Aureal's 'digital ear' enables 3D positional audio using only two speakers. Ajith Ram listens in.

Getting an earful

There is a revolution coming to a PC near you. And it is a sound one. Following years of incremental developments, PC audio is taking off. About a year ago, this rather sedate area of computing was shaken up by a new standard, developed by Aureal Semiconductors. Its A3D standard helped sound cards to produce 3D surround sound through only two speakers, and this helped greatly to enhance the immersive environments in games.

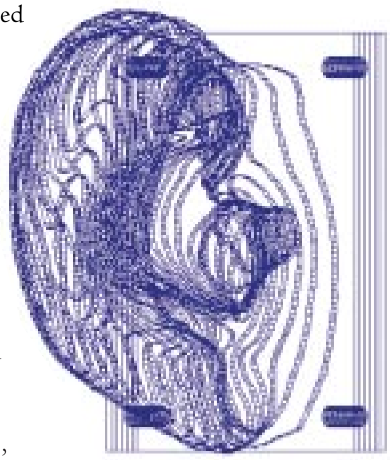
The next major step in 3D audio is likely to come from Sensaura, a little-known British company which is set to make ripples in the audio pond with a host of brilliant innovations. Although less well known than its rivals, Creative Labs and Aureal Semiconductors, Sensaura's pedigree is second to none. The company is part of CRL (Central Research Laboratories), the former research arm of EMI Music. In fact, stereo technology itself was invented there in 1931.

Sensaura is promoting two technologies: Sensaura 3D audio and Macro FX. The latter can be considered to be an invention in itself as it has no comparable predecessor. Like the popular A3D standard developed by Aureal, Sensaura 3D positional audio is based on HRTF (Head Related Transfer Function) algorithms. These define the way in which sound from different directions interacts with our ears and head. The greater the accuracy of the HRTF algorithms, the better the surround sound effect. It is here that Sensaura has a critical advantage over rivals.

"When we started working," says Alastair Sibbald, chief scientist at Sensaura, "the commercially available plastic ears used to calculate HRTFs were not sufficiently accurate, so we were forced to design our own."

The human ear is an intricate organ. Every section serves to identify a particular sound. Therefore, to get accurate HRTF measurements, the shape of the plastic ear has to resemble its human counterpart as closely as possible.

During his research, Sibbald found common myths about HRTF measurements to be false. For decades it had been assumed that the actual material used to make the "ear" was important. "We found that the materials themselves had no significant impact," Sibbald explains. "It is the *shape* of the ear that is important...", even the angle of the microphone used to simulate the ear drum. These findings resulted in Sensaura receiving a patent for its Digital Ear technology. So far, this Digital Ear is probably the most accurate reproduction of its human counterpart.



▲Sensaura's patented Digital Ear: so far, it represents the most accurate reproduction of a human ear

The accuracy of Sensaura's HRTF algorithms is evident in the quality of its 3D audio through two speakers. While most other technologies fail to reproduce sound directly behind the listener's head, Sensaura's 3D positional audio manages to do just that.

Macro FX is another Sensaura technology that is set to create a stir. Until now, all virtual surround sound technologies reproduced audio only at a set distance from the listener. Macro FX breaks this invisible barrier, making sound appear closer to the listener. Imagine a helicopter circling around and coming closer to you. As it gets closer, the volume and the quality of sound changes.

Previously, all virtual surround sound technologies made the helicopter seem as if it were a few feet in front of, or behind, you. But making it appear to be any closer proved difficult. With Sensaura's Macro FX, the same helicopter can be made to hover just in front of you or whiz right past your ear.

The technology has tremendous potential in the music industry ... IMAGINE MADONNA MOVING AROUND YOU AND SINGING SOFTLY INTO YOUR EAR

Additionally, characters in computer games can currently talk to you only from a set distance, but Macro FX allows them to come up to you and whisper in your ear. And, the technology has tremendous potential in the music industry, too. Imagine Madonna moving around you and singing softly into your ear.

Currently, the Yamaha Waveforce 192XG and VideoLogic SonicStorm Pro [*review, next month*]sound cards support Sensaura's 3D surround sound technology. Macro FX will be available in a driver upgrade later this year.

