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HIGHLIGHTS OF 2013/14

EVENTS

MEG III formally opened at the Australian Hearing Hub - the world’s first, and only, MEG imaging facility for use with cochlear implant recipients.

HEARnet Learning® launch by Australian Green Party Senator, Rachel Siewert, during Hearing Awareness Week. The resource already has over 800 registered users accessing 19 online training modules and was a finalist for the CRC Association Award for Excellence in Education and Training.

Co-hosted the XXXII World Congress of Audiology with Audiology Australia, including an interactive and engaging public exposition “Hear for the Future” about hearing loss and remediation solutions.

Two, week-long workshops on “Hearing Impairment and Language Acquisition” were held with the Beijing Language and Cultural University as an Australia-China Science and Research Fund Group Mission; opportunity for knowledge exchange and research collaboration.

ONGOING FUNDING

The HEARing CRC was awarded $28 million over five years from the Australian Government’s Cooperative Research Centre Program.
RESEARCH AND TRANSLATION

Genetic and phenotypic analysis has shown that programmed cell death (apoptosis) plays an important role in age related hearing loss. This novel finding furthers understanding of regulation of apoptosis in the inner ear, and identifies a good target for a therapeutic drug in the future.

A computer game has been developed to improve people’s perception of pitch, when using this, both normal-hearing and cochlear implant recipients have shown an improvement in pitch discrimination. This work has been shortlisted for the Health Informatics Society Australian Health Apps Challenge.

The HEARing CRC worked closely with Cochlear Ltd on the design and testing of a new Straight Slim Electrode Array. This electrode has been released commercially as the CI422 and it is specifically aimed at retaining acoustic hearing after implantation.

The HEARing CRC’s HEARLab® is now available in Australia, Europe and USA, sales figures are good and there are two new training modules relating to the device available on HEARnet Learning. HEARLab itself was shortlisted for the Jamie Callachor 2013 Eureka Prize for Medical Research Translation.

STAFF AWARDS

Harvey Dillon: the NSW Science and Engineering Award for Innovation in Public Sector Sciences & Engineering.

Jorge Mejia: a finalist in both Research Australia’s Discovery Award and BUPA’s Emerging Health Researcher of the Year award, for his work on the Bilateral Beamformer.

Caitlin Grenness: the Oyer Award from the Academy of Rehabilitative Audiology.

Isabelle Boisvert: the New Investigator Award at the Eighth Symposium on Objective Measures in Auditory Implants.

Binbin Zhang: selected amongst the six finalists for the CSIRO sponsored Early Career Researcher Award.

COMMUNICATION

71 Peer-reviewed articles
211 Conference presentations
66 Media/newsletter articles
5,000 video views
1,002 followers
676 views
78 likes
EXECUTIVE SUMMARY

On behalf of the Board, we are pleased to report on the achievements of the HEARing Cooperative Research Centre July 2013 to June 2014.

This report marks the completion of the seven-year term of the HEARing Cooperative Research Centre (CRC) established in 2007. During this time we have worked hard to successfully complete 80 of 94 Commonwealth research milestones, 22 of 22 educational milestones, and 28 of 35 commercial milestones.

Through this work, important research discoveries have been made in the genetic causes of deafness, in the detection and management of auditory processing disorders, and in the outcomes of early intervention in children with hearing loss. Innovation in technology has assisted our industry partners to develop new products and services for hearing loss detection, hearing aids and cochlear implants, as well as the fitting methodologies to achieve best outcomes.

In addition, we have been successful in commercialisation of the Trainable Hearing Aid by Siemens Hearing Instruments Pty Ltd, licensing of NAL-NL2 by international hearing aid companies, and HEARLab® through Frye Electronics in the USA. We have also contributed to the development of Cochlear Ltd’s new Hybrid System.

Commercialisation of our research outcomes has not only assisted take up and use of new products by end-users, but the royalty flows from industry have been reinvested. This investment has contributed to expanded research projects, provided additional PhD support and the development of new infrastructure. This infrastructure included the 3D acoustic environment at the National Acoustic Laboratories (NAL) and the magnetoencephalographic imager (MEG III) capable of assessing brain activity in cochlear implant users at the Australian Hearing Hub.

