3D graphics cards

The 3rd dimension

3D graphics are set to explode on the PC, and to get the best you need a 3D accelerator. We compare the latest cards to find the best buys

Once restricted to expensive workstations and Computer Aided Design (CAD) systems, high-quality 3D graphics have now arrived on the home PC. In fact, 3D graphics is the fastest growing market in the PC industry and it's expected to double over the next two years.

Now that Microsoft has added 3D graphics functions to Windows 95, add-on 3D accelerators are appearing left, right and centre. Adverts claim that everyone with a PC should have one, but what are the benefits of a 3D card? This month, we give an overview of the 3D scene and compare the latest products.

Who needs 3D?

By far the biggest reason for having a 3D graphics card is to play the latest and greatest games. The games industry is quick to adopt new technologies, and an increasing number of titles only work well with 3D acceleration. Products such as LucasArts' Shadows of the Empire demand it, while many others have stickers on their boxes declaring that they're 'enhanced for 3D accelerators'.

Unlike some improvements you can make to your PC, adding a good 3D card can make a huge difference. With the right one the change can be almost as dramatic as adding a sound card to a silent
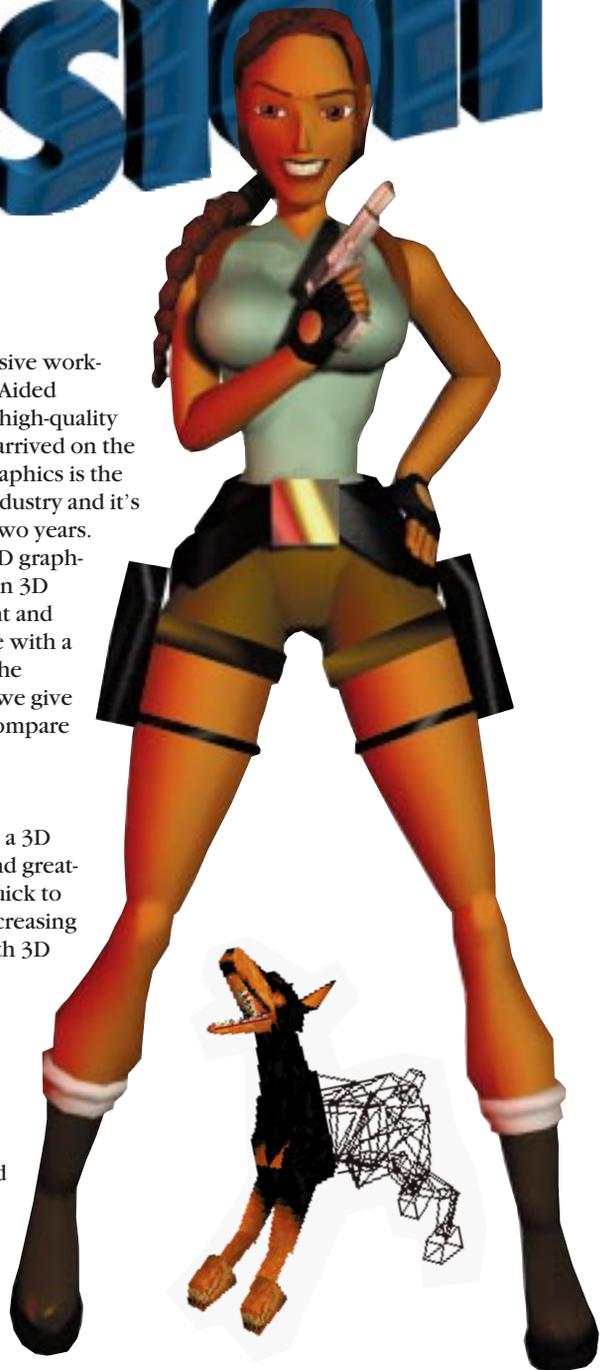
system. Typical improvements in accelerated games include much smoother animation and higher-resolution graphics, while scenery can take on a whole new depth. To find out what effect a good card can have on the latest games, check out the box, 'What's the difference?', on page 80.

