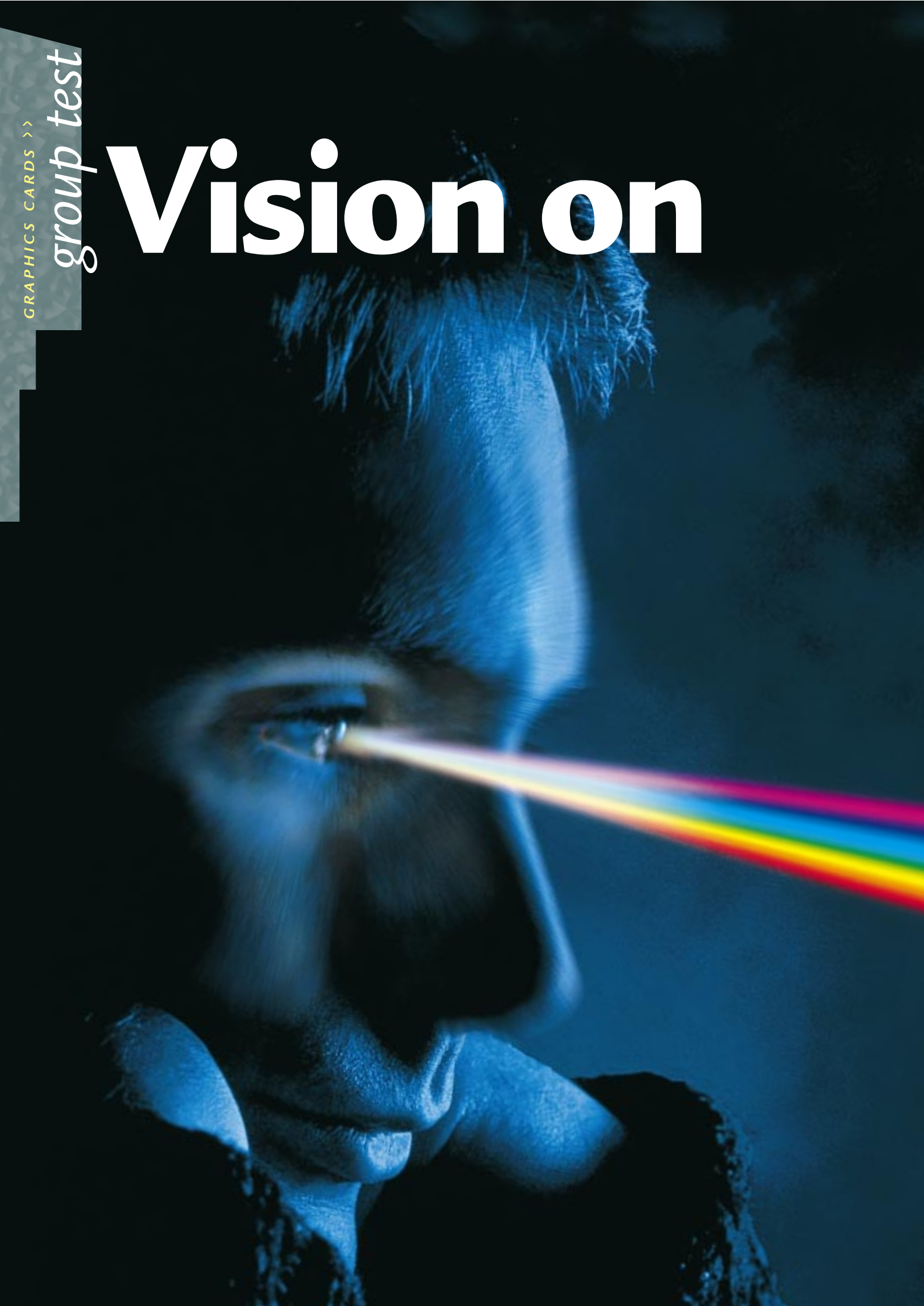# Vision on

If you want to stay ahead of the game, then you need to be well-equipped with a top-notch graphics card. Ajith Ram and David Fearon see how they run.

In a fast-moving industry, graphics technology is one of the fastest-moving elements. As far as Windows desktop performance goes, things have gone pretty much as far as they can: no-one can tell the difference between any modern card when using office applications. The realm of innovation is 3D graphics, which primarily means games.

There are three basic kinds of graphics card these days. The most basic, and cheapest, is the 2D-only adaptor, which is fine if you only use your PC for work and the odd game of Solitaire. The most cost-effective solution for the gamer are 2D/3D combo cards, which combine standard 2D functions plus 3D acceleration capabilities on one card. Almost all new cards have some kind of dedicated 3D acceleration, but their performance varies a lot. For the serious gamer, or those who already have a 2D card and want to upgrade to 3D, there's also the option of dedicated 3D add-on cards, which work alongside your existing adaptor. At the moment, these are mostly based on the 3Dfx Voodoo2 chipset.

If you have a PC bought within the last six to eight months, you probably have an AGP slot on your motherboard. AGP stands for Accelerated Graphics Port. It's a dedicated slot for graphics cards and gives slightly higher performance for some games. AGP is covered in more depth on page 196.

We've tested fifteen of the latest cards, as well as reviewing some of the latest 3D technologies and standards. A development which is just over the horizon is the digital interface standard for connecting LCD panels to a graphics card digitally to get the best picture quality. None were available at the time of writing, but expect announcements from both graphics-card and LCD-panel manufacturers soon.

Contents

Ratings

★★★★★ **Buy while stocks last**
★★★★ **Great buy**
★★★ **Good buy**
★★ **Shop around**
★ **Not recommended**

3D engines & geometry acceleration

One of the last areas where today's hardware struggles, is when keeping up with the demands of 3D-intensive software like games. While most business applications can run quite happily on a 486, even today's fastest desktop processors struggle to keep up with the complex calculations involved in depicting 3D images. The reasons for this are many. Unlike static 2D images like text in a word processor, moving 3D images require the CPU to perform a series of complex calculations. Moving 3D images are rendered in a series of stages which are often described using terms like bi-linear filtering, tri-linear filtering, bump mapping and mip mapping. Let's take a look at some of these techniques.

● Geometry setup
Geometry setup is the first and most important step in creating a 3D image. During this stage, the 3D objects are placed in 3D space. 3D space, unlike 2D, is a three-axis (X, Y, Z) area. Within this space, geometry setup performs three functions — scaling, translation and rotation.

☛ **Scaling** makes objects bigger or smaller according to how far back they are in the field of view.

☛ **Translation** involves moving the object to its correct location.

☛ **Rotation** turns the object so that it attains its correct position.

In a game with twenty different objects on-screen at any given time, the CPU has to complete each of the above procedures for each object. And if this weren't complex enough, computer screens refresh at more than seventy times a second. Therefore, any changes in the position of these objects must also be calculated and displayed for every refresh of the screen.

● Triangle Setup
Triangle Setup converts the data created by the geometry setup into a form that can be input into a 3D accelerator. Some graphics cards, such as the Voodoo2, Millennium G200 and Power VRSG, have their own triangle setup engines which take some of the strain away from the CPU. However, even these triangle setup units are able to process only a small section of the data: the rest must be handled by the CPU.