International collaboration with partners at the Kanazawa Institute of Technology in Japan was key to development of the MEG III. Our Asia-Pacific interactions have been broadened through the competitive award of a group mission from the Australia-China Science and Research Fund, which provided for two, week-long workshops at the Beijing Culture and Language University, aimed at sharing information and identifying collaborative research.

A complimentary approach to the commercial translation of our research has been the development of the HEARing Education and Research Network (HEARnet® online), acting as a platform for communicating outcomes of our research to health care professionals, researchers and the general public. In addition, HEARnet Learning® has been established to deliver accredited online training focused on HEARing CRC technology and innovation, already boasting over 800 registered users.

Recently, the HEARing CRC was fortunate to co-host the XXXII World Congress of Audiology (WCA), in collaboration with Audiology Australia. Held in Brisbane in May 2014, the WCA attracted some 1,780 delegates, and not only featured a strong
program of research presentations showcasing HEARing CRC outcomes, but also enabled HEARworks, our commercial arm, to engage with audiologists and demonstrate HEARLab and other technologies. The HEARing CRC also took this opportunity to engage with the public through a “Hear for the Future” exposition that involved the Deafness Forum and other hearing not-for-profit organisations.

The quality of HEARing CRC outcomes and staff continues to be recognised by a number of awards, most notably Adjunct Professor Harvey Dillon receiving the NSW Government Science and Engineering Award. Emerging researchers were also recognised - Dr Jorge Mejia (as a finalist in both Research Australia’s Discovery Award, and BUPA Emerging Health Researcher of the Year Award), Dr Isabelle Boisvert (received the New Investigator Award from the eighth Symposium on Objective Measures in Auditory Implants) and new PhD graduate Dr Caitlin Grenness (received the Oyer Award from the Academy of Rehabilitative Audiology). PhD student Binbin Zhang, from the University of Wollongong, was a finalist in the CSIRO Early Career Researchers Award – making it three years in a row that HEARing CRC students have reached the finals.

Taken together, these achievements are testimony to the high quality of our research staff and students, the work of our Project Leaders and Science Advisory Group, as well as our dedicated management team.

Good governance underpins this success, and we would like to acknowledge our Directors for their contributions to research, education and commercial outcomes. The HEARing CRC is well supported by our legal advisor, Ms Jenni Lightowlers (FAL Commercial Lawyers), and by our IP attorneys Mr Lorne Wood-Roe (Adams Pluck) and Mr Steven Borovic (Churchill Attorneys).

It is especially pleasing to report that the HEARing CRC was successful in Selection Round 16 of the Commonwealth CRC Program, and was awarded a total of $28 million to be applied over the next five years. This would not have been possible without the continuing enthusiastic support of our individual Members, who have contributed to all of these successful outcomes.

Our Chair, Mr Searby, wishes to add on his own behalf that the foregoing Summary is, above all, a tribute to our Chief Executive Officer and to his management team headed by Mrs Lisa Norden.

As ever, a final special thanks are given to the adults, children and their families, who give so generously of their time to participate in our research.

Mr Richard Searby. Chairman

Prof Robert Cowan. CEO
BOARD OF DIRECTORS

The HEARing CRC Board of Directors is accountable to the Commonwealth and our Members. It is responsible for setting strategic goals and objectives, and oversees the activities of the HEARing CRC, including intellectual property and commercial operations, as managed through HEAR IP and HEARworks.

Current membership is shown over, special thanks go to a number of Directors who left during the reporting period:
- Robin Evans of The University of Melbourne
- Steven Grundy of Australian Hearing
- Jim Piper of Macquarie University
- Barry Roberts of Siemens Hearing Instruments Pty Ltd

To assist the Board in fulfilling its duties, we have the following Committees and Groups:

- **Finance and Audit Committee**
  Providing oversight of the financial operations of the HEARing CRC and its associated companies. This Committee also oversees the relationship with the external auditor, and the process of identification and management of business, commercial and financial risks.

