Fasten your seat belts. *Intel's new graphics bus may promise faster performance and realistic 3D, but our tests of the first AGP graphics cards reveal that the trip could be anything but smooth.*

a bumpy

AGP GRAPHICS

ride

FIRST IT WAS 56K modems, then it was DVD, and now it's Intel's Accelerated Graphics Port. The list of half-finished new technologies being inflicted on computer buyers seems to be at an all-time high. Nearly four years after PCI became the bus of choice in desktop PCs, Intel introduced a new, graphics-only bus that's touted as making quick work of even the most demanding 3D, video, and 2D graphics. The AGP bus—along with a new, dedicated card slot—moves PC graphics off the busy PCI bus and gives the graphics ►

By David English and Michael Desmond

data its own fast lane to the processor. There's just one problem: The new bus may do a better job of confusing buyers than it does of speeding up 2D and 3D graphics operations.

Why did Intel go to the trouble of crafting a new connection? In a word, 3D. AGP can provide a significant benefit to 3D games, titles, and applications that have been designed to exploit its features, letting them deliver greater realism by providing access to fuller scene graphics. The new bus also promises to shortcut increasing demands on the existing PCI bus, now that everything from network adapters to sound boards are beginning to share bandwidth with graphics cards.

NOT FOR EVERY PC

BUT DON'T RUSH OUT and buy an AGP graphics card just yet. To take advantage of the new technology, your system must be equipped with an AGP bus slot—something that began appearing in Pentium II systems sold only since September—or it must have AGP graphics integrated on the motherboard. The secret ingredients: Intel's new 440LX chip set and Microsoft's Windows 95 OEM Service Release 2.1. The 440LX not only adds AGP, it also introduces fast SDRAM memory to Pentium II PCs, providing a boost over the EDO DRAM found in 440FX-based Pentium II systems. All new Pentium II PCs shipped with Windows 95 should have the OSR 2.1 version of the operating system. Be sure to check that OSR 2.1 also came with the USB supplement, which includes a 32-bit device driver that adds AGP support to the operating system (not all Pentium IIs include the supplement).

Because the hardware requirements severely limit the number of PCs that can be upgraded to AGP, graphics board vendors have little incentive to ship retail AGP cards immediately. So you can expect to wait another four to six months before finding a wide selection in stores.

To see if this new graphics bus could really deliver faster performance and more realistic 3D graphics, we tested five of the first shipping AGP boards. Our findings: Although AGP cards can improve the visual detail of software that's optimized for it, we saw little, if any, impact on today's popular software. Graphics-intensive 2D applications like PowerPoint, as well as demanding video-playback operations, do not get a noticeable performance boost on the new bus,

AGP à la Carte

NOT ALL CARDS take advantage of AGP's features like AGP texturing and pipelining. That leads to big differences in the quality of game scenes when running AGP-optimized software. Here are four features to look for.

Feature 1 **AGP 2X mode:** The 2X mode can move data at 528MBps—twice as fast as the original 264MBps 1X mode—by performing two operations for each tick of the AGP bus.

GRAPHICS CARD

Graphics processor

Frame buffer

CPU

AGP CHIP SET

SYSTEM MEMORY

Textures

PCI

AGP can allow graphics cards direct access to the system's memory.

How AGP works AGP promotes your graphics card in the PC's data food chain. It creates a new connection between the graphics card and system memory, so graphics data no longer travels on the busy PCI bus. The 66-MHz bus—twice the speed of the PCI's—provides fast access to RAM for displaying realistic 3D graphics.

and even AGP-enhanced games run at about the same speed.

More important, we found that not all AGP graphics cards provide the same features. It turns out that some boards lack the key texturing feature that lets AGP improve the performance and visual detail of AGP-enhanced 3D software. The reason: Intel's definition of AGP does not require board vendors to support most of its features.

Right now, AGP-enhanced software is as scarce as cheap housing in San Francisco. Hopefully, by the second half of 1998 heavy-duty graphics users will find lots of games and a few 3D design applications—including Caligari's TrueSpace and Virtus's
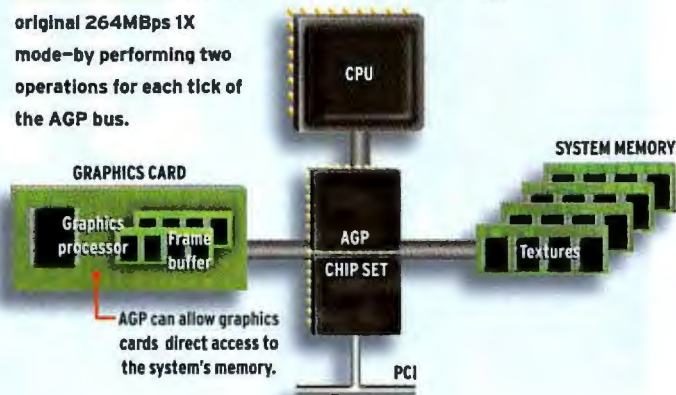
RECOMMENDED

THE ATI Xpert@Work supports the hot AGP features.

NOT ALL AGP boards are created equal, as we found out in our tests with AGP-optimized software. Though all five boards performed ably in a variety of 2D, video, and non-AGP-optimized 3D tasks, we found that two boards could not display AGP-enhanced scenes in our Psygnosis G-Police game tests.