Business applications

Business packages are also going to benefit from a 3D face-lift. When Microsoft introduces DirectX 6.0, its next generation of Windows multimedia extensions, it will give software developers more power to integrate 3D into their applications. Areas likely to benefit include Internet browsers, graphs, presentations, databases and even spreadsheets. New 3D enhancements are also likely to appear directly on the Windows Desktop, although exactly what form these will take is unclear.

Keeping up standards

Traditionally, whenever a new PC technology arrives, manufacturers battle to set the industry standard. This can cause confusion because you can't predict which card will end up with the most support. Fortunately, things are likely to be a little different with 3D graphics. Microsoft has designed Direct3D, which provides a standard way for programmers and hardware designers to use 3D graphics under Windows. In theory, if everyone supports Direct3D, all programs should run with all accelerators. The better the card, the better the end results.

It is inevitable, however, that some titles will be designed to get the most out of certain cards. Manufacturers bundle such games with their cards to show off performance. Examples include Ultim@te Race and Nightmare Creatures on PowerVR-based cards. and Turok on ones that use 3Dfx's Voodoo chipset.

Glossary of terms

Alpha blending/transparency: Alpha blending allows objects to appear in front of each other, with varying degrees of transparency. This effect can be used to simulate things such as water or 'see-through' explosions.

Bi-linear and tri-linear texture filtering: These sophisticated techniques are used to reduce 'blockiness' in textures to produce smoother images.

Depth fog: As the name suggests, depth fog adds (graduated) opacity to parts of an image. It is often used to create realistic smoke or weather effects.

Gouraud shading: The days of wire-frame and flat-shaded 3D graphics are over and Gouraud shading is at least partly responsible for that. The technique allows graduated colour shading to be applied to the surfaces of images, enhancing their realism.

Mapping: All objects in 3D are made up of polygons. Mapping is the technique whereby a picture is applied to the polygon to provide realistic surface detail. It's usually referred to as 'texture mapping'.

MIP mapping: This technique improves the image quality of distant 3D objects. MIP mapping is achieved by using different resolutions of the textures — if the object becomes small enough, a smaller texture is applied. This makes it possible to prevent a chaotic-looking pixel mess in distant objects. Texture details are much better preserved when this technique is used.

Phong shading: This is a shading system that adds life to 3D graphics. It uses more processor power than Gouraud but produces better results. There is likely to be a gradual shift from Gouraud to Phong shading as processing power increases.

Pixel: The basic building block of images/textures.

Rendering: The overall process of creating a 3D image with the chosen features, for example, fog, alpha blending, textures, lighting and so on.

Z-buffering: The Z-buffer is a part of the memory on a graphics card which keeps tabs on an object's position in '3D space'. As in the real world, computer-generated 3D objects have three axes – X, Y and Z – with the Z axis describing the depth of the object. For example, when two combatants cross paths on screen in a 3D fighting game, one has to be drawn in front of the other on the Z axis and it is the Z-buffer that stores this positional information.

OpenGL is another Windows 3D standard that looks likely to be popular, with games such as Quake, Quake 2 and Hexen 2 supporting it. A well-designed product should be compatible with both Direct3D and OpenGL.

It's in the chips

Each of the cards tested boasted a wide range of 3D acceleration features but not all products are created equal. Some solutions offer both 2D and 3D graphics on the same card, while others do only 3D and work with your existing graphics controller. There are a number of different 3D engines, or 'chipsets', available and it's important to look at these when choosing a card.

