CEDAR Audio

BILL LACEY explores a research project that became one of the audio industry's biggest innovators

Tucked away on a quiet street in a small village on the outskirts of Cambridge is a hub of innovation that is central to the development of revolutionary audio technologies, some that we have come to take for granted. Many today can't remember a time when we didn't have real-time digital audio restoration and spectral audio editing. Yet, it was here that it was invented. CEDAR Audio opened for business in January 1989 and, 30 years later, this company has had a profound effect on all things audio. CEDAR, compact in nature, is guided by managing director Gordon Reid (main pic, right) and a small team of colleagues. Together, their commitment to quality establishes a benchmark in the audio industry by which all others are judged.

University of Cambridge beginnings

The origins of CEDAR extend back to 1983. The British Library National Sound Archive under the direction of Dr. Christopher Roads wanted to transfer its aging sound library to digital media. In 1985 he was introduced to Professor Peter Rayner, head of the Signal Processing Laboratory within the Engineering Department at the University of Cambridge, whom he then asked for help in removing many of the degradations of the source material. Rayner understood the complexities of the problem, especially in that it was impractical at the time for real-time processing to occur. Instead, the audio would need to be transferred to computer hard disks and processed. The biggest problems the library were dealing with primarily were thumps, clicks and hiss. The Library funded three years of Doctoral research in digital audio restoration at Cambridge University. This project produced prototype algorithms that could remove those problems. A short sample that took days to process was shared with the public on a BBC forward-looking science show called *Tomorrow's World*.

The worldwide reaction was enthusiastic and demand for this technology materialised overnight. A decision was made to establish a company that could commercialise the process. Roads enlisted Reid (who had a scientific background, commercial experience and was an active musician) to run the operation, which would be set up with a small investment from telecoms giant Cable & Wireless.

Initially envisaged to be a bureau service, Reid understood the record industry and recognised immediately that a more commercially sensible route would be to develop products, as the audio industry would not willingly send their treasured assets away for processing. Nevertheless, during the first 16 months of operation, the company operated as a bureau service to raise revenue while developing what would be the first DOS-based CEDAR system.

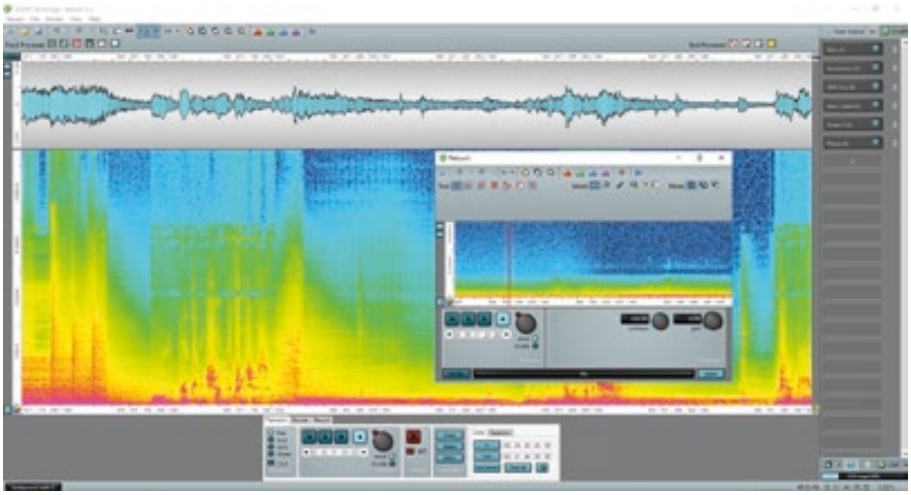
/ CEDAR's headquarters on the outskirts of Cambridge

This was introduced at the Joint Technical Symposium of the World's Archives in Ottawa, Canada in May 1990. The following month, the first two systems were installed at the mastering studios of DigiPro, which operated in both Brussels and Paris. The third system went to BMG Studios in NYC. Reid hired Clive Osborn (main pic, left) as sales manager in 1991. Osborn was also an active musician whom Reid had previously met. The company grew in size as sales continued and product development expanded. In April of 1994 the management, which also included senior engineer Dave Betts, bought CEDAR Audio from its existing major shareholders, the British Library and Cable & Wireless.

The initial product line serviced the needs of record companies and mastering studios. The earliest CEDAR System ran on DOS computers and offered real-time removal of clicks, crackle and hiss. From the start, CEDAR established a tradition of offering an easy to use interface with a set of controls that could be manipulated in real-time. As computing processing power increased CEDAR pushed the envelope further with the introduction of CEDAR for Windows, boasting up to eight two-channel processes in series or in parallel or in any combination, all in real-time. Countless CD releases benefitted from CEDAR processing, including those of Elvis Presley, Arturo Toscanini, Frank Sinatra and the Grammy Award winning Heifetz Collection.

Spectral audio editing

Whilst innovation can be found in every aspect of CEDAR Audio's product line, the introduction of spectral audio editing to the world with CEDAR Retouch deserves special mention. Almost taken for granted today, CEDAR Retouch was the first tool to allow users to modify audio material defined by both its temporal and spectral content, much the same way image editing is accomplished. For the first time technical problems



/ The first CEDAR system from 1990, running under MSDOS

previously impossible to fix could be solved. An absolute triumph of innovation, all spectral editing products today owe their lineage to CEDAR Retouch.