The best of the bunch is the ATI Xpert@Work, the only AGP 2X board in our roundup. It excelled in our PC WorldBench tests and provided consistently high frame rates running G-Police. The Diamond Viper also performed very well but was not as fast as the ATI in our PC WorldBench test.
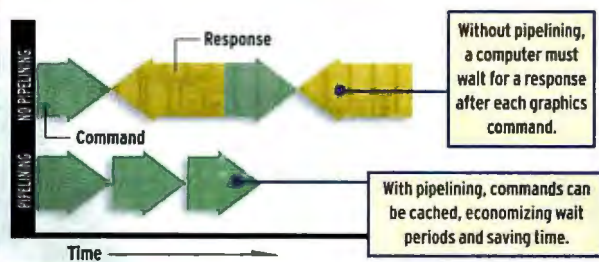
Frankly, we were surprised to find key AGP features missing from some of the boards

we reviewed, so the burden clearly falls on the buyer to make sure the expected features are present in a product. If you want AGP for its 3D potential, for example, ask specifically about AGP texturing support in the graphics card. You may even want to wait until mid-1998, when the first truly AGP-optimized graphics chip sets are expected to roll out.

Feature 2 — Sideband addressing: Cards with this feature provide a separate path for sending and receiving command data, freeing up the data path to achieve top throughput.

With sideband addressing

Data
Commands
Without sideband addressing

Data
Commands travel a separate path.
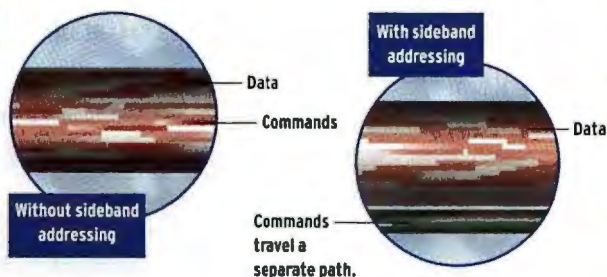
Feature 3 — Pipelining: Get a card with pipelining. It reduces downtime by letting the graphics card issue many commands without the AGP card first waiting for a response.

NO PIPELINING

Response
Without pipelining, a computer must wait for a response after each graphics command.

PIPELINING

Command
With pipelining, commands can be cached, economizing wait periods and saving time.

Time

Non-AGP-enhanced scene

Feature 4 — AGP texturing: Also called Direct Memory Execute mode, AGP texturing provides much greater realism by letting AGP graphics cards use large amounts of your computer's system memory to build 3D graphics.

AGP-enhanced scene

ConceptCAD—that take advantage of AGP's unique talents.

The five boards we tested all boast 3D-capable graphics chips and represent some of the latest graphics technology. We looked at OEM versions of the ATI Xpert@Work, Diamond Viper V330, Matrox Millennium II AGP, Number Nine Revolution 3D, and STB Velocity 128 AGP boards. To compare the performance of these AGP products, we also tested the PCI versions of the same cards. Because the AGP boards are currently available only as part of a new PC, we were unable to select a Best Buy but do recommend one board: the ATI Xpert@Work.

IS AGP REALLY FASTER THAN PCI?

IF YOU WANT TO REPLACE your PCI graphics adapter with an AGP board just to speed up your everyday work, it won't happen—at least, not with the typical Windows business applications that are available today. We tested the five cards on an AGP-equipped Dell Dimension XPS D266 Pentium II computer. We put both the AGP and PCI boards through a battery of business- and multimedia-application tests, including 2D graphics, video playback, and 3D games. The result? Performance that was virtually indistinguishable between the PCI and the AGP versions of these products. For example, the PC WorldBench scores delivered by the AGP and PCI versions of four cards were within a single point of one another—an insignificant difference.

Our video test, which plays back a high-resolution MPEG-2 video clip, failed to show any speed advantage for AGP. The one

exception: The STB Velocity 128 AGP eked out 3 more frames per second than its PCI sibling, which was already pushing out a very nice 30 fps. Even our test of a non-AGP version of the Psygnosis game G-Police showed no difference for most cards.

So what's going on here? Peter Glaskowsky, senior analyst at *Microprocessor Report*, says AGP has nothing to offer current non-AGP-enhanced 3D software. "The kinds of polygon counts [a measure of 3D quality] that we're dealing with today are within what PCI can generally transfer." In other words, there isn't a problem AGP needs to solve. Most graphics and video operations don't use up the ample bandwidth provided by today's PCI cards. The effect is similar to that of adding lanes to an underused freeway. The extra lanes won't get drivers to their destinations any faster, because they are already able to drive as fast as they please.

That said, some PCs may benefit from the new bus, Glaskowsky adds. The traffic created by PCI peripherals such as SCSI hard disk adapters and PCI audio cards can limit the bandwidth available to graphics on these systems.