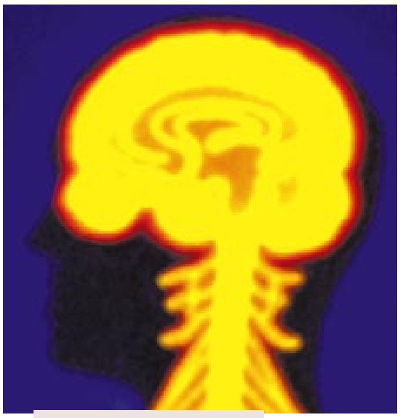
Toby Howard reports on an implant that is a startling step forward in the brain/computer interface.

All in the head

Until recently, controlling computers by human thought was science fiction; now, it's rapidly becoming science fact. Researchers have succeeded in tapping directly into thoughts by implanting tiny electrodes into the brain. It's called "cognitive engineering" and it's mind-blowing. Attempts to use thought-power alone to control computers have traditionally used an electroencephalograph (EEG) to measure the brain's electrical activity. The patient wears a skull-cap studded with electrodes, but because the skull muffles much of the neuronal chatter, the EEG records only large-scale activity when large groups of neurons fire together. It's rather like listening to the neighbours through the wall: you get the general gist but you can't hear all you'd like to.

Bakay and his team are confident that the brain-computer interface will ONE DAY TRANSFORM THE LIVES of severely handicapped people

The crux of the brain-computer interface problem is, how can individual thoughts be picked up? Much research focuses on signal-processing techniques to search the EEG traces for subtle changes in the cranial cacophony, but it's an inexact science. Just a few weeks ago came the startling announcement of a huge leap forward. Neuro-surgeon Roy Bakay and his team at Emory University in Atlanta have developed a brain implant which can monitor extremely small-scale activity in the brain's motor area.



▲One day, we will be able to control our computers by thought alone, via a special brain implant

The implant is a hollow glass cone the size of a ballpoint pen's tip. Called a "neurotrophic electrode", it's inserted via a hole drilled in the skull, into the cerebral cortex above the ear. The placement is crucial. Bakay's team scans the patient's brain using magnetic-resonance imaging, a non-invasive technique that displays computer-graphic images of blood-flow patterns. When the patient is asked to think of moving a limb, the motor area of the brain becomes active and from its increased blood flow the precise location of the active region can be identified. This is where the electrode is implanted. Inside the glass cone is a microscopically thin gold wire surrounded by nerve tissue extracted from the patient's leg, which stimulates neurons from the surrounding cortex to grow into the cell. Over a period of months, the neurons fuse with the wire. "It's like having a little piece of brain inside the electrode," says Bakay.

Unlike previous generations of brain electrodes, the implant needs no cabling. It receives its power from an induction coil sewn into a baseball cap worn by the patient. Any signal picked up from motor neuron activity is detected and amplified by a tiny receiver placed just under the skull. The patient subsequently undergoes a training programme using biofeedback. The electrical activity recorded by the implant controls the sound of a buzzer, and the patient gradually learns which thoughts make the buzzer sound louder and faster. Later, this buzzer is replaced by a cursor on a computer screen and the patient learns to "think" the cursor from side to side.

Two patients have so far received Bakay's implants. The first, who suffered from a fatal degenerative motor neurone disease, received her implants in 1997 and lived long enough to take part in preliminary experiments. "We learned a lot about the basic principles from her," says Bakay. "She helped us identify the brain cells we were looking for." The second is a 53-year-old stroke victim paralysed from the neck down, known as "JR". He has two implants, enabling him to separately control the horizontal and vertical movements of a cursor and select icons which trigger synthesised speech. For the first time since his stroke, JR can communicate. "If you can use a computer, you can talk to the world," says Bakay. The team are confident that the brain-computer interface will one day transform the lives of severely handicapped people, eventually enabling them to operate artificial limbs as easily as if they were their own.

Cognitive engineering is by turns fascinating and frightening. Where does the human stop and the machine start? If the brain-machine communication is two-way, could the machine control the person? Hypothetical questions for now, perhaps, but they might one day become very real.