Early Warning
HEARING LOSS
Detection Technology
Noise-induced hearing loss results from exposure to loud sounds, either a single intense impulse or continuous exposure over a period of time, which can seriously damage sensitive structures in the inner ear.

Other symptoms of acoustic trauma include tinnitus, characterised as the experience of sound when no external sound is present, which often manifests itself as ringing in the ears.

An estimated 50 million Americans have some degree of tinnitus, while 16 million have symptoms serious enough for them to visit a doctor or hearing specialist. Tinnitus is the largest single category for disability claims in the military, with hearing loss a close second.
Plextek has developed an innovative technology to detect the early symptoms of **noise-induced hearing loss (NIHL)** that is capable of being integrated with standard commercial earphones and headphones.

The technology has the potential to limit the worldwide surge in tinnitus in young people, and provide a market edge for leading headphone manufacturers.

*Dr Nigel Whittle - Head of Medical & Healthcare, Plextek Ltd, Cambridge, UK*

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**Tinnitus and Hearing Loss**

Tinnitus has traditionally been a problem for those working in noisy environments, such as rock musicians, soldiers or construction workers. However, instant digital access to loud audio has brought its own risks for music lovers and the younger generation, who often enjoy listening to music at excessive volumes. **The WHO is warning that some 1.1 billion teenagers and young adults around the world are at risk of developing hearing damage due to exposure to damaging levels of sound.**

**SMARTPHONE WARNINGS**

In response to concerns about this early hearing loss trend, many smartphone manufacturers incorporate colour-warning indications in a device’s volume-level graphic to warn the user when they may be cranking the volume up too high. However, these systems are easily overlooked or ignored by users who are unaware of the danger posed by loud music or repeated exposure to even moderately high levels of sound.

Early intervention can be effective in mitigating the worst effects of loud music, but existing technology for testing for tinnitus is generally only available in hospitals or specialised clinics, meaning that it is rare for early signs of the disorder to be picked up.
Technology Development

Plextek has developed an innovative hearing analysis application that can reliably detect the early signs of hearing loss well before a person would become aware of the symptoms.

The technology will scan a user’s hearing daily, creating a fingerprint of their hearing ability and alerting them via a connected smartphone app if there are any subtle changes. It has been designed for integration within standard everyday consumer headphones, and has been described as a potential ‘game changer’ in the prevention of tinnitus and hearing loss.

TEST RESULTS

The prototype works by accurately monitoring subtle changes to Auditory Evoked Potentials (AEP), signals sent from the brain by an acoustical stimulus that measures an individual’s auditory ability level.

Using a standard laptop and USB audio card, tests proved it was possible to record AEP waveforms using in-ear headphones.

Experiments with everyday brands, such as Sennheiser and Sony, were conducted to successfully demonstrate the applicability of this technology and potential mass audience appeal.
Our modern lifestyle means that loud music and noise pollution is ever-present.

Young people, in particular, risk permanent and debilitating damage to their hearing from regular playing of audio at mid to high-volume through headphones. Integration of NIHL-detection technology into commercial headphones or earphones could provide early warning signs of hearing disorders. The ability to self-monitor will allow earphone manufacturers to provide equipment with a built-in safety feature that will provide significant reassurance to their customers.

Dr Thomas Rouse, Lead Consultant, Medical & Healthcare at Plextek.

Benefit to Users

The company’s solution, when integrated into commonly used in-ear consumer earphones or headphones, would remove the clinical barrier to access and could play a game-changing preventative role in the treatment of NIHL. In addition to general consumer use, it would particularly benefit those working within high-risk environments such as building sites, the military, or music venues.

DETECTION BEFORE SYMPTOMS

No existing technology is currently available to enable the facile detection of such damage before the person develops overt symptoms, such as the characteristic buzzing in the ears that indicates tinnitus.

Opportunity

Plextek filed a patent for the technology in 2017 and is currently seeking commercial partners to further develop and drive adoption of the device.
Technical Information

The Auditory Brainstem Response (ABR, also Brainstem Auditory Evoked Potential, BAER) is a series of electrical responses recorded from the auditory pathway between the ear and the upper brainstem following presentation of sound to the ear.

The waveform is effectively an individual fingerprint of auditory capacity, so changes in the ABR may be indicative of evolving injury somewhere along the auditory pathway. People with tinnitus typically exhibit specific changes in the waveform pattern, and those changes can be detected before tinnitus is apparent\(^2\).

**ROBUST AND RELIABLE**

Currently, these can only be measured by expert practitioners using expensive, bespoke equipment in a clinical environment. Plextek’s demonstrator utilises a PC coupled to a soundcard to generate a stimulus and extract a signal over 2000 iterations. Analysis of the ABR waveform can then produce detailed records of temporary and permanent changes, identifying when issues occur. The challenges which were successfully overcome included the need to demonstrate that a system would work robustly and reliably, in the real-world, using modified ‘off-the-shelf’ headphones.

**EARLY DETECTION**

The results demonstrated that a personal monitoring system integrated into standard earphones or headphones can be used for the early detection of auditory disorders including tinnitus. Moreover the technology can potentially detect hidden hearing loss that is not detected by the standard pure tone hearing test. Details of this technology were presented at the 143rd International Convention of the Audio Engineering Society (AES) in New York in 2017\(^3\).

**SMARTPHONE INTEGRATION**

Current work is focused on increasing sensitivity by maximising the signal-to-noise output. Future work will be conducted to miniaturise, automate and integrate the electronics inside headphones, and develop a smartphone app as part of an integrated mHealth system for unobtrusive auditory monitoring.
Business Opportunity

Plextek are seeking to work with a business partner to further develop and commercialise this technology.

Our ideal partner would be a company with an understanding of auditory technology, perhaps a manufacturer of high-end acoustic equipment with a desire to incorporate a robust safety feature into headphones/earphones. Alternatively, companies that supply specialist hearing protection and/or communication systems to the armed forces can benefit from incorporation of our technology into their products.

The commercial structure is likely to involve the following components:

- Licensing (exclusive or non-exclusive) of Plextek proprietary IP associated with the NIHL detection technology.
- Further development work conducted by Plextek to miniaturise, automate and integrate the electronics inside headphones and acquire further clinically relevant data.
- Technology transfer and full commercial development by Partner.
- Simultaneous development of the mHealth app by the Partner or 3rd Party.

1. UK Patent Application No. 1702915.8


About Nigel Whittle

Nigel’s focus at Plextek is on helping organisations in the Medical & Healthcare sectors with their strategic positioning and technological capability. Nigel has a long and successful track record delivering healthcare, life sciences & pharma projects into the marketplace.

Plextek is an engineering consultancy at the heart of technology innovation. With a 30 year history of providing complex engineering solutions to global organisations, we continuously innovate to push the boundaries of engineering today.

If you’d like to chat to Nigel about your project, please call +44 7931 520480 or email nigel.whittle@plextek.com

Nigel Whittle, Head of Medical and Healthcare