Another reason for the parity of AGP and PCI is that vendors use the same graphics chip for both the PCI and the AGP versions of their cards. In fact, we saw much greater differences among product lines in our tests than we did between different bus versions of the same product. ▶

DESKPRO	2000	4000	6000
Processor	166MHz Pentium® Processor with MMX™ technology	200MHz Pentium Processor with MMX technology	300MHz Pentium II Processor
Standard Memory	16MB SDRAM	32MB SDRAM	64MB ECC SDRAM
Hard Drive	2.1GB SMART	3.2GB Ultra ATA	4.3GB SMART ULTRA SCSI
Standard Cache/Max	256KB/512KB	512KB/512KB	512KB/512KB
Video Graphics	S3 Trio V2/GX	S3 ViRGE/GX	Matrox Millennium II (AGP)
Video Memory/Max	1MB/2MB SGRAM	2MB/4MB SGRAM	4MB/16MB WRAM
Expansion Slots/Drive Bays	5/5 Desktop	5/4 Desktop	5/4 Desktop
Ports: Serial/Parallel/USB	1/1 ECP/2	2/1 ECP/2	2/1 ECP/2
Intelligent Manageability	Yes	Yes	Yes
CD-ROM	Optional	Optional	24X with Sound
Software Pre-installed	Windows 95	Windows 95	Windows NT for Workstation
Limited Warranty*	3-Year	3-Year	3-Year
Compaq Monitor	V50 15" (13.77" viewable)	V50 15" (13.77" viewable)	V50 15" (13.77" viewable)
Price†	$1,399	$1,669	$3,859

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AGP 3D: IT'S NOT THE SPEED, IT'S THE LOOK

OKAY, SO AGP may not speed up your existing software. What about games and applications that use AGP-enhanced 3D graphics? In most cases, AGP lets you run heavily textured games with realistic 3D scenes that bring PCI to its knees.

To confirm this point, we tested the AGP and PCI versions of the same five cards using a synthetic benchmark called Final Reality, which was developed by VNU Labs based on a game engine from Remedy Entertainment. The test used 16MB of textures to create complex 3D scenes, large enough to force all our graphics cards to use the PC's main memory to store texture data. The result? The PCI board—and the AGP cards that do not support texturing—ground down to about 1 scene per second. The AGP cards that do support texturing had high scene rates, averaging more than 66 sps.

Running our AGP-enhanced version of G-Police, frame rates were nearly identical between the AGP and PCI boards. Like any well-designed AGP game, G-Police automatically switches from heavy texturing for AGP boards to lighter texturing for PCI boards. So no change in speed—just a change in scene quality.

In fact, AGP promises to rid the world of ugly, oversimplified 3D scenes in PC software. Running the same game—one AGP enhanced, the other not—we saw some impressive improvements in visual detail. In hands-on tests using an AGP-enhanced version of G-Police, we noticed that explosions lost the distracting blockiness around the edges that we saw in the PCI version, and static billboards turned into flashy signs with full-motion video. Behind the improvement: the AGP bus's ability to feed 3D object data to the graphics card's processor several times faster than the PCI bus can.
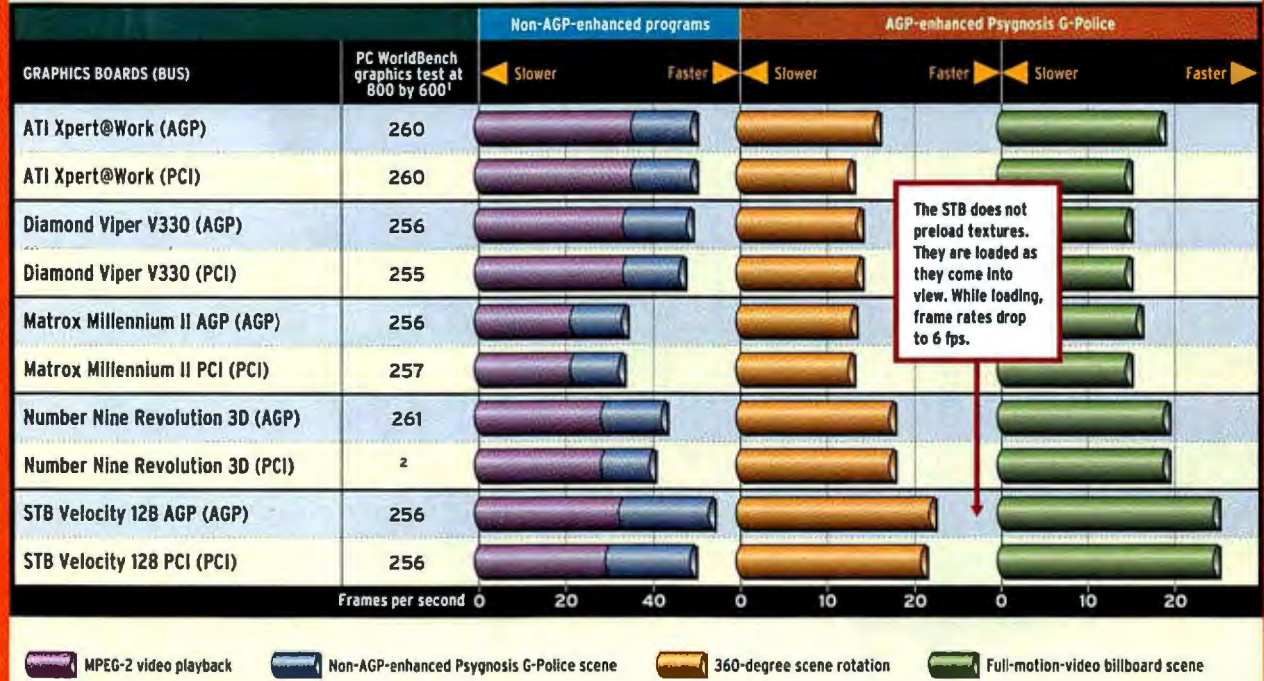
Better scenes, however, do not always mean smooth game play. The STP Velocity board we tested had the fastest frame rates when running the AGP version of G-Police—except when it displayed heavily textured scenes. Each time one of these scenes launched on screen, there would be an annoying ▶

TEST REPORT

AGP Has Little to Offer Today's Apps

BASED ON OUR EARLY TESTS, AGP is not going to speed up your current programs. When we ran PC WorldBench (which uses common business apps), an MPEG-2 video clip, and a non-AGP version of the 3D game Psygnosis G-Police, we found almost no speed differences between PCI and AGP cards. With the exception of the ATI Xpert@Work (the only 2X AGP board we reviewed), our tests on an AGP version of G-Police produced the same results. But in heavily textured scenes, G-Police looked significantly better with the boards that support AGP texturing (ATI, Diamond, and STB).