Exclusively 3D

The Orchid Righteous 3D, Gulliemot Maxi Gamer 3D, Diamond Monster 3D,
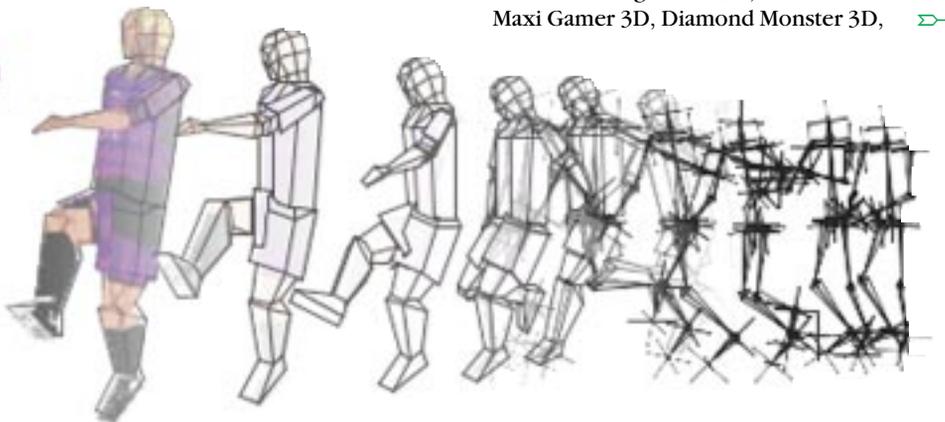
Matrox M3D and VideoLogic Apocalypse 3Dx are all 3D-only cards. This means they provide purely 3D output and must be used with your existing 2D graphics controller.

The first three cards are connected via an external cable and simply take over the screen when required. They are based round 3Dfx's Voodoo chipset, which is by far the most popular and well-supported chipset. The three cards provide 3D acceleration at resolutions of up to 800x600 pixels, and give their best performance at 640x480 pixels.

Voodoo-based cards cannot display 3D images in a window because they take over the whole display. Although this is not a problem for games players, who want full-screen action, it may restrict business use. This is something that you should take into consderation if you like the idea of using 3D in applications.

3Dfx makes another chip, called Voodoo Rush, that displays 3D images in a window, but there is a slight performance drop and few cards use it.

All Voodoo-based cards are generally of a very high quality, especially when used with games, such as Quake 2, that support the OpenGL standard. The Orchid Righteous 3D, Diamond Monster 3D and Gulliemot Maxi Gamer cards support both Direct3D and the OpenGL system.

In contrast, the Matrox M3D and VideoLogic Apocalypse 3Dx cards do their talking internally and use the PowerVR 3D engine. This engine was developed by VideoLogic and NEC, and it can accelerate 3D in both a window and full-screen in resolutions of up to 1024x768 pixels when combined with a 4Mb 2D card.

These two cards are cheaper than their Voodoo-based counterparts and they lack some of the more impressive 3D features. For example, their lighting effects can look particularly poor compared with other cards.

However, if games are written specifically for PowerVR then their performance can be almost as good. Examples include Kalisto's Ultim@te Race, Quake 2 and Activision's Nightmare Creatures, which is reviewed on page 114.

Complete solution

All the other cards tested offer a more complete solution, with both traditional 2D graphics and 3D acceleration in window and full-screen modes.

The STB Velocity 128, Diamond Viper v330 and Elsa Victory Erazor cards are designed around the nVidea Riva 128 processor, a relatively new 3D chip released at the end of last year. In most cases this offers acceleration on a par with Voodoo-based products, and the Riva is particularly noted for its performance with Direct3D software. These three cards can run in resolutions of up to 1600x1200 pixels and have an excellent range of features. The STB Velocity 128 also offers composite and S-Video connectors so you can use it to output to a TV or video.

Hercules opted for a Rendition V2200 chip on its new Thriller 3D card. As well as fast Direct3D performance, the 8Mb version of the Thriller offers video in, video out and capture facilities so you can show images on your TV or record them directly to your hard disk. Again, the Rendition processor is a good performer when it comes to handling Direct3D software.

ATI has developed its own 3D technology, and its XPERT@Work and XPERT@Play boards are designed round the Rage Pro chip. This chip has a well-rounded set of features and was one of the few 3D engines to support all the functions tested by our Final Reality benchmarks. Both ATI cards have a maximum resolution of 1600x1200 pixels and hardware assistance for playing back MPEG2 video; the XPERT@Play also features a TV output option.

Number Nine has also gone for its own technology with the Revolution 3D. Nicknamed 'Ticket to Ride' after *The Beatles*' track, the chip is comparable to Rage Pro in terms of its features and it has some acceleration for MPEG2 video. The Revolution 3D is available in both PCI and AGP versions.

Finally, Creative chose the Permedia 2 processor from 3D Labs for its Graphics Blaster Exxtreme.