One of the hallmarks of any successful company is the ability to recognise trends in the marketplace and continually develop new products to satisfy the demands of existing customers, as well as keeping an eye on the technology of the future and where those developments can best be applied. To that end the management team, which included Dr. Christopher Hicks, steered the company beyond premastering and into the wider entertainment industries, developing tools that would benefit the production, post-production and live broadcast sectors of the industry.

Work began on what was to become known as the DNS1000, whose working title 'The Postman' was coined by Osborn. Introduced in 2000, the DNS1000 was specifically designed to remove background noise in dialogue recordings with zero latency, and it became an immediate success. It was designed to sit on the desktop or on the mixing console and featured seven faders for real-time control. In 2005, on behalf of CEDAR Audio, Dr. Hicks and Dave Betts accepted an Academy Award presented by the Academy of Motion Picture Arts and Sciences for the development of the DNS1000. Further refinements of the product led to the DNS2000, which was designed specifically to integrate with Pro Tools systems and take full advantage of the automation features the host DAW offered.

The live broadcast and location sound sector of the entertainment industry were next to benefit from CEDAR innovation. Out in the field Reid and Osborn observed multiple microphone channels being fed into a single two-channel DNS unit so the DNS 8 was designed to offer eight channels of live background noise reduction that would 'learn' and adjust as needed, allowing broadcasters to have a separate channel of noise reduction for individual mics on set resulting in more effective processing. The DNS 2 was a two-channel unit designed for portable use at the point of capture, whether on film sets or live broadcast environments. You'll often find a DNS in use at the side of the pitch for sporting events, as well as news broadcast and live sound events.

Forensics, security and surveillance

As early as 1993, Reid and Osborn observed that a lot of customers were using CEDAR products in ways for which they were not designed, particularly in the area of audio forensics. Anything that could possibly improve a signal was sought by these customers. Intelligibility of the source audio was paramount, as opposed to retaining the original quality of the 'wanted' signal — which is the guiding principle of premastering and entertainment workflows. Seizing upon the increasing power of computer processing,

/ **Clive Osborn with a DNS 2 at SoundPro 2018**

CEDAR Audio developed a series of products dedicated to the needs of audio forensics. The first of these were CEDAR's Adaptive Filters, released as a set of modules for the new CEDAR Cambridge host computer system. These were more aggressive than traditional audio industry filters to better meet the needs of audio forensics workflows. FNR is a powerful broadband noise reduction module designed to dramatically improve the intelligibility of speech that is overwhelmed by background noise.

To service the security and surveillance industry CEDAR Trinity was developed. Specifically designed for live surveillance, this serves as a live audio recorder offering multi-user access, the ability to jump back in time and apply different filters to increase intelligibility while real-time recording continues, and verification for evidential purposes. The filter section within this, called Trinity Enhance, has since appeared on the CEDAR Cambridge System as well as being made available as a plug-in.

Elsewhere, the SE 1 Speech Enhancer is designed to be a rugged, portable solution for police, security and counter-terrorism surveillance. It offers minimal latency, mains or battery operation and is small enough to fit in your pocket.

Late 2018 brings continued innovation at CEDAR. The latest CEDAR Studio 8 collection of plugins has been released, now making available DNS Two, a plugin version of the DNS 2, new Retouch features, AU support and iLok authorisation. It was voted Best Plug-in in the 2018 Resolution Awards. CEDAR Cambridge 12 introduces new hardware, a stunning redesigned user interface and a new process module, Unwrap. Unwrap can completely restore the distortion that can sometimes occur as a result of wrapping by some digital audio recorders. The results are positively jaw dropping as Unwrap can take a previously 100% unusable clip of audio and make it completely intelligible and usable. Meanwhile, the SE 1 has been upgraded to V2 firmware, improving noise reduction and speech enhancement with lower residual noise.

The technologies developed by CEDAR Audio to enhance speech for entertainment, forensics and security have potential uses beyond those applications. Consider the everyday occurrence of smartphone calls from noisy environments like restaurants or in the street, with the person on the other end struggling to understand what you are saying. Or consider making voice-activated calls from your car while simultaneously treating the recipient to road noise, radio and possibly passengers talking in the background, making it almost impossible to understand what you are saying. Maybe consider consumer appliances that are designed to listen to your voice commands and which are confused by

/ **Audio & technical support engineer Paul Alexander demonstrates CEDAR Studio 8**

the noise of children playing or the television blasting in the background. Or consider people with hearing disabilities who struggle with intelligibility in almost all situations,

/ **DNS 2 dialogue noise suppressor in use pitch-side by Graham Smith, sound recordist at the 2018 FIFA World Cup finals**

especially when at a party and straining to hear the person next to you (referred to as the 'cocktail party problem').

A new spinoff from CEDAR called AudioTelligence is in the process of applying ground-breaking technologies initially developed by CEDAR Audio to improve upon these everyday problems. The goal is to improve intelligibility by separating the wanted speech from the background through a process referred to as 'blind audio signal separation'. Where or how this technology will be adopted has yet to be determined, but the possibilities are indeed exciting.

It began 34 years ago with a conversation between the British Library and Cambridge University, and the University's relationship with CEDAR Audio still exists. Cambridge University remains a leader in research into digital signal processing and currently two Cambridge University professors and a director of studies are among CEDAR's directors. The team is determined to ensure that CEDAR Audio remains a leader in digital audio restoration and speech enhancement. That's something we should all be grateful to hear — intelligibly, of course.

/ **The HQ of CEDAR-spinoff AudioTelligence**