GRAPHICS BOARDS (BUS)	PC WorldBench graphics test at 800 by 600[1]	Non-AGP-enhanced programs		AGP-enhanced Psygnosis G-Police			
		◀ Slower Faster ▶	◀ Slower Faster ▶	◀ Slower Faster ▶			
ATI Xpert@Work (AGP)	260						
ATI Xpert@Work (PCI)	260						
Diamond Viper V330 (AGP)	256						
Diamond Viper V330 (PCI)	255						
Matrox Millennium II AGP (AGP)	256						
Matrox Millennium II PCI (PCI)	257						
Number Nine Revolution 3D (AGP)	261						
Number Nine Revolution 3D (PCI)	2						
STB Velocity 128 AGP (AGP)	256						
STB Velocity 128 PCI (PCI)	256						
Frames per second		0 20 40	0 10 20	0 10 20			

The STB does not preload textures. They are loaded as they come into view. While loading, frame rates drop to 6 fps.

■ MPEG-2 video playback　　■ Non-AGP-enhanced Psygnosis G-Police scene　　■ 360-degree scene rotation　　■ Full-motion-video billboard scene

[1]We ran PC WorldBench at three resolutions but report only 800 by 600, which showed the greatest differences. Higher scores are better.　　[2]Could not complete test.

HOW WE TEST All tests were performed under Windows 95 on a Dell Dimension XPS D266 Pentium II PC with 64MB of SDRAM. We ran PC WorldBench 1.0 at 800 by 600, 1024 by 768, and 1280 by 1024 resolutions. For our non-AGP multimedia tests, we used the Mediamatics MPEG-2 player software to run a 30MB MPEG-2 video screen saver from Interactual Technologies called Star Trek: First Contact. We unsynched the audio so that the system would play as many frames per second as possible. Our 3D test was an automated scene in Psygnosis G-Police, which has a built-in frame counter to gauge frame rates. (For those applications that use DirectX, we used the version provided with the board.) The AGP-enhanced version of G-Police automatically switches from heavy texturing for AGP graphics boards to lighter texturing for PCI boards, so that the game will run with PCI at acceptable frame rates.

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delay while the game loaded the textures into the scene.

Surprisingly, two of the AGP boards we tested—the Number Nine Revolution 3D and the Matrox Millennium II AGP—fared just as poorly as the PCI boards, both visually with the AGP-enhanced G-Police test and in performance with the Final Reality benchmark test. Both boards displayed the same light texturing the PCI boards did when running G-Police. The Millennium displayed just 1 sps in the Final Reality benchmark, while the Revolution 3D choked out 1.6 sps. In both cases, the scene rates were essentially unchanged from those of their PCI counterparts.

We discovered that both the Revolution 3D and the Millennium II boards lack support for AGP texturing, which the other three cards possess. So while these two boards are running on a 66-MHz bus, they perform like PCI graphics cards on a 33-MHz bus. When our benchmark test called on the cards to pull texture data directly from system memory, the data first had to be copied to the graphics frame buffer in a time-consuming two-stage operation.

Both Matrox and Number Nine point out that their AGP graphics cards are designed for a business audience using 2D applications, not those interested in heavy-duty game play and 3D ani-

BOTH STB's Velocity and Diamond's Viper have AGP texturing.

mation. But the bigger question is, How can cards that legitimately claim to be AGP compliant lack its most critical feature?

Ask Intel. Explains Jim Nucci, Intel AGP marketing manager: "Any graphics card that plugs into the AGP connector is considered AGP whether it's the 1X mode, 2X mode, still using the PCI protocol, or having the high-performance features designed in. From Intel's perspective, it's all AGP." In other words, when Intel developed AGP, it did not make AGP texturing a requirement for AGP graphics cards.

TEXTURES AND TROUBLE

IT TURNS OUT that four different AGP features can be left out of a card, and it can still be called "compliant." The most visible feature is the AGP 1X versus AGP 2X specification. Where 1X runs at 66 MHz and provides 264 megabytes per second of band- ▶

Proceed With Caution

WHEN IT COMES to buying PC hardware and software, conventional wisdom says never to buy version 1 of anything. Of course, we never follow that advice. Here are some tips on how to protect yourself if you are buying a new AGP graphics card.

Making the right choice. First, make sure you know what you are buying. If a system or graphics-board vendor says it provides AGP graphics for enhanced 3D perfor-

mance, don't assume that the graphics card actually supports the most important new features, like AGP texturing and sideband addressing. If you want to take advantage of AGP's advanced 3D-handling capabilities, AGP texturing is by far the most important feature. But be careful: Not all system and board companies use the same terminology to discuss the texturing features of their products. You can look for a few key phrases, however. If a board vendor says that it supports AGP texturing, Direct Memory Execution, or execute mode, you can feel relatively assured that the product will be able to enhance AGP-optimized games and software.

