

### The science and technology behind Australia Hears

**Testing your hearing, ordering state-of-the art hearing aids, and fine tuning them to suit your own hearing needs can now all be done over the internet. It's a simple, inexpensive process that can be completed in the privacy of your own home, and with or without the assistance of an audiologist.**

The new hearing aids, available from Australia Hears Pty Ltd, contain advanced sound-processing technology from Dynamic Hearing called Adaptive Dynamic Range Optimisation (ADRO®), that was developed for cochlear implants. Similar technology is now incorporated in three out of the five highest quality Bluetooth headsets available in 2010.

The ADRO hearing aids match the best available digital hearing aids in the market, but come at less than half the cost.

### A new approach to amplification

Professor Peter Blamey, the founder and managing director of Australia Hears, has spent the past 30 years researching ways to improve the sound quality of cochlear implants and hearing aids. Blamey is also deputy director of The Bionic Ear Institute.

He has long been aware of the limitations of conventional digital hearing aids designed to compress a wide range of input sounds into a narrower output range. In 1998, he hit upon the idea of using a processing chip within the aids to select the most informative parts of a sound range and present them at comfortable levels at each frequency for the listener. The ADRO technology he invented splits sound into 32 different frequency channels, then uses statistical rules as part of the digital amplification strategy to optimize the audibility, comfort and intelligibility of sounds without compromising sound quality (Box 1).

The rules are set for each individual user, and keep the audibility and comfort levels the same as those of a person with normal hearing. "If the sounds falls below the audibility target, it is made louder," Blamey explains. "If it rises above the comfort target, it is made softer."

Each individual can set his or her own comfort levels for different environments with an easy-to-use software program. This eliminates the need to fit hearing aids on the basis of the averages of a sample population as done in conventional hearing aids — a boon for individuals whose hearing preferences are not typical.

Even the software used to customise the hearing aids is evidence-based, using data collected from 176 ears to predict and suggest amplification levels to the individual.

"Conventional compression technology can match ADRO technology in terms of audibility or comfort but not both simultaneously unless very high compression ratios are used.

However, application of these high compression ratios can reduce speech intelligibility in background noise and adversely affect sound quality in quiet surroundings," Blamey notes.

### Fuzzy logic makes sense

ADRO hearing aids work on four 'fuzzy logic' statistical rules, which can be true for part of the time rather than always being true or false. Each rule is applied independently to each of the 32 frequency channels in an individual's hearing aids.

Each rule has a critical role.

The comfort rule ensures that sustained sounds are not too loud more than 10% of the time.

The audibility rule ensures that sustained sounds are not too soft for more than 30% of the time.

The hearing protection rule stops sudden loud sounds from being amplified beyond a maximum level for the listener.

The background noise rule prevents low-level background noise from being over-amplified and annoying to the user.

### ADRO amplification has been shown to:

- make soft sounds more audible  
At the same time as
- making loud sounds more comfortable  
At the same time as
- improving intelligibility for speech in background noise  
At the same time as
- providing preferred sound quality.

### Applying four technologies

Hearing aids from Australia Hears include four technologies that enable easier and more flexible customisation.

1. The ADRO processor optimizes sound for a listener across 32 different frequency channels.

2. An automatic adaptive directional microphone reduces the loudness of background noise from some directions. Research shows that these microphones provide better speech perception than either omnidirectional or fixed directional microphones.
3. Incorporation of adaptive feedback cancellation that prevents the high-pitched whistles of feedback loops that occur when the microphone of an amplifier is too close to its speaker.
4. A patented ultra-low delay processing technology to eliminate perceptible distortions or echoes caused by sound delays as sound is processed from analogue to digital signals. The Australia Hears technology has the shortest delay of any device in the industry.

### Clinical trials

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The ADRO amplifier has been evaluated against an alternative amplifier in several clinical trials<sup>1-6</sup>. Results from these trials, which were conducted by the Cooperative Research Centre (CRC) for Cochlear Implant and Hearing Aid Innovation in Melbourne, showed that 42 experienced hearing aid users preferred hearing aids with ADRO sound processors over conventional compression processors in most situations. These preferences were associated with improved sound quality, improved speech perception in quiet and in noise, and improved loudness control.

“This is one of the few hearing-aid sound systems to have completed rigorous clinical trials successfully,” Blamey says. “The trials showed that 3 out of 4 users preferred the hearing aids with the ADRO processor rather than the compression processor that is used in most other hearing aids.”

In the studies, both the ADRO and non-ADRO processors were tested in the same type of hearing aid hardware in a diverse range of subject groups. The researchers also varied the comparative experimental conditions.

### Additional uses

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ADRO also has the flexibility required to improve hearing for any level of hearing loss, whether it's a person with normal hearing using headsets and telephones, a person with mild hearing loss who needs hearing aids, or a person with severe-to-profound hearing loss and requires a cochlear implant.

“ADRO is being applied in headsets and other devices for listeners with normal hearing to provide improved audibility and intelligibility to compensate for poor telephone transmission lines, and to protect hearing from loud sounds and acoustic trauma,” Blamey explains.

In 2007, Blamey was honoured by the American Academy of Audiology with the International Award for his work in hearing and language research.

### Product heritage

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The products of Australia Hears are based on research conducted at the Bionic Ear Institute, funded by the CRC for Cochlear Implant and Hearing Aid Innovation.

The ADRO technology is used in cochlear implant sound processors made by Cochlear Limited of Sydney.

The digital signal processing algorithms used in Australia Hears products were developed at Dynamic Hearing in Melbourne and the House Ear Institute in Los Angeles, and are licensed from Dynamic Hearing Pty Ltd.

The hearing instruments are manufactured in Thailand by America Hears using high-quality components including digital signal processing (DSP) chips from Sound Design Technologies in Burlington, Canada, and microphones and speakers from Knowles of Itasca, Illinois.

### Further reading on clinical trials

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Blamey, P.J., Martin, L.F.A. & Saunders, E. Hearing aid benefit as a function of hearing loss. *Thirteenth Australasian International Conference on Speech Science and Technology* Melbourne, Australia, December 14 - 16, 2010.

Blamey, P.J., Macfarlane, D. & Steele, B. An intrinsically digital amplification scheme for hearing aids. *EURASIP Journal of Applied Signal Processing* **18**, 3026–3033 (2005).

Blamey, P.J., Martin, L.F.A. & Fiket, H.J. A digital processing strategy to optimize hearing aid outputs directly. *Journal of the Academy of American Audiology* **15**, 716–728 (2004).

Dawson P.W., Decker, J.A & Psarros, C.E. Optimizing dynamic range in children using the Nucleus cochlear implant. *Ear & Hearing* **21**, 230–241 (2004).

James, C.J., Blamey, P.J., Martin, L., et al. Adaptive dynamic range optimization for cochlear implants: A preliminary study. *Ear & Hearing* **21**, 49S–58S (2002).

Martin, L.F.A., Blamey, P.J., James, C.J., et al. Adaptive dynamic range optimization for hearing aids. *Acoustics Australia* **21**, 21–24 (2001a).