What's the difference?

It's all very well saying that a 3D accelerator can make a world of difference to your games but what kind of improvements are we actually talking about? The screens below show Tomb Raider running with and without 3D hardware (we used an Orchid Righteous 3D card). As you can see, graphics take on a whole new depth with vastly improved lighting, smoother shading and much better definition. The other main benefit of acceleration is speed — but it's difficult to get this across in a screenshot.

With 3D acceleration

Without 3D acceleration

These two screens show the City scene from Final Reality, in which a spacecraft flies through a Blade Runner-style city. The ATI XPERT@Play (left) produced some stunning images, with good use of lighting and fogging effects. But the PowerVR-based VideoLogic Apocalypse 3Dx (right) didn't manage to render the searchlights, the flames from the spaceships' rocket engines or the glass dome as effectively.

Drivers

It's no good having the best hardware if it doesn't come with good software to drive it, and drivers are particularly important in the graphics world. The graphics driver is the piece of software that tells Windows how to work with the graphics card and it can have an incredible impact on performance.

Most companies update their drivers regularly to increase speed or add functionality, and you can usually download the latest ones from the manufacturers' Web sites. All the cards we looked at were tested with the latest drivers available when they were reviewed, and you should look for cards with both Direct3D and OpenGL compatibility.

Patches

If a game doesn't support a particular card, the card manufacturer will often work with the developer to produce a small utility which 'patches' the game to make it run with its hardware. You can usually find patches for the latest games on the Internet, or on magazine cover CDs.

Testing

All the cards were tested using version 1.01 of Final Reality, the 3D benchmarking software created by VNU Labs and Finnish games designer Remedy Entertainment. The program comprises a series of tests that simulate the demands of the latest Direct3D games and indicates how well cards will perform in the real world. The final result is an 'FR Mark' that can be used to compare products. We've included the program on this month's cover disc so you can see how your own system measures up. We also looked at how each card performed with the latest games, including Quake 2 and Tomb Raider II.

By far the highest scoring card was the Hercules Thriller 3D. This isn't surprising because it contains more memory than most and it's the newest card tested. However, while the Thriller 3D offered all of the functions measured by Final Reality, its images were not as smooth as some – in fact, at times they were quite jerky. Quake 2 performance was also disappointing compared with others because Hercules' Windows 95 driver was not OpenGL-compatible.