- **Nominations and Appointments Committee**
  Making recommendations on the appointment and remuneration of Directors to the Boards of the HEARing CRC and HEARworks. If required, this Committee also assists in the appointment of a Chair, or CEO.

Support Members Group
Established to provide a forum for the Supporting Members to meet with the Board and Management to ensure that the Board is aware of needs and issues affecting end-user and industry Members.

Science Advisory Group
Assists the Board and CEO in the annual Research Project Review, and in special reviews, such as the Third Year Review, conducted by the CRC Program. Membership includes two independent scientists with specific expertise, together with key scientists drawn from across the Members.

Commercial Working Group
Assists the CEO and management in the development and assessment of commercial and technology transfer strategy and plans for outcomes arising from research projects.

MANAGEMENT TEAM

**Chief Executive Officer:**
Prof Robert Cowan

**Chief Financial Officer and Company Secretary:**
Mrs Lisa Norden

**Executive Assistant:**
Ms Amanda Campbell

**Communication and Education Manager:**
Dr Jane Sewell

**Finance Assistant:**
Mrs Dianna Xu

**Intellectual Property and Commercial Officer:**
Ms Katarzyna D’Costa

**Management Team Assistant:**
Ms Meghan Stewart

**Online Communications Manager:**
Mr Greg Lawrence

**Research Project Coordinators:**
- Dr Isabelle Boisvert
- Ms Pamela Jackson
- Dr Adrienne Paterson

HEARWORKS BOARD OF DIRECTORS

HEARworks Pty Ltd operates under a Management Deed and Trust Deed with the HEARing CRC Ltd and its Members, and is responsible for implementing and managing commercial activities and application of technology on behalf of the HEARing CRC.
RICHARD SEARBY
AO, QC, MA, Hon LLD.
Independent Chair

MICHELE ALLAN
BSc, PhD, GAICD, FAICD.
Independent Member

LISA SPRINGER
BSc, PhD, GAICD.
Independent Member

FIELD RICKARDS
BSc(Hons), M Ed, PhD.
Nominee Member: The University of Melbourne

NEVILLE MITCHELL
BComm, CA(SA).
Nominee Member: Cochlear Ltd

PAUL GUTHRIE
BApp Sc.
Nominee Member: Siemens Hearing Instruments Pty Ltd

BILL DAVIDSON
Nominee Member: Australian Hearing Services

SAKKIE PRETORIUS
BSc, MSc, PhD.
Nominee Member: Macquarie University

ROBERT COWAN
BSc(Hons), MSc, MBA, PhD, FAudSA(CCP), GAICD, FICRA.
CEO HEARing CRC
Hearing loss is the second most common disability in Australia, and its prevalence is increasing. What can we do to slow this trend?

Hearing loss can be both acquired (due to noise injury, exposure to chemicals) or age-related. It is estimated that 5% of the population worldwide suffer from industrial, military or recreational noise-induced hearing loss and there are currently no treatments available to restore function to damaged auditory pathways. The prevalence of hearing loss increases from less than 1% in people under 15 years of age to over 80% in people above 70. With an aging population, a treatment that could prevent or reduce age-related hearing loss would have significant impact worldwide.

Noise exposure is a major contributor to acquired hearing loss; this exposure occurs both in and out of the work place. Our knowledge in this area received a huge data injection through the ABC Citizen Science Project, launched as part of National Science Week in August 2012. More than 8,000 people, across a wide age range, took part in a detailed online hearing survey that was important in both understanding and raising awareness about hearing loss, it also incorporated a hearing test and collected information about individual lifetime noise exposures and attitudes.

Analysis of the Citizen Science data is ongoing but has revealed insights into individual and social group attitudes to noise exposure risk. Findings have influenced the development of the HEARing CRC’s HEARsmart™ campaign; HEARsmart will be an overarching brand for a range of prevention initiatives over coming years.