● Texture Mapping
This is a technique for adding extra detail to the 3D object. It is best described as wrapping a 2D coloured paper over a 3D object. For instance, if you had a 3D image of a car on-screen, a texture would be wrapped over it to depict coloured metallic paint. This process is painstaking, as it has to be repeated for every pixel on the object and each pixel of the texture, known as a texel, which lies on top. Many textures can be wrapped over the same object, and this is multitexturing. Some games, like Quake2, take advantage of multitexturing. The best results are obtained when the game is accelerated using hardware like the Voodoo2. A 2D/3D card like the Millennium G200 offers multitexturing.

● Mip Mapping
A mip-map is a cut-down version of a texture, and map-mapping is a trick used to create more texels without performing the equivalent number of calculations. If a mip-map is one fourth the size of the original texture, reading a single texel from this mip-map is the same as reading four texels from the original texture. If applied using proper filters, the image quality is actually higher, as it smoothes out jagged edges.

● Bi-linear Filtering
This technique reads four texels, calculates their average — that is, the average of their relative positions — colour and so on, and displays the result as a single-screen texel. This results in blurring at close quarters, which in turn reduces an otherwise blocky, pixellated appearance. Bi-linear filtering is now standard on most PC graphics cards.

▶**WITH B-LINEAR FILTERING TURNED OFF**

▶**WITH BI-LINEAR FILTERING TURNED ON**

● Z-buffering
Z-buffering is a method of calculating pixels which have to be loaded into the frame buffer, the memory that stores soon-to-be-displayed data. 3D accelerator chips take one pixel, render it, and proceed to the next one. The problem with this method is that the accelerator has no way of knowing whether the calculated pixel is to be displayed immediately or later.

Z-buffering includes a "Z" value in every calculated pixel. If the Z value for a particular pixel is smaller than another one, it means the pixel with the smaller Z value must be displayed first.

● Anti-aliasing
Anti-aliasing is a technique to reduce the "noise" present in an image. To represent any image, a certain amount of information is needed. If the object is in motion, ideally, that information should include its every possible position, colour, size changes etc. But if this information is not available, the CPU often fills in the missing segments with meaningless noise. Anti-aliasing, along with mip mapping, removes this noise.

● **Gouraud shading**
A technique to make objects appear more solid by applying shadows to the surface of the object. The algorithm determines the colours of adjacent polygons and makes a smooth transition between them. This ensures that there is no sudden change in colour over the object.

● **Bump mapping**
This method gives a "bumpy" look to surfaces. For instance, a bump-mapped mountain can have realistic-looking furrows and protrusions on its surface. However, the industry is yet to arrive at a standard set of procedures to render this visually impressive feature.

It is obvious that these techniques involve complex calculations which stretch a CPU's capabilities. Even with dedicated 3D accelerators performing many of the above functions, the CPU is still the biggest bottleneck to better graphics. The main reason for this is that the CPU handles most of the geometry calculations — that is, the position of every filtered, mip-mapped, bump-mapped and anti-aliased pixel that appears on-screen. With current 3D accelerators spewing out over a 100 million pixels per second, this is beyond the abilities of even the fastest CPUs. The 3D accelerator literally has to wait for the
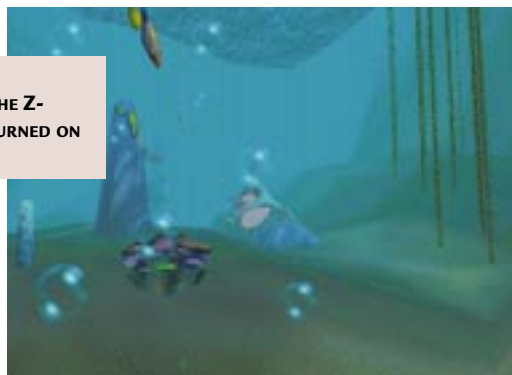
▶**WITH THE Z-BUFFER TURNED OFF**

▶**WITH THE Z-BUFFER TURNED ON**

◀**WITH FLAT SHADING**

◀**WITH GOURAUD SHADING**

CPU to finish its calculations. There are two very different means of getting over this problem, advocated by two distinct parties. The most affected parties, the 3D-hardware manufacturers, want to use dedicated geometry processor, such as the Pinolite from Fujitsu incorporated in the Hercules Conspiracy graphics card. Such processors take over the 3D calculations from the CPU. On the other side of the debate, this is the least acceptable solution for CPU manufacturers, particularly Intel, because once geometry processors become standard on graphics boards, it only takes a mediocre processor to perform other functions such as running the operating system and monitoring devices. This eliminates the need for gamers and CAD/CAM professionals to constantly upgrade to faster CPUs.

Recognising a threat to a major source of revenue, Intel has proposed its upcoming Katmai processor as a solution. Like AMD's 3D Now!, the Katmai has 70 new MMX-style instructions (KNI) that speed

up 3D calculations. Intel claims that KNI will provide a performance increase of between 40 and 100 percent. But the problem is that even if the performance boost is a full 100 percent as Intel claims, it still may not be sufficient to cope with the brute power of the new 3D accelerators.

Some experts estimate that today's accelerators, like the new Millennium G200 and the Voodoo2, require CPUs twice as fast as those available. Therefore, when Katmai débuts next year with speeds around 450MHz, even its better 3D performance won't be sufficient to deal with the next generation of 3D accelerators. Furthermore, most users, even gamers, do not upgrade regularly and have CPUs which are relatively slow. Therefore, the best solution appears to be dedicated geometry processors. With major firms like S3 reportedly working on incorporating geometry processing into their graphics boards, this is almost certainly the way the industry will move. And that is bad news for Intel.

Graphics standards

The hard facts about the software involved with graphics cards and 3D graphics.

UNREAL, WHICH USES THE GLIDE API

It's all very well being surrounded by the latest and most advanced 3D hardware, but of course hardware by itself isn't much use to anyone. What makes a product really useful is the software. There are two distinct layers to the software involved with graphics cards and 3D graphics — the APIs, and the applications. There's a lot of talk among the 3D-graphics fraternity about the merits and demerits of the various 3D APIs. An API (Application Programming Interface) is a piece of software that lets programmers communicate with a device — in this case, a graphics card — using a standard set of commands, enabling them to harness the power of the hardware as easily as possible.

Three different APIs dominate the 3D graphics world as far as the home user is concerned — OpenGL, Direct3D and Glide. There are other standards, but they are less prevalent. For professional uses of 3D graphics, notably 3D design and animation of the type used in film and television, OpenGL is the most-used API. It stands, predictably enough, for Open Graphics Language. Windows 95 OSR2 and Windows 98 both understand OpenGL commands, so applications that use it will work even if you don't have any specific 3D hardware. Being an open standard, it is used on many platforms, from PCs running Windows to high-end Silicon Graphics and Sun workstations running Linux, Solaris, or one of the many other types of Unix. Its open nature is its main strength, and developers prefer it because it's well understood and relatively easy to develop applications that use it.

Unless you're into 3D design, the only time you're likely to use OpenGL is when playing Quake II (*see below*). But if you're thinking of getting into applications like TrueSpace, Infini-D or LightWave, make sure that the graphics card you go for has a set of OpenGL drivers, since you can then use the hardware acceleration features for real-time shaded and textured previews, making working in three dimensions much easier.

At the slightly less esoteric end of the scale is good-old Direct3D. This is part of a set of APIs known as DirectX. DirectX is written by Microsoft, and is therefore only available on PCs running Windows 95, 98 or NT. It's primarily a games API, and comprises Direct3D, DirectSound, DirectInput (for input devices) and a couple of others. Windows NT4 only supports version 3. But for Windows 95 and 98, as well as the upcoming NT5, DirectX is now up to version 6.