Final Reality

Card	FR Mark
XPERT@Work	3.25
XPERT@Play	3.25
Blaster XXtreme	2.75
Monster 3D	3.0
Viper v330	3.1
Viper v330 AGP	3.15
Victor Erazor	3.2
Maxi Gamer 3D	3.1
Thriller 3D	3.3
M3D	2.4
Revolution 3D	2.6
Revolution 3D AGP	2.6
Righteous 3D	3.0
Velocity 128	3.0
Apocalypse 3Dx	2.3
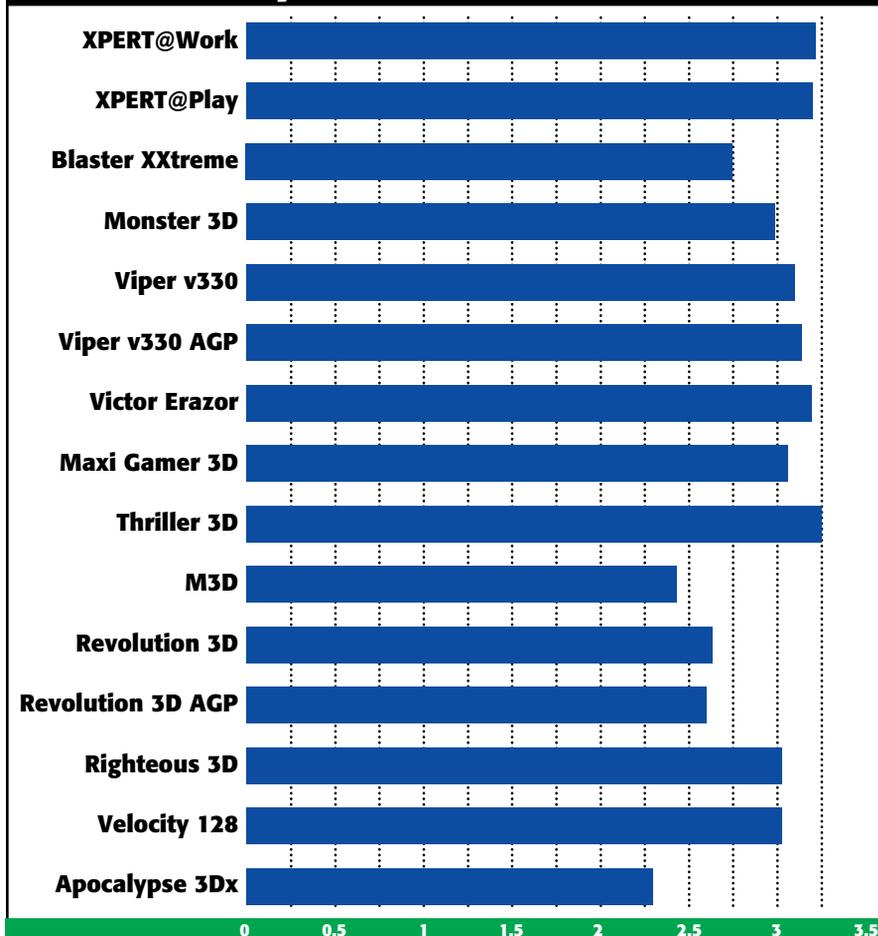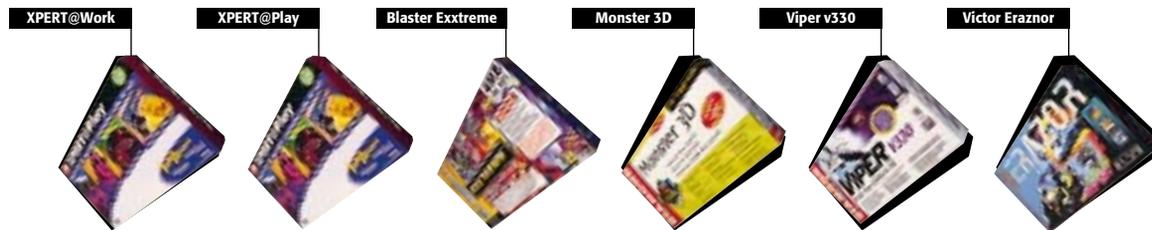
3D graphics cards

3D graphics cards compared

| Product	XPERT@Work	XPERT @Play	Graphics Blaster Exxtreme	Monster 3D	Viper v330	Victory Erazor
Product						
Supplier	ATI	ATI	Creative Labs	Diamond	Diamond	Elsa UK
Price (RRP)	£128 (4Mb) £152 (8Mb)	£124 (4Mb) £153 (8Mb)	£99	£149	£186	£175
Telephone	01235 833666	01235 833666	01734 344322	01189 444400	01189 444400	01844 261872
Version tested	AGP	PCI	PCI	PCI	AGP/PCI	PCI
Minimum requirements	Pentium	Pentium	Pentium 100, 16Mb	Pentium 90	Pentium 90	Pentium 166
Specifications						
2D & 3D	●	●	●	○	●	●
3D only	○	○	○	●	○	○
Chipset	Rage Pro	Rage Pro	Permedia 2	Voodoo	nVidia Riva 128	nVidia Riva 128
Memory	4Mb/8Mb	4Mb/8Mb	4Mb	4Mb	4Mb	4Mb
Maximum resolution (pixels)	1600x1200	1600x1200	1600x1200	800x600	1600x1200	1600x1200
3D features						
Texture bi-linear filtering	●	●	●	●	●	●
Z-buffer sorting	●	●	●	●	●	●
Texture MIP mapping	●	●	●	●	●	●
Texture tri-linear mapping	●	●	●	○	○	○
Depth fog	●	●	●	●	●	●
Specular gouraud shading	●	●	●	●	●	●
Vertex Alpha	●	●	○	●	●	●
Alpha blending	●	●	●	●	●	●
Adaptive Alpha (lighten)	●	●	●	●	●	●
Multiplicative Alpha (darken)	●	●	○	●	●	●
Subpixel accuracy	●	●	●	●	●	●
Direct3D support	●	●	●	●	●	●
OpenGL (Windows 95)	○	○	●	●	●*	●*
Ratings						
FR Mark	3.23	3.22	2.75	2.99	3.12/3.15	3.19
Quake 2 (frames per sec)	17.4	17.2	13	21.3	19.3/17.3	17.3
Features	★★★★	★★★★★	★★★	★★★★★	★★★★	★★★★★
Performance	★★★★★	★★★★★	★★★	★★★★★	★★★★	★★★★
Value for money	★★★★	★★★★★	★★★★	★★★★★	★★★	★★★★
Overall	★★★★	★★★★★	★★★	★★★★★	★★★★	★★★★
Extras						
Bundled software	3 applications	2 games 1 application	2 games 2 applications	10 games	2 games 4 applications	8 demos 3 applications