The first campaign launched under HEARsmart will be the National Acoustic Laboratories’ Know Your Noise website. The website is the front end of a large “noise” database that allows visitors to calculate their individual risk of hearing loss. The site will soon be promoted by over 70,000 postcards, printed and distributed by Avant Card across 1,500 venues Australia-wide, as well as social media activities targeted at young people.
In association with WorkCover NSW, we are also working to improve awareness of workplace hearing health. Labels for industrial use have been developed and trialled, and positive outcomes have led to expanded use. With the support of WorkCover (who are aiming to integrate it into their Workers Code of Practice), Proactive Agricultural Safety and Support Inc (an organisation promoting safer rural industries) and several local government areas supported by State Cover Mutual insurers, this simple but effective activity is becoming widely implemented, and has also been taken up in New Zealand and the United States. In addition, an iPhone/iPad App has been created to enable workers to record sound levels, this is important for both raising awareness and building noise archives. Other prevention activities are being carried out in association with construction and utility industry partners and with farming communities.

Raising awareness is part of the equation, but to reduce hearing loss we must also initiate action. We have developed affordable Active Noise Control Hearing Protectors that limit sound exposure to below 80dB while enabling wearers to easily communicate with one another. We have also integrated our patented super-directional beamformer technology (described on page 10 of this report) into a prototype of these protectors.

Leisure noise is another important factor in hearing loss, our project teams investigated ear plug use in young people when clubbing. Findings suggest that young people were more receptive to using ear plugs in such venues than had been anticipated. Early in 2015, live music venues will be targeted through HEARsmart campaigns to raise awareness of hearing health and promote safe listening behaviour.

Genetic studies underpin our work. We have identified several genes associated with age-related hearing loss and in association with phenotypic work, have implicated the process of programmed cell death (apoptosis) in the inner ear. These studies have provided novel understanding of the molecular regulation of apoptosis in the hearing organ and indicate a possible target for therapeutic intervention to slow or prevent progressive hearing loss. Medicinal chemistry work has generated potential therapeutic compounds targeting apoptosis. These compounds have undergone initial in vitro testing to determine their capacity to protect against age-related and other types of deafness. Provisional patents have been filed for lead compounds and are being developed through the Walter and Eliza Hall Institute of Medical Research. HEARing CRC research will now focus on delivery vehicles for therapeutics.
RESEARCH EXCELLENCE: REMEDIATING HEARING LOSS

Hearing devices, such as hearing aids and cochlear implants, are effective solutions for restoring communication. What would further improve them?

We are developing a range of digital sound processing strategies to maximise the performance of hearing devices – hearing aids, cochlear implants, and even hearing protection. These strategies include noise reduction, signal compression and expansion, loudness and gain adjustments.

Our recent work has targeted bilateral hearing. ‘Bilateral’ hearing refers not only to hearing with both ears, but also the ability to combine sounds arriving at the two ears. This ability is critical to sound localisation and hearing in noisy environments. We have developed a **super-directional beamformer** that can be applied to hearing devices, hearing protectors, as well as FM loop systems. This application is driven by an innovative mathematical algorithm that combines sound recorded by microphones on either side of the user’s head (mounted discreetly on the hearing device’s earpiece). The approach is not in itself unusual, but the patented algorithm is, as it successfully reduces unwanted noise and creates what’s known as a “super-directional output” for the listener.

The beamformer technology has already been integrated into second generation trainable hearing aids (see over), cochlear implant technology as well as our hearing protection device. Testing under conditions that represent real world listening environments showed a 2dB benefit in ‘sparse noise’ and 1.5dB benefit in ‘diffuse noise’ for both hearing aids and cochlear implants, this is significant given that decibels are measured on a logarithmic scale. Implementation of this technology will continue, with work focused on developing the capacity for hearing devices to automatically control the beamformer for the user.

**Speech Reference Limiting** is another application that we have developed to control sudden changes to loudness of incoming signals, for example a passing truck. This has demonstrated significant potential to improve the comfort, safety and intelligibility of acoustic headsets and other listening devices. This technology has been patented internationally and has strong commercial interest.

