and Olivetti moved to the Alpha processor and Convex has chosen HP's PA-RISC chip after evaluating MIPS. PA-RISC will be driven further by HP and eleven international manufacturers of computers that make up PRO, the Precision RISC Organization. Members include Hitachi, Convex, Hughes Aircraft, Mitsubishi Electric, OKI, Prime Computer, Sequoia, Stratus, Samsung, Yokogawa Electric, and Winbond.

High functionality/low-cost graphics

While SGI is perceived to be the leader in high-end, high-performance

graphics they are certainly not in that market at entry-level prices. HP is. With the introduction of the model 715 supporting CRX-48Z graphics we can offer the highest functionality, highest performance graphics at the lowest cost. The new Virtual Memory X (VMX) functionality of PowerShade takes low-cost 3D a step further, allowing 3D graphics on any X device including an X-Station.

Multimedia

By providing a dedicated Digital Signal Processor, 24-bit digital stereo and 16-bit analog stereo microphone inputs, and digital stereo output, the SGI Indigo appears more targeted at multimedia authoring applications rather than serious 3D applications. Described by SGI as "the first of a new breed of computers, the RISC PC," it appeals to SGI's animation and communication graphics customer base in an attempt to prevent defection to lower priced Macintosh products or multimedia PCs.

HP delivers not just individual multimedia capabilities but an unmatched level of integration across the entire product line including X-Stations with the MPower product.

SGI's strengths versus HP

- † New R4400 Processor - the newly announced R4400 processor is the follow-on to the MIPS processor family. Implemented in 0.6 micron CMOS, it is available in 100 MHz, 134 MHz, and 150 MHz internal clock rate versions and is binary compatible with the R3000/4000. The R4400 will deliver an estimated 113 SPECmarks.

Counter with:

Due to the architecture of the SGI systems, any speed enhancements realized by upgrading the CPU to the R4400 chip will not translate into graphics performance. SGI relies upon their proprietary ASIC Geometry Engines to provide graphics performance, not the CPU. HP delivers both applications performance and graphics performance improvements with any CPU upgrade.

Upgrade costs for the R4400 chip may be prohibitive. The R4000 version of the Indigo sells for approximately \$5,000 above the R3000 version. The cost of the R4400 chip alone runs between \$1,300 and \$1,600, providing a very expensive upgrade path.

† Ultra High-End Graphics - Introduced in July, 1992, the Reality Engine is SGI's top-end graphics subsystem offering functionality oriented to the virtual reality market segment. It is available as a three-board set on either the Crimson or Power Series machines.

Counter with:

Carrying a price tag of \$100,000 to \$250,000, the Reality Engine is analogous to an Indianapolis 500-type race car. It demonstrates aptitude, but has little practical application. The highly specialized and technically advanced nature of this product's capabilities implies a target audience that will develop most of its own software. Given this, available applications will be slow in accumulating.

‡ Multiprocessors - The SGI Power Series systems offer multiprocessor capability not available in the HP workstation line.

Counter with:

While multiprocessor solutions over the spectrum of coupling, from loosely coupled clusters to tightly coupled massively parallel architectures, provide specific families of applications with performance benefits, it is widely accepted that system performance of multiprocessor boxes is in no way additive over the number of processors in the system.

SGI claims of 166 SPECmarks for an 8-processor system is based around the Power Series multiprocessor version of the R3000 with the multiprocessor SPECthruput benchmark. It is neither measured by conventional SPECmark89 or SPECint92 and SPECfp92 uniprocessor benchmarks nor is it the sum of the individual SPECmark ratings.