If you want to get the most performance out of your AGP hardware, make sure the board you buy supports AGP's data streamlining tweaks. Look for mentions of sideband addressing and pipelining—both features can really help speed texture data between system memory and your graphics board. Also, look for an AGP board that supports 2X mode. Our tests on an AGP version of Psyg-

nosis G-Police showed a slight performance advantage for the one AGP 2X board we evaluated—ATI Xpert@Work. The 2X's faster data rate could provide an advantage down the road, when games provide 32MB or more of texture data for scenes.

AGP PCs. When buying an AGP-capable desktop system, avoid products that put the AGP graphics chip directly on the motherboard. Some of these systems may not be able to accept future upgrades to AGP cards with improved graphics chip sets. How will you know? Before you purchase a system, ask the sales representative if AGP graphics is provided as an add-in card or in the motherboard, and then get the model names of the board and chip used in the graphics subsystem.

Keep in mind that AGP is a new and confusing technology, and that sales representatives may not be able to provide all the answers you need. If you get precise information about the graphics hardware, you can double-check with the graphics hardware company itself. —M. D.

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"Most users are potentially going to be disappointed by what they get out of first-generation cards, motherboards, and software.

PETER GLASKOWSKY   senior analyst, *Microprocessor Report*

width, 2X cards are able to double that bandwidth, providing a data path that carries 528MBps. The 2X cards can push more data over the 66-MHz connection by executing two operations for each tick of the AGP clock.

It sounds good, and it may be in the future. Our tests with the AGP-enhanced version of G-Police showed only a small increase in frame rates. The ATI Xpert@Work was the lone AGP 2X board in our group. Unlike results for the four 1X boards, G-Police ran slightly faster on the AGP board than it did on PCI. All of the 1X boards showed little or no change in frame rates between AGP and PCI.

A more important feature, at least for AGP-enhanced 3D games and software, is AGP *texturing*, also called Direct Memory Execute mode by Intel. This is the feature that lets AGP graphics cards pull 3D texture data straight from system RAM, allowing 3D scenes in future games to incorporate megabytes of data to achieve enhanced realism. As mentioned above, two of the five AGP cards lacked this critical feature and, when running the AGP-enhanced version of G-Police, showed the same lightly textured scenes as the PCI boards.

Two other features round out the AGP shell game. *Sideband addressing* speeds up AGP data transfers by taking the address and command instructions off the data pipe and sending them instead along a sideband to the system chip set. This data frontage road on the AGP freeway makes additional AGP bandwidth available for moving graphics data.

Likewise, *pipelining* squeezes more efficiency out of AGP command traffic. Normally, the graphics card issues a command and then waits until it receives an answer before issuing the next command—in effect, the board spends a lot of time waiting at red lights. AGP's pipelining feature lets the board issue multiple commands in rapid succession without waiting for a response—
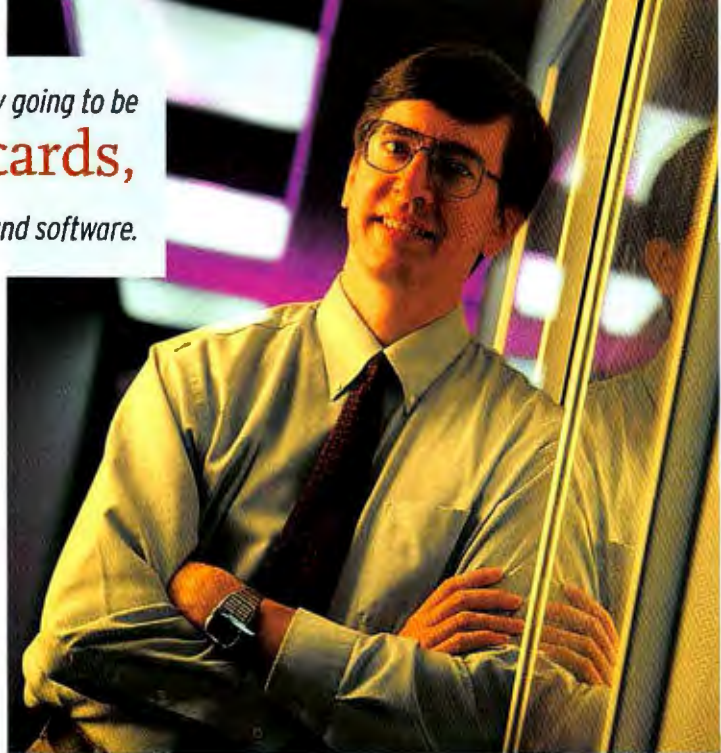
the lights are timed to let AGP commands run uninterrupted.

The challenge for buyers is that any one of these four features may or may not be present in the AGP graphics card they get with their systems. One graphics card may be 1X compliant and still offer AGP texturing, sideband addressing, and pipelining, while the 2X card in the system next to it may lack the other three features. And as far as Intel is concerned, it doesn't matter—all are considered AGP.

Why did Intel allow such a confusing variety of features? To ensure there would be products for the new bus slots. "They were worried that most vendors wouldn't be able to provide 2X graphics chips, and they were correct," says Glaskowsky. "The pipelining, the sideband addressing—those are difficult things to do."