HEARING AIDS

The HEARing CRC developed a **hearing aid fitting algorithm** (called NAL-NL2) that is now widely available for professional fitting and optimisation of hearing aids. Its predecessor, NAL-NL1, was used in fitting over half of all hearing aids worldwide, and now NAL-NL2 is one of two world standards that has been recognised by several awards internationally. Since its development, the algorithm has been licenced to over 20 international hearing aid and audiological test equipment manufacturers, as well as researchers and practitioners.

Work is now progressing on the development of a novel prescription procedure for hybrid devices incorporating both acoustic and electric hearing in the same ear.
To improve efficiencies in the fitting of hearing devices, we have developed (and patented) **trainability** – the capacity for a hearing aid user to fine-tune the settings of his/her device for automatic deployment in different listening environments. This next generation technology has been licenced to Siemens Hearing Instruments Ltd Pty and we are exploring its application in cochlear implants.

**COCHLEAR IMPLANTS**

Working together with our Industry Member, Cochlear Ltd, enables the HEARing CRC to support product technology and development as well as the communication teams responsible for global guidelines and clinical recommendations. This relationship enhances project experimental design as well as seamless knowledge transfer and commercial application of outcomes.

Electrode development studies focus on enhancing mechanical and functional performance of implants, as well as preservation of residual acoustic hearing. Our in-house expertise enables temporal bone, surgical insertion and first-time-in-human studies of new designs to **guide electrode design and surgical approaches**. Examples of recent studies include:

- A Straight Research Array (SRA) that has now been successfully commercialised as the CI422 electrode: the electrode is particularly useful for patients with residual acoustic hearing; and
- Modified Modiolar Research Array, a pre-curved, thin electrode that has superior placement within the cochlea, design and safety studies are complete and clinical trials are about to commence.

Studies exploring the use of novel biocompatible materials and surface technologies, not previously used in cochlear implants, have indicated that a **semi-automated fabrication process** may be beneficial for producing future implant arrays.

Research has also established that dexamethasone eluted from silicone coated electrode arrays (aimed at **controlling the inflammatory response** in the cochlea post electrode insertion) is safe in animal models, does not increase risk of meningitis and provides a workable approach to directly delivering drugs to the cochlea; dexamethasone itself does not appear to increase electrode functionality as hypothesised but studies suggest it may prevent excessive bone growth due to surgical trauma.

Sound coding strategies, algorithms and programming approaches are effectively evaluated using the HEARing CRC’s clinical trial network, including a number of organisations around Australia. Evaluations recently undertaken include testing **algorithms**:

- that show potential for improving tonal language perception (see below);
- that are novel for sound processors, including a bilateral wireless link;
- for bilateral sound coding that improve access to fine timing information for implantees; and
- that address Spatial Noise Reduction, providing improvements in recipients speech perception.

![Image](https://via.placeholder.com/150)

Jin Xu and Dimitra Stathopoulos were finalist in the Visualising Health competition for an image from the HEARing CRC’s microfocus radiography facilities.

Understanding pitch perception is fundamental for improving sound coding for **tonal language**, and is also important for enjoyment of music. The eTone strategy has been developed to this end, to enhance temporal (timing) information for use in cochlear implants. Pilot testing shows a modest but significant improvement, current work is focused on reducing the processing requirement of the algorithm so that it can be migrated into Cochlear Ltd’s commercial signal path.

A complementary approach is to investigate our ability to train subjects to better perceive pitch. aTone was developed in a game format and tested with normal-hearing subjects as well as cochlear implant recipients. Results show that subjects undertaking the training have a significant improvement in pitch discrimination. The aTone game was a finalist in the Health Informatics Society Australia Health Apps Challenge this year.
RESEARCH EXCELLENCE: (RE)HABILITATING HEARING

Only 20% of older Australians with hearing loss seek professional help, those that do, often do not utilise their hearing device. How can we change this?

