# Sound advice

**Gordon Laing finds that, oddly, your sound card could be to blame for slow frame rates in games.**

This month I've looked at 3D surround sound for games, particularly in terms of the four-channel EAX and A3D solutions from Creative Labs and Aureal respectively – and wouldn't you know it, a whole load of performance issues emerged. Believe it or not, your innocent sound card makes a significant contribution to the total frames per second you end up getting on screen.

## Surround theory

The human brain is a very cunning processor, which in terms of audio can pretty much determine the location and condition of a sound given just two ears and the ability to turn using our head and body.

The sound source could be a car engine, a mouth, a musical instrument, slamming door, or even a glass breaking as it hits the floor. The source itself radiates the sound in a variety of ways – most of the sound out of a person's mouth comes from where their face is pointing, whereas an engine radiates sound in pretty much all directions (see diagram).

Once the sound is radiated, the environment comes into play. The actual medium between source and listener greatly affects the sound, as anyone knows who has shouted on a windy day, or heard something underwater. The first part of the sound we hear has travelled directly from the source in a straight line.

However, some of the sound could reach our ears after bouncing off a wall or object, and the material of these obstacles absorbs certain frequencies, along with reducing the overall volume. This 'first-order reflection' arrives not only sounding different from the direct source, but also slightly after it. Second-order reflections and so on take this effect further still. The quality and delay of the reflected sound reveals a great deal about the surrounding environment and its size.

Most humans can perceive precisely where first-order reflections are coming from, and some can distinguish second-order reflections too. However, as more and more reflections arrive at the ear, the brain tends to combine them into one late-order reflection echoing effect known as reverb. Using reverb properly is the first key to simulating different environments.

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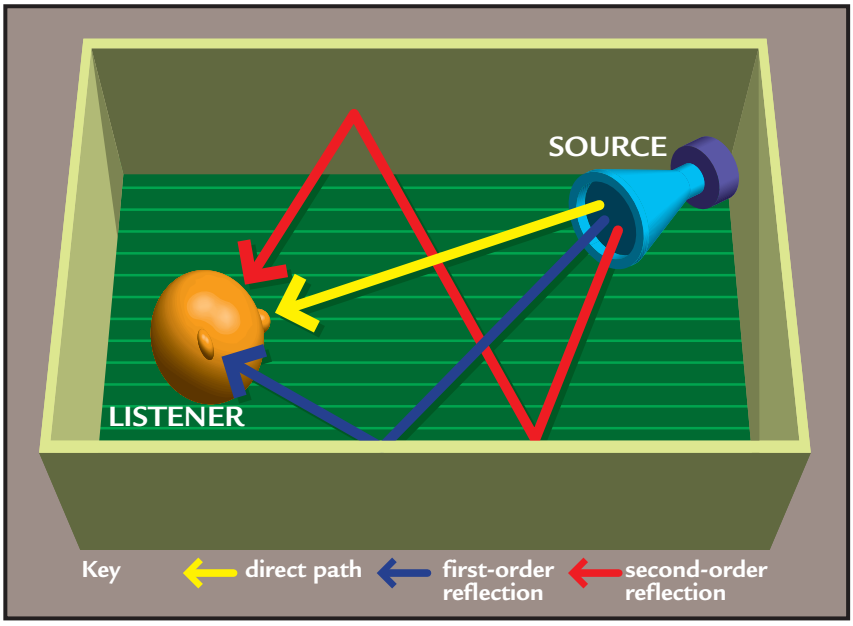
## Sound standards

Surround sound for the movies is pre-recorded and delivered consistently to the ear, no matter what cinema or home it is replayed in. Just about the only thing Dolby cares about is how far away the rear speakers are from the front and from the listener. Beyond that it's the same linear delivery, without any interaction from the listener – the same as listening to music.

This is obviously no good for games, where the sound needs to interactively change with the on-screen action in real time. What now seems like a very long time ago, Creative Labs (www.soundblaster.com) came up with its SoundBlaster mono audio standard for DOS games on PCs. As the standard matured, realism improved with stereo capabilities (SB Pro), and quality leapt forward with CD resolution (SB 16). When you started your game, you'd select the audio option that matched your sound card.