Many developers have traditionally hated DirectX: they cite its complexity, lack of decent documentation, bugs and inconsistencies. In particular, id Software, the developer of Quake and Quake II, chose to use a subset of OpenGL rather than Direct3D for Quake II.

A real, practical 3D Windows interface is unlikely to happen for at least five years

While going through its first few incarnations, you'd often see letters in magazines such as *PCW* with the title "DirectX ruined my life". This was

because of its propensity for completely fouling up people's PCs — particularly the graphics drivers — when they tried to install it, which they had to do if they wanted to play the latest games. But from version 5, DirectX has been much better behaved. With version 6, some developers have even said that it's now quite good. Either way, with the enormous pressure Microsoft has been able to bring to bear on games developers and the industry in general, there's no question of being able to avoid DirectX and Direct3D. It's a standard part of Windows 98, anyway.

Glide is a specialised but nonetheless important API. It is specific to 3Dfx's Voodoo Rush and Voodoo Graphics chipsets and doesn't work with any other cards. But since 3Dfx is still the card of choice for so many gamers, a lot of games have either Direct3D and Glide support, or support for Glide only. Certainly, in the "early days" of 3D hardware (about a year ago) there was nothing to touch the speed or quality of 3Dfx, so implementing Glide-only versions of games made sense. Now that the competition is catching up, there's more of a slant toward Direct3D games. But many games which give the option still look better in Glide mode if you have a 3Dfx card.

In a similar vein to Glide is an API called PowerSGL. This is the interface used by cards based on NEC's PowerVR chipset. Despite a great deal of marketing hype, PowerVR has failed to make a huge impression on the gaming fraternity in the manner of 3Dfx, but there are games, notably Unreal, that specifically support it.
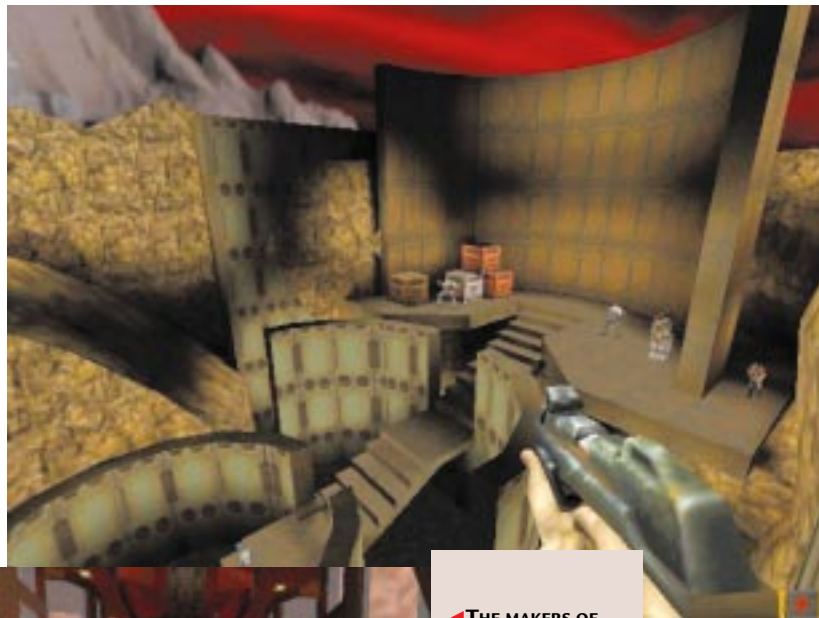
◄ **THE MAKERS OF QUAKE II SPURNED DIRECT 3D IN FAVOUR OF A SUBSET OF OPENGL**

If you're considering a Voodoo 2-based add-on card, remember that these cards are for gaming only: they completely take over the display when in 3D mode, so you can't use 3D features in a desktop window. This rules them out for 3D design applications. Conversely, if you have a 2D/3D combo card and you don't want to dabble in anything other than 3D games, you won't need more than 8Mb of video memory on the card. 8Mb lets you run double-buffered, Z-buffered 3D games at 800x600 resolution, which is more than adequate for the lifetime of any current card. It's only when you need to run 3D applications at the more normal Windows desktop resolutions, 1024x768 or 1280x1024, that you'll need 12Mb or above.

But with all these millions of R&D dollars that the graphics-card manufacturers are spending on the design and fabrication of ever more complex 3D hardware, is the finished article always going to end up being used to get a few more frames per second out of Unreal and its successors? For the time being, yes. There's still no sign of any practical alternative to a 2D Windows desktop, despite the whizzy 3D interface that the girl in Jurassic Park used to override the security grid. A monitor is a two-dimensional surface, so a two-dimensional interface is the most practical thing to use; trying to navigate in a pseudo-3D environment is liable to confuse rather than help.

A real, practical three-dimensional Windows interface is unlikely to happen for at least five years. Those who've seen the film version of William Gibson's *Johnny Mnemonic* will remember the virtual reality glasses and actuator gloves that Keanu Reeves used to navigate Gibson's Cyberspace. It sounds cheesy, but this is what's needed to make everyday 3D virtual environments a possibility. The real problem, though, is not a technological but a social one. Will we really be able to suspend our self-consciousness sufficiently to be able to don a pair of goggles and poke at things in mid-air when we know our colleagues are watching?

PCI *vs* AGP

There has been some debate about the merits of an AGP graphics card over its PCI counterpart. Most of it has been fuelled by the performance (or lack of it) of the AGP cards. The 32-bit PCI slot with a maximum bandwidth of 128Mb/sec is showing its age on bandwidth-hungry components like graphics cards. The AGP slot (Accelerated Graphics Port), theoretically at least, eliminates the PCI's limitation by providing direct access into the PC's RAM.

With an AGP 2X specification, it is possible to get a peak transfer rate of 512Mb/sec, and with the new AGP 4X, the bandwidth increases to 800Mb/sec — almost eight times faster than PCI. However, as our tests proved, this does not translate into eight times better performance. One reason is that although the bottleneck of the PCI bus is eliminated, the RAM into which AGP provides direct access is still running at only 66MHz or 100MHz — four to five times slower than the processor. Also, there is the misconception that with an

AGP card, you can use the main memory rather than having extra memory on the graphics card itself. This is not so, as many graphics cards now have fast SGRAM running at 125MHz speeds. Hence, any extra data transfer from the slower main memory, even over the AGP bus, is bound to slow things down.

But this does not mean that the AGP slot is redundant. As new games that make use of larger textures appear, the memory on the graphics board may not be sufficient to hold them, even with 12Mb or 16Mb on the card. Then, AGP's
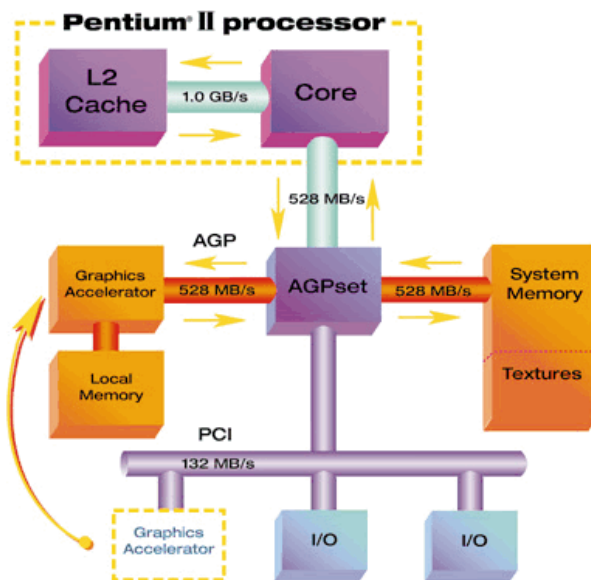
ability comes into focus, as its massive bandwidth helps in the transfer of large textures. So, if you are an avid gamer who intends to buy some of the upcoming titles, go for an AGP 2D/3D card like the Millenium G200 or the Banshee.