A large multi-site retrospective study investigating help-seeking for hearing impairment concluded that the most important facilitators for older adults were positive attitudinal beliefs, support from family and/or friends and confidence to use a hearing aid. Addressing these findings, further studies found:

- confidence using hearing aids was negatively influenced by visual disability;
- improved hearing aid user-guides, developed using best practise guidelines, improve older adult’s ability to complete complex hearing aid management tasks – improvements address scope, layout, typography and reading level and may impact on visual disabilities noted above; and
- a patient-centred approach to audiology, that involved family/friend support would benefit audiological assessment and hearing remediation outcome.

Hearing-impaired people frequently report listening difficulties despite receiving sound amplification. Central Auditory Processing Disorders (CAPD) can contribute to these difficulties, however these disorders are not well understood. CAPD is an umbrella term for a variety of commonly occurring disorders that affect the way the brain processes auditory information. Language and literacy impairment is common in CAPD and our research is making some major contributions to this emerging field:

- the overall profile and impact of CAPD in primary school children is now better understood and a diagnostic clinical tool has been developed for audiologists. This tool identifies how far from the average a child’s auditory processing results are, specific to their age. A calculator and training module for this have been made available on HEARnet Learning (see pages 15 and 19);
- prosodic awareness (rhythm, stress, and intonation of speech) has been identified as a training target that may benefit children with CAPD. An intervention study addressing this is undergoing preliminary testing with school aged children and although standard measures do not show significant changes, parents and teachers report improved reading and fluency;
- audio-visual stimulation benefits normally hearing children where there is background noise, but not those with CAPD;
- children with difficulty listening in noise have poor attention switching ability – this can be assessed using a novel test developed through the HEARing CRC; and
- Spatial Processing Disorder (SPD) has been identified as a major cause of CAPD. Research has
led to the development and commercial release of the Listening in Spatialised Noise - Sentences Test (LiSN-S) for clinical use with hearing-impaired people (through Phonak AG).

The HEARing CRC is fortunate in having access to a novel mechanism to explore auditory processing in Macquarie University’s magnetoencephalography (MEG) imaging facilities, based at the ARC Centre of Excellence in Cognition and its Disorders (CCD). MEG is being used to better understand transmission and processing of acoustic information in the auditory processing pathways of individuals with 1) normal hearing and 2) those with different types of hearing loss (including CAPD).

MEG imaging is also being employed to evaluate strategies for tinnitus remediation, in particular, investigating customising tinnitus remediation programs to the individual - comparing subjective percepts of the patient with objective findings. Tinnitus affects roughly 20% of the population, sufferers experience ringing in the ears for which there is currently no cure.

In August 2013, a ground breaking prototype MEG facility was formally launched at the CCD. The facility, and its associated functional analysis software, can be used to evaluate cortical implant performance and marks a world’s first in imaging. This was made possible by the HEARing CRC and a collaboration between CCD, CSIRO, Cochlear Ltd and the Kanazawa Institute of Technology in Japan. This new prototype compliments the adult and child MEG facilities at CCD.

LOCHI STUDY

In collaboration with the National Acoustic Laboratories, the HEARing CRC initiated the Longitudinal Outcomes of Children with Hearing Impairment (LOCHI) study. This study is systematically following 467 children from initial diagnosis of hearing loss through to age 16 to assess benefits and factors associated with successful use of hearing aids and cochlear implants, as well as different modes of habilitation. The long term study is financially supported by the HEARing CRC, the American National Institute of Health and the Oticon Foundation.

LOCHI is recognised as a unique study whose results influence clinical candidature and intervention for hearing impaired children worldwide. To date, analysis of data measured at three and five years post introduction to the study have been completed. Findings have identified several predictors of outcomes (successful or otherwise) with device fitting before six months of age being shown to be associated with significantly better outcomes. This clearly demonstrates both the necessity for, and benefit of, universal newborn screening programs.