Notes: *= All nVidea cards tested with Alpha GL drivers on Quake 2 Products tested on a Carrera Power Pro II-300 system with 64Mb of RAM
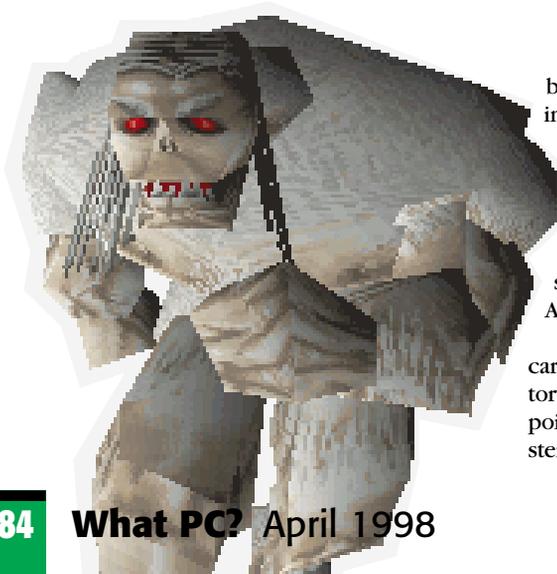
ATI's XPERT cards came next, with both offering great scores and registering every feature on the Final Reality checklist. Images were smooth and the only drawback was the lack of OpenGL compatibility, although ATI plans to put this right soon. It was also interesting to see only a slight difference between PCI and AGP versions.

All of the Voodoo and nVidea-based cards performed well, with the Elsa Victory Erazor moving into the lead by a few points. But again, it was the Diamond Monster 3D that gave the smoothest visuals.

The performances of the Matrox M3D and the VideoLogic Apocalypse were a little strange. They scored relatively low FR Marks and lacked several key features, especially noticeable under Final Reality, but they offered the highest frame rate under Quake 2.

The Number Nine Revolution 3D turned in a poor and rather puzzling performance with low scores from both the PCI and the AGP version of its card. The same was true of the Creative Labs Graphics Blaster Exxtreme, although its visuals were definitely as good as the Riva-based cards.