Multiple Graphics Cards

Until now, it was necessary to use a dedicated 3D accelerator (like Voodoo2) and a general 2D display card (like Millennium G100) to achieve high games performance and maintain flicker-free displays. The dedicated 3D card is connected to the main 2D card using an external pass-through cable. When not in use, the 3D card allows the video signal to bypass it and go into the monitor. However, when a 3D game is launched, the 3D accelerator kicks in and provides the display.

Our tests suggest that this age of separate cards is coming to an end. The new generation of display cards like the Millennium G200, Banshee and Savage 3D, in addition to being AGP compatible, offer 3D performance that is better than many dedicated 3D accelerators. However, there is still a niche market for dedicated 3D cards like Voodoo2. This is the realm of gamers who are never satisfied with *any* level of

performance. They opt for two Voodoo2 cards in SLI (Scan Line Interleaving) mode, where each card draws alternate lines on the screen, theoretically doubling the performance. Our tests show that the actual
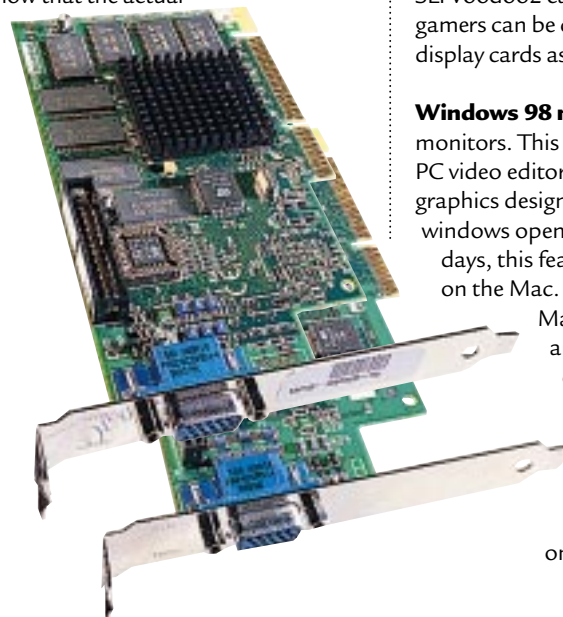
increase is between 30 and 60 percent. However, even this market might disappear soon. With chipsets like the Riva TNT and the Permedia 3 on the horizon, with more power than even two SLI Voodoo2 cards, even die-hard gamers can be content with the same display cards as office users.

Windows 98 now supports multiple monitors. This is an ideal solution for PC video editors, stockbrokers and graphics designers who need multiple windows open at a time. In the old days, this feature was available only on the Mac. Most new cards like the Matrox Millennium G200 and the ATI Xpert98 have drivers optimised for this feature. It does mean using an extra PCI card for each additional display, though, as there is only one AGP slot.

group test
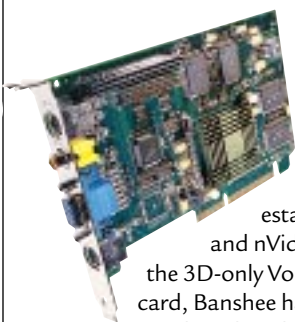
Graphics Cards

3Dfx Banshee BETA

The Banshee represents 3Dfx's latest foray into the 2D/3D market and is an attempt to woo OEMs away from established companies like Matrox and nVidia. Banshee's core is identical to the 3D-only Voodoo2. An AGP 1X graphics card, Banshee has a slightly higher fill rate than Voodoo2 but does not have a multitexturing unit. This means lower performance in games like Quake2 which use multitexturing. Our test board came with 8Mb of memory which was not upgradable, but this is likely to change. Banshee has a TV-out option, but does not have DVD motion assist. It was the fastest performer in our tests.
★★★★
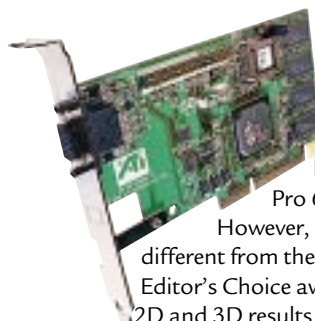
ATI Xpert98

The 8Mb ATI Xpert98 is the latest incarnation of the Rage Pro 64-bit RISC processor. However, its performance was not very different from the Xpert@Work which won our Editor's Choice award last year. Although the 2D and 3D results were adequate, it fell short of the standards set by the newer entrants like the Banshee. The picture quality was also less than optimal with poor bilinear filtering and anti-aliasing. However, the Rage Pro Turbo is one of the few chipsets that has true motion compensation for DVD playback. ATI also offers an inexpensive upgrade kit which includes a TV tuner.
★★★
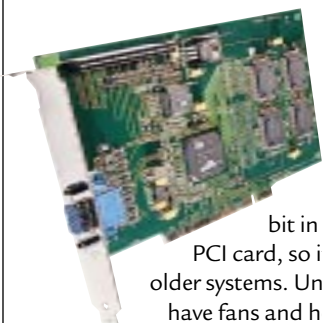
Creative Labs Graphics Blaster Exxtreme

Creative's card is based around the Permedia 2 chipset, which is getting on a bit in graphics-cards terms. It's a PCI card, so it may be better suited to older systems. Unlike the latest chipsets which have fans and heatsinks attached to them, the Permedia 2 chip needs no extra cooling. The card has 4Mb of SGRAM on-board. The relative age of the Permedia 2 is highlighted by the card's performance: with a Final Reality score of just 3.24, it's not speedy. The Incoming frame-rate test yielded just 30 frames per second, and the card wasn't able to run Forsaken at all.
★★
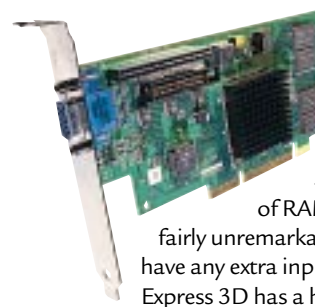
Diamond Stealth II G460

The G460 is Diamond's variation of the Intel i740 chipset. Unlike the Express 3D though, the G460 has 8Mb of RAM on-board. The card itself is fairly unremarkable: an AGP part, it doesn't have any extra inputs or outputs. Whereas the Express 3D has a heatsink and fan on the main graphics processor, the G460 just has a heatsink. Its Final Reality performance was very slightly behind the Express 3D, but not significantly so. In the game frame-rate tests, the G460's performance was moderate: it managed a respectable 59 frames per second with Incoming, and the Forsaken test yielded 28 frames per second at 1024x768.
★★