In order to confirm and utilise the findings of the LOCHI study, and to better inform clinical practice, a series of projects focused on the habilitation of children with hearing loss have been initiated. These projects bring together a large group of national and international collaborators and findings include:

- the average age of cochlear implantees is reducing and this delivers better outcomes for recipients;
- family participation, socioeconomic advantage and maternal education positively influence language development in implantees;
- aural-oral and auditory-verbal early interventions are more successful than sign language and bilingual-bicultural approaches with reference to the implanted child’s speech production;
- children with implants have predictable strengths and weaknesses in language acquisition; and finally
- it is vital to continuously monitor auditory learning to ensure appropriate intervention.

Dr Graciela Tesan and David Meng at the MEG facility at the ARC Centre of Excellence in Cognition and its Disorders.
The HEARing CRC has been at the forefront of investigation into the remote delivery of audiology services. Initial studies have examined:

- remote hearing assessment;
- remote mapping of cochlear implants; and
- remote training and supervision of clinicians.

These projects have demonstrated the feasibility and reliability of remote delivery using internet-based technologies. There are now two accredited modules on HEARnet Learning that have been developed to assist audiologists and clinics with understanding and implementing findings, these are: A Home Based Model of Cochlear Implantation – The Role of Telepractice and Remote Cochlear Implant Mapping.

A self-fitting hearing aid (integrating the HEARing CRC’s patented trainability algorithm) is a concept that has been investigated primarily for application in the developing world. This would be a first-of-its-kind, totally stand alone and not requiring telephone or computer assistance to assess or remediate hearing. Our investigations to date have included detailed analysis of necessary engineering and audiometric features as well as considering the requirements of associated literature and social issues around perception and likely adoption of this new technology.
HEARnet Learning is an online training website for healthcare professionals to gain a greater understanding of how cochlear implants and other hearing technologies, and associated clinical practices, can improve treatment of hearing loss.

HEARnet Learning was originally set up to help explain HEARing CRC research findings to audiologists and other health professionals. Soon after its launch, it became apparent there was opportunity to include more detailed research information in the form of interactive online training.

The site now hosts lectures on specialist clinical skills such as electrophysiology (understanding the electrical patterns in the brain caused by listening to sound) and diagnosing auditory processing conditions such as Spatial Processing Disorders.

Featured lectures also enable professionals and the public to learn more about the history of the cochlear implant, for example, the Future of Hearing: Research, Technology and the Cochlear Implant module presented by HEARing CRC CEO, Professor Robert Cowan.

HEARnet Learning training modules are currently free to access. Furthermore, ten of the 19 modules have been accredited by Audiology Australia for Continuing Professional Development (CPD) Points and discussion is underway with other professional bodies for the similar arrangements.

The modules are accessible via all computers and devices with some of the modules captioned for the hard of hearing. To create your own HEARnet Learning account, go to: www.hearnetlearning.org.au.

“We recommend HEARnet [Learning] modules to General Practitioners, speech therapists, teachers and other professionals who need easily accessible but accurate educational resources. In doing this I have had regular compliments on the excellent quality and accessibility of good clear information in an easy to use format.”

Janette Thorburn
Principal Audiologist
Manager Clinical Services
Australian Hearing
WORKING TOGETHER

As a Cooperative Research Centre, collaboration is essential in all we do.

The HEARing CRC operates across a range of sites. The University of Melbourne and Sydney’s Australian Hearing Hub (AHH) are focal points, together with a Brisbane node based at The University of Queensland.

Our 26 HEARing CRC Members are located across Victoria, New South Wales and Queensland. Most of our research projects involve a number of different interdisciplinary and end-user focused Members, ensuring that relevant research and clinical questions are addressed, and that outcomes are rapidly translated into application. Member involvement ranges from the direct provision of personnel or infrastructure, through to an individual’s specialist advice or expert input.

Communication across numerous sites is greatly enhanced by regular video conferences and cloud technologies to enable data sharing. A Research Project Coordinator is located at each site to facilitate collaborative activities and to coordinate reporting requirements.

In order to foster broad understanding and collaborative linkages between our research projects, Project Leaders discuss their activities at an Annual Research Project Review, usually held at the HEARing CRC’s headquarters in Melbourne.