There's more. Next year, Intel expects to release an AGP 4X mode, which will boost available bandwidth to 1 gigabyte per second or greater. While Intel won't discuss details, Glaskowsky says that the AGP 4X clock will run at 133 MHz, double the current rate, while the graphics cards will perform two operations for each clock tick. Don't count on upgrading your current AGP sys-

AGP GRAPHICS BOARDS FEATURES COMPARISON

BOARDS	BASICS					AGP FEATURES			
	Graphics chip	Installed/maximum video RAM	Video RAM type	Maximum refresh rate (Hz) at 1024 by 768		AGP version	AGP texturing	Sideband addressing	Pipelining
ATI Xpert@Work 905/882-2600 ext. 1 www.atitech.com	ATI 3D Rage Pro	4/8	SGRAM	120		2X	●	●	●
Diamond Viper V330 800/468-5846 www.diamondmm.com	NVidia Riva128	4/4	SGRAM	120		1X	●	○	●
Matrox Millennium II AGP 800/361-1408 www.matrox.com/mga	Matrox MGA-2164WA	4/16	WRAM	140		1X	○	○	○
Number Nine Revolution 3D 800/438-6463 www.nine.com	Number Nine Ticket to Ride	4/16	WRAM	150		1X	○	○	○
STB Velocity 128 AGP 888/234-8750 www.stb.com	NVidia Riva128	4/4	SGRAM	120		1X	●	●	●

● Yes ○ No

tem with a 4X card, though—it probably won't be possible.

"Because the signal levels will be different, 4X will not work with anything you buy in the previous AGP implementations," says John Latta, an industry analyst with the *Wave Report*.

Unless you shop very carefully, you could end up with a graphics card that fails to provide a meaningful improvement over current PCI graphics, even when it is running AGP-optimized software. "Most users are potentially going to be disappointed by what they get out of first-generation cards, motherboards, and software," says Glaskowsky.

SHOW ME THE SOFTWARE!

OF COURSE, AGP's new features aren't worth much without software that takes advantage of them. "There's one problem with AGP, and that is, where are the applications?" asks Amid Rahmat, senior analyst at PC graphics research firm Jon Peddie Associates. "At the end of the day, it is all based on where the applications are and where the operating system is."

Microsoft is scheduled to build AGP support directly into the Windows 98 operating system; however, that upgrade has been delayed until April or May. In the meantime, AGP graphics cards must have the 32-bit device driver installed before Windows 95 will recognize them. (As we mentioned earlier, you need to make sure the driver comes with the OSR 2.1 version of Windows 95.) Users will also have to install version 5 of Microsoft's DirectX—a suite of multimedia operating system components and device drivers—to enable AGP's 3D features.

Many graphics board vendors will struggle for a while with incorporating support for AGP in their products. "You have to bear in mind that the chip vendors have their own time lines," says Jon Peddie's Rahmat. "It's going to settle down, but it won't settle down until next year. It'll take the chip vendors and the board vendors another three to six months to start figuring out the chip issues and the driver issues."

On the software side, you can expect a lot of programs to add partial support for AGP texturing in the near future—or at least those features that are easy to implement, such as adding AGP texturing to individual objects rather than to entire scenes. Some game developers say that adding support for AGP texturing is not difficult, and many expect to provide downloadable patches on their Web sites that will add limited AGP support to some existing applications.

Still, like the Pentium MMX chip introduced in January 1997, AGP requires developers to add specific support in order to fully realize the performance advantage of the new technology. With software development cycles taking 6 to 12 months, it could be a year or more before a large number of AGP-enhanced titles show up on store shelves.

AGP TEXTURING: THE SECRET SAUCE

IN ORDER TO DISPLAY a realistic 3D environment, programs apply graphics images, called *textures*, onto the surfaces of the polygons that make up 3D shapes. Done properly, these textures are stitched together to form ▶

THE BLUE RING around the flash above is an example of alpha blending.
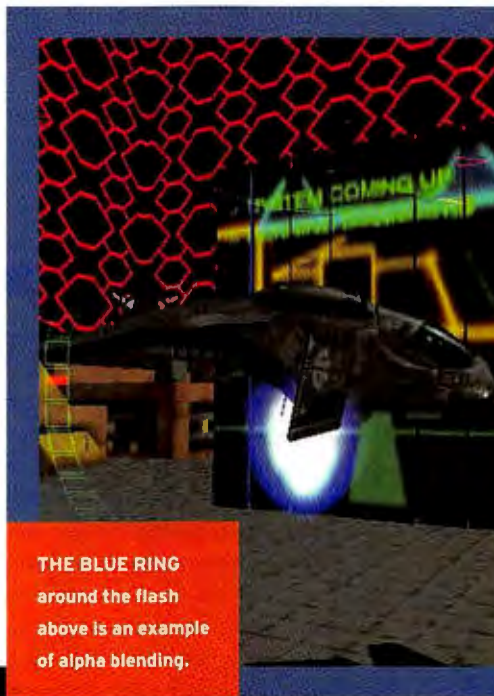
ture-mapped 3D objects look realistic from different angles.

3D filtering. Also called bilinear or trilinear filtering, 3D filtering eliminates blockiness in 3D images and textures by averaging the color data among adjacent pixels.

Fogging. Fogging blends a 3D object with a fixed color so it appears to fade away as it moves further from the viewer.