Diamond Viper V550

The Viper 550 is built on the new Riva TNT chipset which is meant to succeed both the Riva 128 and the Riva 128ZX. The board we tested was not a full production version and had beta drivers. However, even with these limitations, the Viper 550 proved to be an impressive performer. With a theoretical maximum fill rate of 180 million pixels per second, the TNT aims to beat the Voodoo2 SLI solution (*p220*). The Viper comes with 8Mb of memory and a high RAMDAC of 250Hz. However, unlike the Millennium and the Rage Pro, the Diamond board does not have motion compensation for DVD playback.
★★★★

Diamond Viper V330

Based on nVidia's Riva 128 chipset, the Diamond Viper had been a good performer in our previous group tests. However, this time around, its position was usurped by newer cards. Installing the V330 was slightly troublesome, as the drivers supplied were over two years old and would not work with Windows 98. We had to download and install the latest drivers from Diamond's web site. Although the Viper had above-average performance in both 2D and 3D, its image quality left much to be desired and was well below the Millennium G200 and the Banshee. It has a TV-out option, but does not have hardware DVD assist.
★★★

Graphics Cards
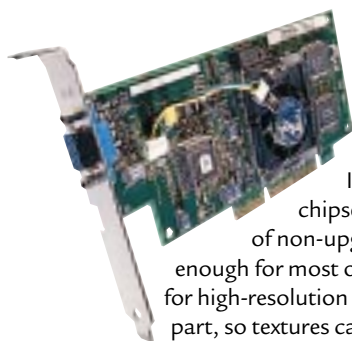
Intel Express 3D

Given that this card is made by Intel, it's no surprise that it employs Intel's own i740 graphics chipset. The card has only 4Mb of non-upgradable RAM, which is enough for most office applications but not for high-resolution 3D graphics. It's an AGP part, so textures can be stored in the PC's main memory. The i740's colour depth is limited to 256 colours at a resolution of 1280x1024, so hardcore business users won't want it. Its poor performance in real-world games means that hardcore gamers won't want it either. A card for undemanding home applications only.
★★

Matrox Millennium G200

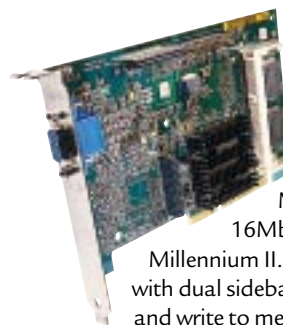Built around the new 128-bit G200 chipset, the 8Mb Millennium G200 (upgradable to 16Mb) is an ideal successor to the Millennium II. Featuring full AGP 2X support with dual sideband addressing (the ability to read and write to memory at the same time), the Millennium was the second-fastest board in our group test. With a high RAMDAC of 250Hz and 8Mb of SGRAM, it is targeted at office users. The G200 had the best picture quality among all the cards we tested. It also has motion-assist for software DVD playback. It supports both DirectX and OpenGL.

Matrox Mystique G200

Built around the same G200 chipset as the Millennium, the Mystique has a TV-out and is targeted primarily at gamers. While the Millennium has slightly faster SGRAM, the Mystique has 8Mb SDRAM which is upgradable to 16Mb. With a high RAMDAC of 230Hz, the card is able to support resolutions as high as 1600x1200. Like the Millennium, the Mystique had excellent image quality and fast 3D performance, which should please many gamers. It has hardware assist for DVD playback and supports both DirectX and Open GL. It comes with a software bundle that includes Motorhead and Tonic Trouble.
★★★★
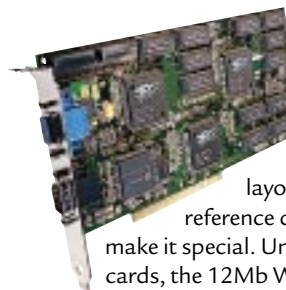
MegaByte Wicked 3D

Wicked 3D is the catchy name for this unique Voodoo2 board. The layout is identical to the 3Dfx reference design, but it's the drivers that make it special. Unlike all other single Voodoo2 cards, the 12Mb Wicked 3D is able to support a resolution as high as 1024x672. This is impressive, as even two Voodoo2 cards in SLI mode can support only 1024x768. Moreover, the drivers give you the ability to increase the refresh rate in 1Hz increments, so the user can take full advantage of their monitor's bandwidth. This card also supports Wicked Vision [see p200]. Wicked 3D produced the best results in our Direct3D tests.
★★★★
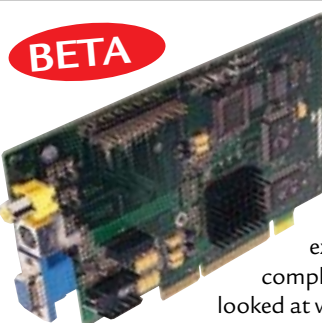
S3 Savage 3D – PREVIEW

BETA

The Savage carries S3's hopes of breaking back into the high-performance graphics market after a considerable lull. It's an extremely sophisticated and complex chipset, and the model we looked at was a pre-production reference design. Nonetheless, the card put in a very good performance, coming second only to the Banshee in the Incoming frame rate test and equalling it on the Forsaken benchmark. Its Final Reality result was less impressive, but given our card's pre-production status, we can't condemn it on that score. It looks as though the Savage will be a chipset to contend with: we'll test it again as soon as production samples are available.
★★★★
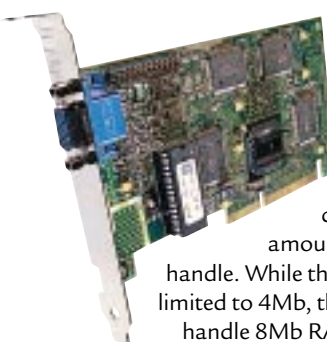
STB Velocity

The Riva 128ZX on the STB board, although a new chipset, is still only an enhanced version of the older Riva 128. The difference is mainly in the amount of memory that it can handle. While the Riva 128 boards were limited to 4Mb, the enhanced ZX is able to handle 8Mb RAM. We noticed little performance difference between the two chipsets. However, users who require higher resolutions might want to consider the new Velocity board. The picture quality of the card was identical to its predecessor. The Velocity does not have hardware assist for DVD playback.
★★★★★

Voodoo2 cards

How the magic works in the cards we tested.

Since its launch nearly six months ago, the Voodoo2 from 3Dfx has reigned supreme in the games arena. Even now, with the entry of more powerful chipsets like the Riva TNT, a Voodoo2 SLI solution is hard to beat. Of the five Voodoo2 boards we tested, the **Wicked 3D** proved to be the best in terms of features and performance. While other Voodoo2 cards offered a maximum resolution of only 800x600, the Wicked board supported 1024x672. This is only slightly less than the maximum resolution (1024x768) offered by even a Voodoo2 SLI solution. Moreover, the Wicked driver allows the user to increase the refresh rate in 1Hz increments. The board also supports Wicked Vision [below]. The **Canopus Pure3D II** was another board which stood out. In addition to excellent drivers, Pure 3D was the only Voodoo2