Microsoft, however, changed the entire multimedia standards game with its DirectX standard in Windows 95. The idea was that DirectX offered a load of commands, also known as APIs, which did things like 'make a sound on the left' or 'draw a sphere in front'. Games would then simply make DirectX calls and the hardware manufacturers would have to ensure their sound and graphics card drivers understood them.

The audio portion of DirectX 1 and 2 was called DirectSound, and this offered basic stereo left and right panning effects. DirectX 3 introduced DirectSound3D (DS3D) which offered a range of commands to place a sound anywhere in 3D space. This was known



as positional audio, and required significant processing power. Sadly we had to wait for DirectX 5 before Microsoft allowed DS3D to be accelerated by third-party hardware, reducing the stress on the main system CPU.

## Beyond DS3D

DS3D may have supported positional audio, but it didn't offer much support for adding reverb, let alone considering individual reflections, to simulate different environments. Re-enter Creative Labs with its Environmental Audio Extensions (EAX) and Aureal (www.a3d.com) with its A3D systems.

Aureal developed A3D initially with NASA for flight simulators, and it's indeed the technically superior standard. The current version, A3D 2, actually takes the geometry information of the room that is fed to the graphics card, and uses it to render realistic sonic reflections and occlusions (where an object gets in the way). Using a technology called WaveTracing, A3D 2 genuinely calculates up to 60 first-order reflections, which interact in real time with the environment, and then groups later-order reflections into overall reverb. The A3D API is entirely independent from DS3D and works by itself to create positional effects and reverb.

Creative Labs took the computationally easier approach with EAX, by gathering together all reflections and creating predefined reverb effects. These simply simulate certain rooms, such as an aircraft hangar, carpeted hallway or stony cave. Creative then submitted this list of predefined reverb effects as an open set of extensions to Microsoft's DS3D – they are, quite literally, environmental audio extensions. In games which use DirectSound and EAX, DS3D provides the positional effects, while most programmers simply apply a single EAX preset reverb setting until the player moves into a new room. To be fair, EAX has just recently been updated to version 2, which also includes support for occlusions, however, it is still nowhere near as thorough as A3D 2.

## Hardware support

As A3D 2 is such a computationally-complex system, Aureal developed a processor dedicated to the number crunching – called the Vortex2. It's available on sound cards such as VideoLogic's SonicVortex2 for around £50 (www.videologic.co.uk). Soon-to-be-released drivers for the Vortex2 are also expected to support hardware acceleration of DS3D and EAX for wider games compatibility.

**A3D 2 genuinely calculates up to 60 first-order reflections, which interact in real time**

EAX is most widely offered on Creative Labs' SoundBlaster Live cards, which also start at around £50 – in fact, in terms of gaming, all Live cards are essentially the same, with the different packages offering a variety of hardware and software bundles aimed at recording musicians. While any Aureal Vortex2 card will record 16bit audio and talk to MIDI instruments, packages such as Creative's £180 SB Live Platinum wipe the floor with them in terms of semi-pro recording facilities.

Rather than create a dedicated chip for EAX as Aureal has for A3D 2, Creative Labs' Live cards employ an EMU 10K1 DSP (Digital Signal Processor). Creative's LiveWare program actually loads the appropriate EAX software into the DSP, which allows a certain amount of upgrading. Some Live cards are over a year old, but the latest LiveWare 3 drivers will give any of them support for the latest EAX 2 commands – the basic drivers are free downloads, and there's probably sufficient processing power for an additional upgrade later this year too. However, there's not sufficient muscle for this DSP to effectively process A3D 2 commands.

Aureal has also recently announced A3D 3, which should turn up later in 2000 with new sound cards featuring an enhanced Vortex2 chip, along with a DSP to accelerate the new commands. A3D 3 also has some interesting support for Dolby Digital and streaming which we'll cover in future hardware columns when more information is available.

## Games support

Modern PC games support EAX, A3D, or sometimes both sound standards. Quake III Arena, along with demanding OpenGL for graphics, only supports positional audio via A3D 2. With Creative's backing, however, there are already more games supporting EAX 1 than A3D 2.

Unreal Tournament is fairly unusual in that it supports positional and environmental audio from both DS3D (with EAX) and A3D 2, so is the perfect testbed to compare sound systems. I ran separate tests using a VideoLogic SonicVortex2 and Creative Labs SoundBlaster Live Platinum. The test system was a PIII 550 with 128MB of RAM and, ahem, an ageing Matrox Marvel G200 graphics card. I used four-channel output, connected to the power amps and speakers of my home cinema surround-sound system as described in the boxout overleaf.

