

THE
GUARDIAN WEEKLY
QUIZ[Back to online version](#)

GuardianUnlimited: Print version

Sounds convenient

Audio spotlights can aim as precisely as laser beams, writes Alok Jha. And they're moving from the lab to the home

Alok Jha

More The Guardian, Thursday March 31 2005

Science

Several years ago, an artist at the Chicago Cultural Centre came to Joseph Pompei with a problem. He had combined dozens of chattering voices in one of the exhibition spaces but, because the room was small, the sounds interfered with each other. The cacophonous result threatened to derail his exhibit.

Pompei, an electronics expert and former student at the Massachusetts Institute of Technology's (MIT) Media Lab, had the answer. He threw out the museum's speakers and replaced them with some of his own, several years in the development. The results were startling. "When you walked into the room, it was almost completely quiet until you walked into one of the zones that the artist had prescribed that would deliver sound to you," he says.

Pompei's big idea is "audio spotlights", which aim sound as precisely as a laser beam. If you're a centimetre outside the target area, you hear nothing.

Imagine the advantages: you could listen to the radio without disturbing someone sitting next to you watching television. Or you could while away a long car journey with music, while everyone around you sits in peace. All without having to retreat from the world by wearing headphones.

Now the technology is coming to a living room near you. Pompei reckons that a typical home audio spotlight system will be yours for about £700 when it goes on sale later this year.

Pompei's invention turns the traditional method of delivering sound on its head and rethinks some of the technology behind today's amplifiers and speakers - ideas that have changed little for nearly a century.

While working part-time at the speaker manufacturer Bose during high school, he realised that the audio industry, with its focus on improving sound quality, was overlooking the issue of sound control - where it came from, where it went and who heard it.

To change that, he exploited a phenomenon of sound waves travelling through the air.

"The air is a non-linear medium - the waves that go through it change

shape very slightly as they travel," he says. The peaks of the waves, for example, end up travelling just a little bit faster than the troughs and the wave shears. This produces frequencies that weren't there to start with.

His audio spotlights generate a beam of ultrasound. Humans can't hear ultrasound but, as the waves travel through the air, they distort and generate audible byproducts. These audio waves can be predicted mathematically and Pompei, knowing the resulting audio waves he wanted, worked backwards to find the ultrasound waves that would create them.

Early attempts to do this in the 1980s led to huge amounts of distortion in the audio waves being created. These systems might have been able to produce interesting sound effects but speech was hard to understand. And you could forget about listening to music.

Pompei added a processing step to his system that pre-distorted the audio signal coming into his amplifier. "Then you modulate that into ultrasound so that when it goes through the air, it comes back to the original sound you started with," he says.

Another problem was implementation. Researchers had trouble building a system that was practical and generated a clean ultrasonic signal.

"What it comes down to is that if you want clean audio, you need clean ultra sound," says Pompei. "It wasn't so obvious back then. The apparatus they created was extremely expensive - several thousand dollars in components alone. They had massive problems in power consumption, heating and inefficiencies."

To get round this problem, Pompei had to design a new type of speaker and amplifier. Normal speakers create sound waves by passing a changing current across a piezoelectric crystal, which vibrates in response. This mechanism won't work to create clean ultrasound, so Pompei invented a thin film made of metal and plastic to do the job.

Because audio spotlights offer control of the sound, rather than the best sound quality, their use has so far been restricted to professional audio environments such as museums, exhibitions and shops. The creative uses are big too - rock band U2 are thinking of using audio spotlights at concerts to create directed sound displays in the same way they use light. Domestic versions are now being produced, but Pompei doesn't expect them to completely replace normal speakers in all applications.

"Loudspeakers have about a hundred-year lead on us for development but we're catching up very quickly," says Pompei. "While it's acceptable for any listening environment, if you put it side by side with a \$10,000 top end hi-fi system, it's not quite there yet."