board that had a cooling fan and heatsink, making it a good choice for compulsive overclockers. The Canopus board was also the only one with a TV-out. Creative Labs was the first company to come out with a Voodoo2 board. Almost identical to the 3Dfx reference design, the **3D Blaster** supports a maximum resolution of 800x600 and has 12Mb of memory. Arowana is one of the later entrants into the Voodoo2 bandwagon. Identical to the reference design, the board posted respectable but hardly unexpected results. Like the Creative and Canopus boards, the Arowana board
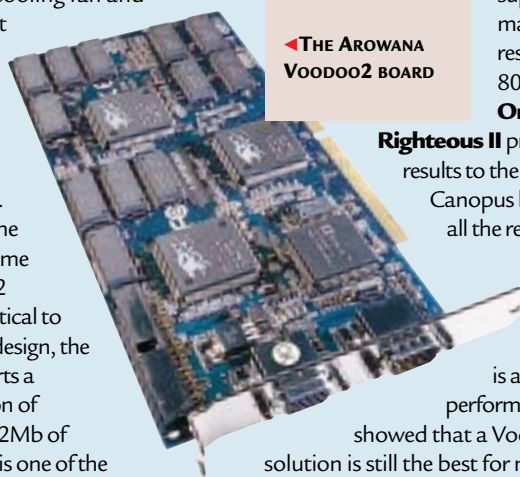
◀ **THE AROWANA VOODOO2 BOARD**

supports a maximum resolution of 800x600. The **Orchid Righteous II** produced similar results to the Creative and Canopus boards. With all the regular features of a Voodoo2 card, the Righteous II is a solid performer. Our tests showed that a Voodoo2 SLI solution is still the best for many games. Even at a higher resolution of 1024x768, the SLI mode offers a performance increase between 30 and 60 percent, giving performance scores of 169fps in Forsaken and 174fps in Incoming.

Wicked Vision

How one company is taking 3D into another dimension.

At a time when every graphics-card manufacturer is promising a "true 3D" experience, it is difficult to identify a product that gives a truly special experience. Wicked 3D is one company that is attempting to break the mould. Its technology, Wicked Vision, unlike regular "3D", provides true holographic images.

Attempts to produce holographic images on-screen are nothing new. Previous failed attempts included cheesy red and blue spectacles or clumsy polaroid goggles. Wicked Vision is different in many respects. To begin with, unlike previous attempts, it does not need software to be specifically written for it. This removes a major hurdle to its acceptance. As it is an API-level implementation of holographic imaging, any game that is written for APIs like DirectX, OpenGL or Glide is instantly transformed into a true holographic one.

Currently, over 100 games, including hitss like Quake, Unreal and Incoming, can be played using Wicked Vision.

Wicked Vision does require extra hardware. In addition to the Wicked 3D Voodoo2 board, the kit includes a pair of wireless LCD glasses and a transmitter which sits on top of the monitor. When not in use, the transmitter, which kicks in when the game is launched, allows the signal to pass through into the monitor. The spectacles are made of LCD shutters which flicker at a set rate. The rate of flicker is slightly different for each eye. The holographic images are a result of the brain's ability to merge these separate signals into one, creating the illusion of depth. Wicked claims that games are being developed specifically for this process, which would allow objects to come out of the screen as in an Imax movie.

Wicked 3D drivers are still in a rudimentary state, so some games might be distorted and text blurred. However, the technology holds immense promise.
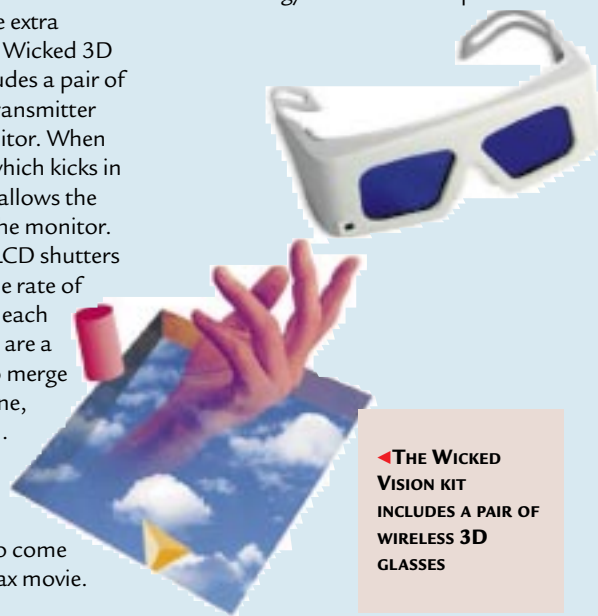
◀ **THE WICKED VISION KIT INCLUDES A PAIR OF WIRELESS 3D GLASSES**

Table of features

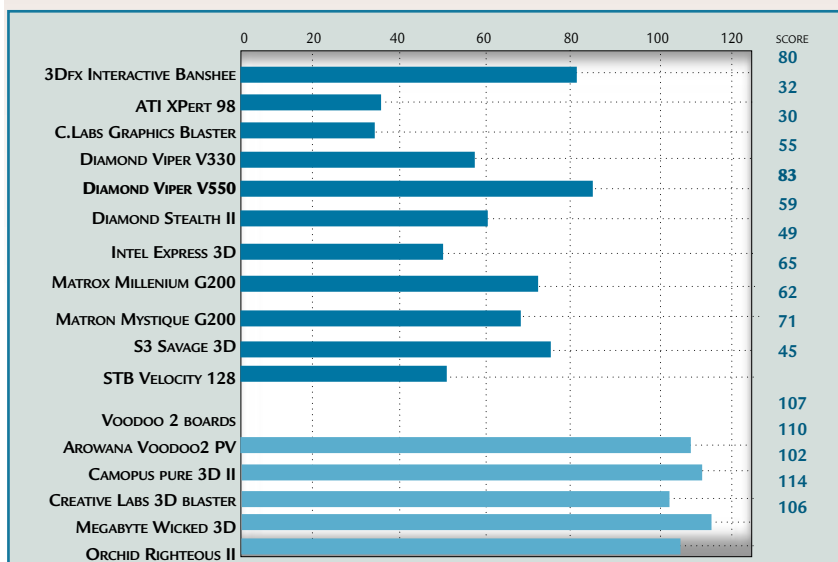| MODEL	3DFX BANSHEE	AROWANA PV820	ATI XPERT98	CANOPUS PURE 3D II
SUPPLIER/CONTACT	N/A	ICOM INNOVATIONS	ATI	EVESHAM MICROS
telephone	n/a	0800 731 8419	01628 533115	01386 769600
Web address	www.3Dfx.com	www.arowana.com	www.atitech.com	www.total3d.com
Price inc VAT	n/a	£135.13	£69.00	£269.08
Price ex VAT	n/a	£115.00	£58.72	£229.00
PCI/AGP	AGP	PCI	AGP	PCI
RAM onboard/Max RAM	8Mb/16Mb	8Mb/8Mb	8Mb/8Mb	12Mb/12Mb
Chipset	3Dfx Banshee	3Dfx Voodoo2	Rage Pro Turbo	3Dfx Voodoo2
RAMDAC speed	250MHz	135MHz	230MHz	135MHz
TV out	No	no	No	Yes
Max res/ colours	1600x1200x4bn	800x600x65k	1600x1200x16.7m	800x600x65k
Max refresh at max res	100Hz	120Hz	75Hz	120Hz
Windows drivers	95, 98, NT4	95, 98	95, 98, NT4	95, 98