| Maxi Gamer 3D | Thriller 3D | M3D | Revolution 3D | Righteous 3D | Velocity 128 | Apocalypse 3Dx |
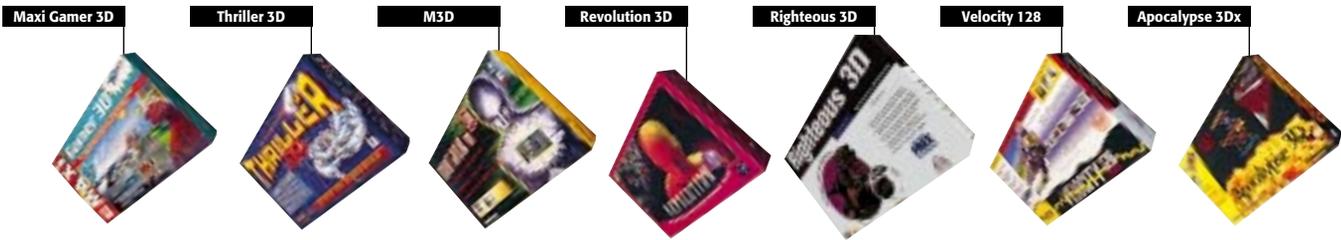
	Gulliemot Maxi Gamer 3D	Hercules Thriller 3D	M3D	Number Nine Revolution 3D	Righteous 3D	Velocity 128	Apocalypse 3Dx
	Ubisoft	Imago Micro	Matrox	Mentor Computers	Orchid	STB	VideoLogic
	£99.99	£117 (4Mb) £211 (8Mb)	£88	£194 (4Mb) £234 (8Mb)	£210	£147	£69 £99 (with games)
	0181 944 9000	01635 861122	01793 441100	01582 483381	01256 479898	0181 897 1003	01923 260511
	PCI	PCI	PCI	AGP/PCI	PCI	PCI	PCI
	Pentium 90, 8Mb	Pentium	Pentium 133	Pentium	Pentium 90, 8Mb	Pentium 90, 16Mb	Pentium 133, 32Mb
	○	●	○	●	○	●	○
	●	○	●	○	●	○	●
	Voodoo	Rendition V2200	PowerVR PCX2	Ticket to Ride	Voodoo	nVidia Riva 128	PowerVR PCX2
	4Mb	4Mb/8Mb	4Mb	4Mb/8Mb	4Mb	4Mb	4Mb
	800x600	1600x1200	1024x768	1920x1,060	800x600	1600x1200	1024x768
	●	●	●	●	●	●	●
	●	●	●	●	●	●	●
	●	●	●	●	●	●	●
	○	●	○	●	○	○	○
	●	●	○	●	●	●	○
	●	●	●	●	●	●	●
	●	●	○	●	●	●	○
	●	●	●	●	●	●	●
	●	●	○	●	●	●	○
	●	●	○	●	●	●	○
	●	●	●	●	●	●	●
	●	●	●	●	●	●	●
	●	○	●	○	●	●*	●
	3.05	3.25	2.41	2.63/2.62	3.03	3.04	2.28
	20	16.1	25	17.4/17.4	19	17.3	22
	★★★★★	★★★★★	★★★	★★★★	★★★★★	★★★★	★★★
	★★★★	★★★★★	★★★	★★	★★★★	★★★★	★★★
	★★★★★	★★★★	★★★★	★★	★★★★	★★★★	★★★★
	★★★★	★★★★	★★★	★★★	★★★★	★★★★	★★★
	None	1 game (8Mb only)	2 games 20 demos	2 applications	7 games	3 games 2 applications	5 games (£99 version)

★ = Poor ★★ = Below average ★★★ = Average ★★★★ = Good ★★★★★ = Excellent ○ No ● Yes

BEST BUY · BEST BUY · BEST BUY · WHAT PC?

We knew that choosing a single Best Buy would be difficult and, after testing all the cards, we found it impossible. What you should buy very much depends on whether you need an add-on 3D card, or both 2D and 3D functions.

Although it scored less than other Voodoo cards, the Diamond Monster 3D turned in the smoothest images of the 3D-only cards. It looks great running games like Quake 2 and Tomb Raider II, and comes with a good bundle of software. It therefore receives our Best Buy in this category.

Judging the 2D/3D cards was a little harder. The Hercules Thriller 3D leapt ahead in speed tests, but our Best Buy has to go to the ATI XPERT@Play. The card combines a complete set of features with a strong performance and, at £124, it's good value.

RECOMMENDED · RECOMMENDED · WHAT PC?

In terms of pure Direct3D performance, the Hercules Thriller 3D can't be faulted and runs away with our Recommended award. The video capture and TV output facilities on the 8Mb version will also come in handy for would-be film producers and they are compatible with US NTSC and European PAL formats. All Hercules needs now is an OpenGL driver for Quake 2 addicts.

An honourable mention goes to the Elsa Erazor Victory. It's a fine all-rounder and the best of the three nVidea cards, although all of these gave a good performance with Direct3D.

If you are looking for a cheap Quake 2 accelerator, then either the Matrox M3D or the VideoLogic Apocalypse 3Dx cards are worth a look. Chris Cain