MIP mapping. Another ubiquitous feature, MIP mapping, stores several sizes of a texture-mapped image to best fit the bit map onto objects as they vary in size. MIP maps avoid blockiness when zooming in on texture-mapped images, and reduce the annoying sparkle caused when the graphics chip stretches or condenses a texture-mapped image to fit an object.

Alpha blending. This feature combines two overlapping texture maps to create the illusion of transparency, such as when looking through water.
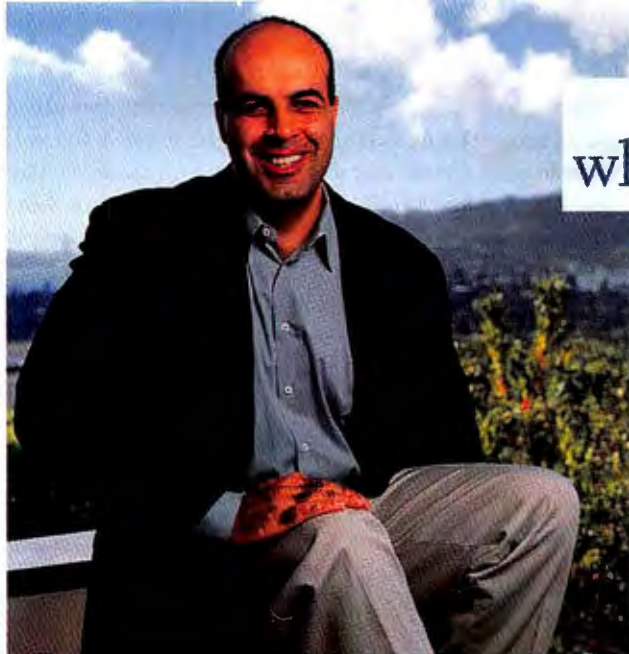
3D SPEAK

The 3D graphics market is buried in obscure jargon, much of which is used to describe critical display features found in 3D graphics chips. Some examples follow.

Perspective correction. All five boards support perspective correction, which makes tex-

3D FEATURES					SUPPORT
Perspective correction	3D filtering	Fogging	MIP mapping	Alpha blending	Warranty for parts/labor (years)
●	●	●	●	●	5/5
●	●	●	●	●	5/5
●	○	○	●	○	3/3
●	●	●	●	●	5/5
●	●	●	●	●	lifetime

"There's one problem with AGP, and that is,

where are *the* applications?"

AMID RAHMAT senior analyst, Jon Peddie Associates

video card? Well, you could, but it would be expensive—particularly when you consider that the extra video memory would be used by only a small number of 3D applications.

For those graphics cards that support AGP texturing, game programmers can use system memory as if it were dedicated texture memory located directly on the card. Games get instant access to 8MB, 16MB, or even more texture memory, depending on the amount of available system RAM. The only drawback, say some developers, is that it takes longer for data to move from main memory to the graphics card than it does from the card's onboard RAM, so some AGP-enhanced software may run slower.

Nevertheless, game makers are hot on this new technology because of the potential for fancier scenes. Access Software, maker of the Pandora Directive game, is developing its upcoming Tex Murphy: Overseer title with AGP in mind. The game places live-action digital video inside 3D-rendered rooms. On an AGP system, Access says, frame rates could double over those of PCI systems, from about 10 fps to 20 fps.

The AGP-optimized version of Tex Murphy: Overseer uses as much as 16MB of textures at a time. When played on a system with a PCI card, the program uses its own software to process texture data from system memory, through the CPU, and ▶

the illusion of real-world objects. The problem: Many megabytes of texture data are required to create great-looking scenes.

With most graphics cards packing 2MB, 4MB, or at most 8MB of graphics RAM, there is not much room for displaying texture data. On a 4MB PCI graphics card, for example, software developers can count on being able to use only about 2MB for texture data. And that figure goes down as your screen resolution goes up, since that 4MB on board is shared by both display graphics and stored 3D textures. So why not just put more memory on the

The 100-MHz PC

SO YOU'VE DECIDED to buy a new AGP-equipped Pentium II system. Don't jump too soon. Come spring, Intel plans to significantly improve the performance of Pentium II PCs by speeding up the motherboard from the typical 66 MHz to 100 MHz. The 50 percent boost is the first speed increase for Intel-based PC motherboards since the introduction of the 60-MHz and 66-MHz Pentium CPU in 1993, when the motherboard bus was boosted from 33 MHz. Unlike AGP, which mainly improves performance of 3D operations, the faster motherboard will enhance performance across all applications. You can expect to see Intel match its upcoming Deschutes processor (the slimmed down, .25-micron version of Pentium II running at 333 MHz and beyond) with the faster motherboards.

The payoff. So what do you get with a 100-MHz bus? Quicker CPU access to main memory, which will benefit virtually every

application. Over the past several years, as Intel CPU speeds ramped up from the initial 60 MHz to a blistering 300 MHz, the rate at which data moved along the memory bus barely changed—it's still limited to a maximum of 66 MHz. To counteract the growing speed mismatch, vendors placed fast cache memory both inside and next to the CPU. The Pentium II, for instance, has 64K of superfast internal, primary cache, and another 512K of external, secondary cache that runs at half the processor's speed. But when the two levels of cache can't give the CPU the data it needs, it must call data from main memory along the 66-MHz bus.