*Unreal Tournament – a great showcase of A3D 2's stunning positional audio capabilities*

## Quality

First things first: playing games in four channels with either EAX or A3D is a

## Four-channel speaker systems

While DS3D/EAX and A3D will happily simulate 3D sound using only two speakers, the best effects are when four speakers are used. Both SoundBlaster Live and Vortex2-based sound cards feature a pair of analog stereo outputs, one for the front speakers, the other for the rear.

If you've got an existing surround-sound system for movies, you may well be wondering whether you could use the same four-corner speakers for your PC games. Unfortunately, most PC speaker packages are designed for one or the other. DVD movie packages take the raw compressed Dolby Digital bitstream from the digital SPDIF output and decode it, before sending it to the appropriate amps and speakers. The best gamers can hope for is a plain analog stereo connection from their sound card, and non-interactive Dolby ProLogic processing.

Unfortunately, it would take too much processing power to realtime encode the analog four-channel EAX/A3D output into Dolby Digital, to feed games to a movie speaker package. Equally annoying are four-channel analog gaming packages which won't decode Dolby Digital.

Creative Labs' DeskTop Theatre 2500 package, however, offers the best of both worlds with SPDIF input and decoding for Dolby Digital movie soundtracks, but also analog pass-through inputs for directly addressing the four corner speakers. Hopefully, more speaker manufacturers will take this approach.

My own movie surround system consists of a Dolby Digital processor with separate power amps for the speakers. I connected the front two sound card channels to my processor's analog input and set the mode to plain stereo.

For the rear channels, I had to insert a passive QED switching box between my processor and power amp, to allow my sound card to access my surround speakers. I'd prefer not to have used a switching box, but at least the front channels are uncompromised, and the resulting sound for games is superb.



***These are the logos to look out for to find games that use EAX and A3D technology (from Creative Labs, left, and Aureal, below left)***

remarkable and highly recommended experience, but which sounds better? I've read plenty of editorial reckoning A3D 2 is superior in quality to EAX 1, but only slightly. I'd say it's more like the difference between night and day. Certainly EAX significantly improves the basic DS3D experience with nice reverb effects, but switching to A3D 2 is stunningly different. In Unreal Tournament and Quake III Arena, A3D 2 positions sounds so precise that you can hear someone running around a room, and then turn to just the right point to face them – it's an unbelievably realistic experience that greatly enhances the game. Even Creative's latest EAX 2 demos fall way short of those for A3D 2 supplied with oldish Vortex2 cards.

### Performance

Now for the big but. The Vortex2 processor may accelerate A3D 2, but it still places a big hit on your main CPU. Using the timedemo stats in Unreal to show a framecount, I measured approximately 55fps for basic stereo DirectSound, 45fps for DS3D with EAX and 35fps for A3D 2 – that's quite a significant hit and Aureal is understandably concerned.

The 3DSoundSurge website (http://3dsoundsurge.com) measured better performance of recent A3D drivers from Aureal, and I can certainly confirm that Vortex2 owners should immediately download the latest set with v2.25 of the A3DAPI.DLL. Games programmers can also make a big difference by optimising support for A3D 2. The 3DSoundSurge website found that Heretic II most effectively implements A3D 2, and with the latest A3DAPI.DLL measured a performance hit of only one per cent between A3D 2 compared to plain DirectSound; using earlier DLLs, there was as much as 25 per cent difference.

Sadly there are other issues with Vortex2 sound cards. Unlike the Live cards, there's currently no SMP support for dual-processor machines. Aureal says it will support SMP with a new WDM driver for Windows 2000 available around the time of the new OS' launch, but hasn't confirmed one for NT. There are also rumours concerning incompatibilities with some motherboards and Athlon processors, so check your manufacturer's website for patches or warnings before committing to A3D.

I would say, however, that A3D 2 is worth it. Having tried both systems, I'd sooner suffer the performance hit and enjoy the sheer sonic superiority of A3D 2. After all, my frame rate can be significantly improved by upgrading my Marvel G200. Sadly, no amount of hardware can make me a better player, so I'm just off for a bit more practice – the name's Zardoz if you fancy an easy frag on a Quake or Unreal server!

### CONTACTS

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