MODEL	CREATIVE 3D BLASTER	CREATIVE GRAPHICS BLASTER EXXTREME	DIAMOND STEALTH II G460	DIAMOND VIPER 550
SUPPLIER/CONTACT	CREATIVE LABS	CREATIVE LABS	DIAMOND MULTIMEDIA	DIAMOND MULTIMEDIA
telephone	01245 265 265	01245 265 265	0118 944 4400	0118 944 4400
Web address	www.creativelabs.com	www.creativelabs.com	www.diamondmm.com	www.vreativelabs.com
Price inc VAT	£229.13	£79.00	£69.00	Approx £150
Price ex VAT	£195.00	£67.23	£58.72	Approx £128
PCI/AGP	PCI	PCI	AGP	AGP
RAM onboard/Max RAM	12Mb/12Mb	4Mb/4Mb	8Mb/8Mb	8Mb/16Mb
Chipset	3Dfx Voodoo2	Permedia2	intel i740	nVidia Riva TNT
RAMDAC speed	135MHz	230MHz	203MHz	250MHz
TV out	no	no	No	No
Max res/ colours	800x600x65k	1600x1200x65k	1600x1200x16.7m	1920x1200x16.7m
Max refresh at max res	120Hz	75Hz	60Hz	85Hz
Windows drivers	95, 98	95, NT4	95, 98, NT4	95, 98, NT4

MODEL	DIAMOND VIPER V330	INTEL EXPRESS 3D	MATROX MILLENIUM G200	MATROX MYSTIQUE G200
SUPPLIER/CONTACT	DIAMOND	INTEL	MATROX	MATROX
telephone	0118 944 400	01793 431155	01753 665544	01753 665544
Web address	www.diamondmm.com	www.intel.com	www.matrox.com	www.matrox.com
Price inc VAT	£61.00	£62	£129.25	£129.25
Price ex VAT	£51.91	£52.77	£110.00	£110.00
PCI/AGP	AGP	AGP	AGP	AGP
RAM onboard/Max RAM	8Mb/8Mb	4Mb/4Mb	8Mb/16Mb	8Mb/16Mb
Chipset	Intel i740	Intel i740	G200	G200
RAMDAC speed	203Mhz	203MHz	250MHz	230MHz
TV out	No	no	No	Yes
Max res/ colours	1600 x 1200 x 256	1600X1200X256	1920x1200x16.7m	1920x1200x16.7m
Max refresh at max res	60Hz	60Hz	85Hz	85Hz
Windows drivers	95, 98, NT4	95, 98, NT4	95, 98 NT4	95, 98, NT4

MODEL	METABYTE WICKED 3D	ORCHID RIGHTEOUS 3D II	S3 SAVAGE 3D	STB VELOCITY 128
SUPPLIER/CONTACT	WATFORD ELECTRONICS	FROM HIGH STREET STORES	N/A	STB
telephone	01582 745555	n/a	n/a	01753 212 600
Web address	www.Wicked3D.com	www.orchid.com	www.s3.com	www.stb.com
Price inc VAT	£211.50	£210.33	n/a	£115.00
Price ex VAT	£180.00	£179	n/a	£94.87
PCI/AGP	PCI	PCI	AGP	AGP
RAM onboard/Max RAM	12Mb/12Mb	12Mb/12Mb	8Mb/8Mb	8Mb/8Mb
Chipset	3Dfx Voodoo 2	3Dfx Voodoo2	Savage 3D	Riva 128ZX
RAMDAC speed	135MHz	135MHz	250MHz	250MHz
TV out	No	No	Yes	No
Max res/ colours	1024x768x65k	800x600x65k	1600x1200x16.7m	1600x1200x16.7m
Max refresh at max res	85Hz	120Hz	85Hz	60Hz
Windows drivers	95, 98, NT4	95, 98	95, 98, NT4	95, 98, NT4

PCW Labs report

Results for Incoming

Incoming (SCORE, 0–120 scale)

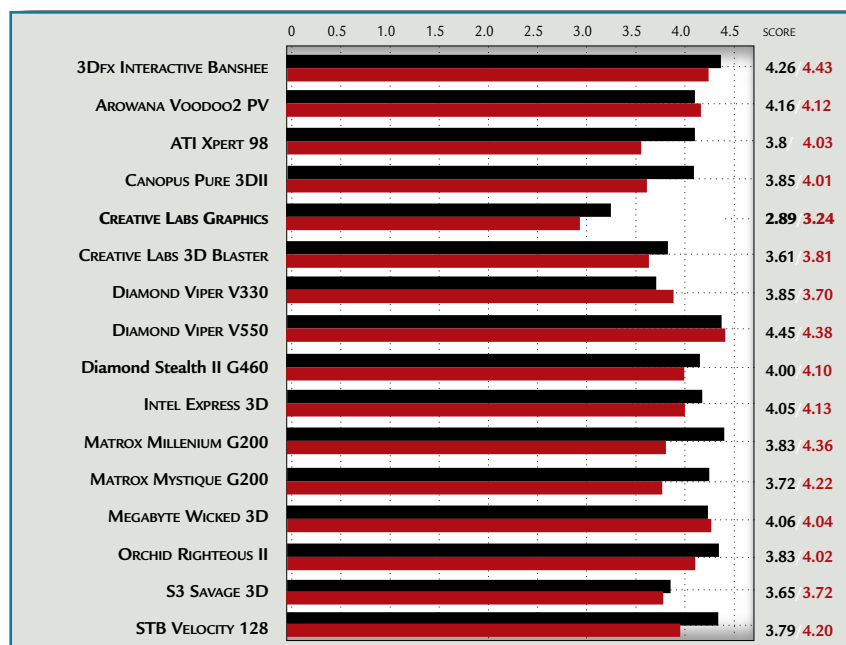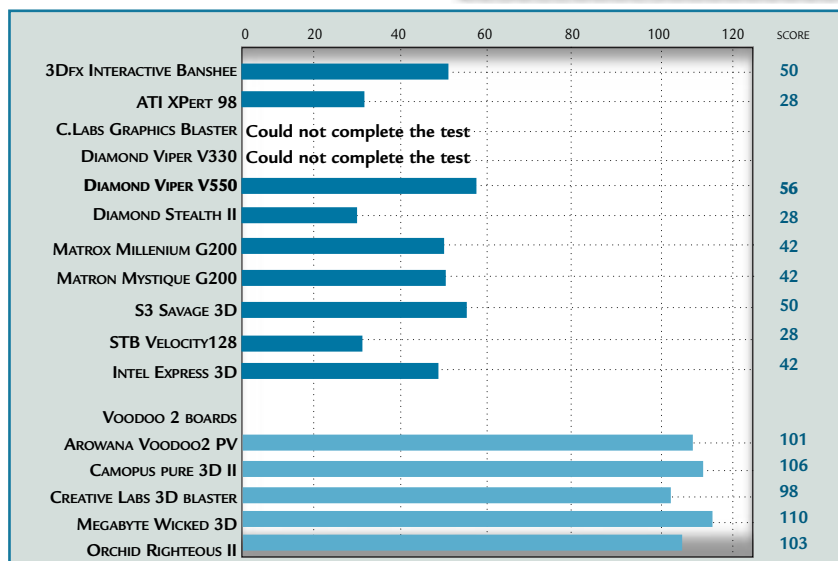| Card	SCORE
3Dfx Interactive Banshee	80
ATI XPert 98	32
C.Labs Graphics Blaster	30
Diamond Viper V330	55
Diamond Viper V550	83
Diamond Stealth II	59
Intel Express 3D	49
Matrox Millenium G200	65
Matron Mystique G200	62
S3 Savage 3D	71
STB Velocity 128	45
Voodoo 2 boards	
Arowana Voodoo2 PV	107
Camopus pure 3D II	110
Creative Labs 3D blaster	102
Megabyte Wicked 3D	114
Orchid Righteous II	106