Worth the wait? It may be, particularly if you use a lot of multimedia titles, DVD software, large database files—or any application in which the CPU must resort to quick cache memory. In fact, software-based playback of DVD video and audio really needs the faster access to work well, says Peter

Glaskowsky, senior analyst at *Microprocessor Report.* "If you want to put a DVD player in your PC, I wouldn't get a current machine," warns Glaskowsky. He also notes that the AGP bus, which must compete with the CPU for access to main memory, will get a boost with the new motherboards since data can be accessed from memory at a higher rate.

What comes after 100 MHz? Nathan Brookwood, processor analyst for the research firm Dataquest, says that 100 MHz may be the limit for motherboard bus speeds. At higher frequencies, electromagnetic interference becomes difficult to manage—the motherboard, in effect, starts to act like a transmitter.

"I think we'll probably see solutions that go more to intrachip connections—the 'system on a chip' that everyone is talking about," says Brookwood. "If you can get rid of most of the interconnections between chips by moving everything onto one big piece of silicon, you have solved a lot of problems." —M. D.

to the graphics board. The work-around allows Access to provide high levels of realism on existing PCI machines—but at a terrible cost in frame rates. Says Bruce Ward, an Access producer, "Now [with AGP] we can have Z-buffering, fast hardware transforms, and various other hardware functions that improve both the look and the speed of the rooms."

The enhanced version of Psygnosis' G-Police title is another example of how AGP helps games. On AGP systems with 32MB of memory, the game uses 8MB of texture data to create scenes. But on AGP systems with 64MB of system memory, the texture data bumps up to as high as 16MB. In other words, the more system memory you have, the better off you are. Other 3D games that will support AGP texturing include Acclaim's Forsaken, Rage Software's Incoming, Game Fx's Out of the Void, and Microsoft Baseball 3D.

Games are not the only applications that will benefit from AGP's texture-handling talents; many vendors of 3D design applications plan to add AGP capability next year. An updated version of MetaCreations' Bryce landscape creation software should feature a full-size preview of rendered 3D scenes. Currently, the preview window is limited to a wire frame (augmented by a postage-stamp-size rendering). The company also says it will beef up the 3D user interface in some of its programs as AGP systems
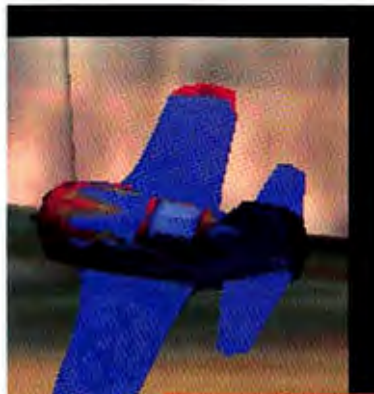
BE SURE to check that your graphics card has 3D filtering. The feature reduced blockiness and smoothed lines in the image at top, especially in its background.

dors such as Gateway 2000, Dell, and Compaq are beginning to incorporate it on their Pentium II PCs. AMD and Cyrix, however, cannot use Intel's proprietary slot 1 (the socket for the Pentium II processor package) for their own processors, so they will have to come up with alternatives to Intel's 440LX chip set.

With the probable success of the Pentium II, AGP will likely supplant PCI as the most popular graphics technology. By 1999, the market-research firm Mercury Research expects AGP graphics systems to outsell PCI graphics systems by more than two to one. That's certainly an incentive for application developers to add AGP to their software. AGP will also not add much to the price of a new PC. By the time you read this, both Dell and Gateway 2000 expect to be selling Pentium II-233s with AGP graphics cards for $1999. Notebooks with AGP cards should start turning up in the second quarter of next year, following the introduction of mobile Pentium II processors.

So should you move to AGP graphics now? If you don't need to upgrade your PC immediately, there is no compelling reason to rush out and buy an AGP-capable system and graphics board. In fact, if you can wait until the release of Windows 98—expected in several months—you will probably enjoy a smoother transition to AGP than you might otherwise. What's more, the graphics boards available in six months will be much more likely to support AGP's most useful features.

If you just can't wait to buy a Pentium II PC, and are running mostly business applications, you might be able to save yourself a bit of money. Assuming that the graphics board in your old PC is a PCI card and that it's working fine, try ordering your new PC without the graphics card and put your current PCI card in it instead. You can then pick up a better AGP card later if and when you need it.

Are you into games, or do you want to be the first on your block with the latest graphics? Make sure you purchase a board like the ATI Xpert@-Work or the Diamond Viper V330, both of which support the AGP texturing feature. On the other hand, if you simply happen to be running 2D applications on an AGP-capable system, any of the boards reviewed here perform like their PCI counterparts.

There are many questions surrounding AGP, and buyers should be asking them. "Ultimately, they are the people paying the money," says Glaskowsky, "and they need to make sure they know what they're getting."

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"Now [with AGP] we can have...**fast hardware**

transforms and other...functions that improve the

look *and* **speed** *of the [game's 3D-rendered] rooms."*

BRUCE WARD   **game producer, Access**

become more commonplace. Caligari's TrueSpace will offer improved AGP support, and Virtus's ConceptCAD will add it, which should give both applications faster and smoother rendering of high-resolution 3D scenes.

INVESTMENT PROTECTION

IF AGP DOES SO LITTLE aside from enhanced 3D, why consider buying an AGP-equipped PC and graphics card at all? For one thing, Intel, Advanced Micro Devices, and Cyrix are all arranging for their chip sets to support the new bus, and system ven-