FOR REAL-WORLD TESTING, WE USED TWO OF THE LATEST 3D GAMES, INCOMING AND FORSAKEN. WE USED THE FRAME RATE COUNTER OPTIONS OF BOTH GAMES TO ASSESS PERFORMANCE. WITH INCOMING WE TESTED ALL THE CARDS AT THE DEFAULT 640X480 RESOLUTION. WE TESTED ALL THE NON-VOODOO2 CARDS WITH V-SYNC ON, AND THE VOODOO2 CARDS WITH V-SYNC OFF. OTHERWISE WE DIDN'T ALTER ANY OF THE GRAPHICS SETTINGS, TO ENSURE A LEVEL PLAYING FIELD. YOU CAN DIRECTLY COMPARE THE RESULTS FROM ONE SET OF CARDS TO ALL OF THE OTHERS IN THAT SET

Results for Final Reality

FINAL REALITY HAS TWO DISTINCT SECTIONS, WITH 2D AND 3D TESTS. THE 2D SECTION SHOWS WHAT KIND OF PERFORMANCE YOU CAN EXPECT FOR WINDOWS APPS, WHILE THE 3D TESTS USE ALL OF THE 3D FEATURES OF THE CARD IN A SERIES OF GAME-LIKE ANIMATED 3D SCENES. IT RUNS UNDER WINDOWS 95 AND DIRECTX 5 AND USES A 3D ENGINE DEVELOPED BY REMEDY. THE VISUAL-APPEARANCE FACTORS ARE WEIGHTED IN IMPORTANCE AND COMBINED WITH THE OVERALL PROCESSING SPEED TO PRODUCE AN OVERALL MARK. AGAIN, THE HIGHER THE SCORE, THE BETTER THE RESUT. FINAL REALITY CAN BE DOWNLOADED FROM WWW.VNU.CO.UK. ALL THE CARDS WERE RESTED RUNNING AT A RESOLUTION OF 1024X768, IN 16-BIT COLOUR AND AT A REFRESH RATE OF 100HZ,

Final Reality (0–4.5 scale, SCORE columns)

Card	SCORE (black)	SCORE (red)
3Dfx Interactive Banshee	4.26	4.43
Arowana Voodoo2 PV	4.16	4.12
ATI Xpert 98	3.8	4.03
Canopus Pure 3DII	3.85	4.01
Creative Labs Graphics	2.89	3.24
Creative Labs 3D Blaster	3.61	3.81
Diamond Viper V330	3.85	3.70
Diamond Viper V550	4.45	4.38
Diamond Stealth II G460	4.00	4.10
Intel Express 3D	4.05	4.13
Matrox Millenium G200	3.83	4.36
Matrox Mystique G200	3.72	4.22
Megabyte Wicked 3D	4.06	4.04
Orchid Righteous II	3.83	4.02
S3 Savage 3D	3.65	3.72
STB Velocity 128	3.79	4.20

Results for Forsaken

Forsaken (SCORE, 0–120 scale)

Card	SCORE
3Dfx Interactive Banshee	50
ATI XPert 98	28
C.Labs Graphics Blaster	Could not complete the test
Diamond Viper V330	Could not complete the test
Diamond Viper V550	56
Diamond Stealth II	28
Matrox Millenium G200	42
Matron Mystique G200	42
S3 Savage 3D	50
STB Velocity128	28
Intel Express 3D	42
Voodoo 2 boards	
Arowana Voodoo2 PV	101
Camopus pure 3D II	106
Creative Labs 3D blaster	98
Megabyte Wicked 3D	110
Orchid Righteous II	103

AS IN THE INCOMING TEST, WE USED THE FRAME RATE COUNTER OPTION OF THE GAME TO ASSESS PERFORMANCE. TWO OF THE CARDS, THE CREATIVE LABS GRAPHICS BLASTER EXXTREME AND THE DIAMOND VIPER V330, WERE UNABLE TO RUN THE GAME AT ALL. WITH FORSAKEN WE USED THE MAXIMUM RESOLUTION THE CARDS WOULD SUPPORT, 800X600 OR 1024X768. BEAR THIS IN MIND WHEN COMPARING CARDS: OBVIOUSLY, A CARD THAT RAN THE TESTS AT 800X600 WILL LIKELY GIVE A HIGHER FRAME RATE THAN ONE WHICH RAN AT 1024X768. OF THE OTHERS TESTED, ALL EXCEPT THE INTEL EXPRESS 3D WERE ABLE TO RUN AT A RESOLUTION OF 1024X768. THE INTEL COULD ONLY MANAGE A RESOLUTION OF 800X600. THE VOODOO2 CARDS WERE RUN AT 800X600 WITH V-SYNC OFF.

Editor's Choice

Diamonds are a gamer's best friend — this Viper sure does bite!

There's no doubt that the pace of development in graphics cards is of benefit to the end-user. In the days of 2D-only cards, there may have been a difference of just a few percent between the best and the worst; but with 3D applications you can really feel the benefits of the best cards. And this isn't just in speed terms, but in visual features and quality. Watching the Final Reality, Forsaken and Incoming tests, the top performers were clearly visible even before the objective compilation of the results.

With some cards there's a trade-off though, particularly the Voodoo2 variants. Their speed is superb and they support practically all 3D features, but the overall look of the images they produce is lacking a little in vibrancy; plus they're very expensive, for 3D-only units. It looks as if 2D/3D combo cards really are the way to go, unless you've got around £500 to spare and need the ultimate games acceleration with twin Voodoo2s. Even 3Dfx has admitted that the dominance of 3D-only cards may be coming to an end, with its superb Banshee chipset. This, along with S3's Savage and Matrox's G200, has proved that the technology is now good enough to give superb 2D and 3D performance on one card with few, if any, compromises. Of course, you could argue that the pace of development means that these cards will soon be obsolete. There's no getting around that, but if you buy one of our winners, you'll probably be so pleased, it won't bother you.

Given the high price and 3D-only limitations of the Voodoo2 cards, we felt that Editor's Choice had to go to a 2D/3D combo card. Although the 3Dfx Banshee put in a storming performance, the unit was a sample and not eligible for an award. But look out for it when the major manufacturers start shipping the chipset on their products. However, it was clear which card *should* win our coveted **Editor's Choice** award – the **Diamond Viper V550** trounces all other 2D/3D cards in terms of speed, even with the beta drivers supplied to us for the review.

If you really want the highest performance for games and don't want to use the card for desktop 3D, then a Voodoo2 is still the best performer. Top of the heap was the **Wicked 3D** from **MetaByte**. It's not cheap, but it was the fastest and most fully featured, plus there's the Wicked Vision add-on.

Consequently, we gave it a **Highly Commended** award. The second Highly Commended goes to the **Matrox Millenium G200**. Performance in both 2D and 3D is nothing short of superb, it's fully AGP 2x compliant, and it has OpenGL drivers for both Windows 95/98 and NT. On top of that, its visual quality is the best of the bunch.

The Diamond Viper V550 trounces all other 2D/3D cards in terms of speed

● *Many thanks to Mesh Computers for the loan of a PII 400 for use as a test machine.*