The HEARing CRC is also keen to embrace international collaborations and in 2013-14 there were 25 Australian and 26 International Collaborators contributing to our research projects.

NEW COLLABORATIONS

Involvement in the HEARing CRC has also fostered a number of new collaborations and initiatives that will enhance capacity in hearing healthcare research and delivery of clinical services:

- the First Voice Alliance is an affiliation of HEARing CRC Members – the Hear and Say Centre, The Shepherd Centre and Taralye, with the Cora Barclay Centre and the Telethon Speech and Hearing Centre. Together with their New Zealand affiliated organisation, First Voice provide early intervention services to more than 1,000 hearing impaired children; and

- The Australian Hearing Hub (AHH) is a state-of-the-art facility at Macquarie University that brings together researchers and professionals from disciplines including nanofabrication, language and cognitive sciences, audiology, speech pathology and psychology. Opened in April 2013, the AHH builds on the long-term collaborations established by the HEARing CRC and is a focus for partnerships amongst research, education, and clinical health service agencies.
Carrie Newbold joined the Cooperative Research Centre for Cochlear Implant and Hearing Innovation (CRC HEAR) in 2001. She was contracted for a two-week position and 13 years later she has evolved, alongside the CRCs, into a prolific and capable researcher.

She completed her PhD through CRC HEAR and left the CRC for some time to gain industry experience with one of our Members, Cochlear Ltd.

“...The CRC (both the second and current incarnation) has not only provided me a long-lasting career, but with a range of interesting and diverse opportunities. I’ve completed a PhD, worked alongside the engineers at Cochlear Ltd and then returned to research,” reflects Carrie.

She has enjoyed the collaborative environment the HEARing CRC has fostered and the cross-institutional relationships and partnerships she’s been able to create. She was also the winner of the CSIRO Cooperative Research Centres' Award for early career researchers in 2005 and the Victorian Ministers Prize for Research into Reduction, Refinement, Replacement.

“Along the way I’ve visited multiple countries, made countless friends and snuck in a baby (or is that ‘out’?)” she jokes.

Carrie was a project leader on two projects for the HEARing CRC and will continue in the extension CRC. She has enjoyed the flexibility and fluidity of the CRC and now works part-time and is “looking forward to working with the team again over the next few years.”
GETTING OUR RESEARCH HEARD

It is essential that our research and its outcomes are communicated to people who can use and apply them.

The Internet, and more recently social media, has facilitated wide reaching and often two-way communication of our research, research outcomes and commercial activities. These tools enable us to engage and interact with a range of organisations and individuals – and when blended with more traditional approaches, allow us to tailor information to different audiences, using the most appropriate channels.

The HEARing CRC has three main audiences:
- researchers and health care professionals;
- the general public; and
- Government and advocacy groups.

Our organisation website and also the HEARnet sites enable us to interact with all of our interested parties. In addition, our ever increasing social media presence is a popular tool for reaching out to any interested public users, as well as many of our Members and other professional groups.

We have adopted specific approaches to communicating with each of our audiences. For researchers and health professionals (including clinicians) established approaches such as publication of peer-reviewed journal articles and conference proceedings, conference presentations and invited keynote addresses remain very important. We also utilise our Member’s publications and internal communication networks to communicate with these groups.

Print, online and television are key media channels for communicating with the general public, we attempt to drive media interest in the hearing area as well as providing comment where appropriate. To access this group we also undertake and participate in public activities, for example:
- HEARnet online pre-release during Hearing Awareness Week 2013
- HEARnet Learning and MEG III launch at the Australian Hearing Hub
- XXXII World Congress of Audiology and the Hear For The Future Public Expo.

Interaction with Government decision makers can be somewhat opportunity based, however we maintain an active involvement with the Office of Hearing Services to help drive action in this area.
The HEARing CRC online

HEARing CRC
(www.hearingcrc.org)

Launched in 2009, the HEARing CRC’s corporate site outlines research projects and personnel, governance, structure and educational activity and provides a platform for both research and corporate literature. In addition, it provides a secure intranet for staff working through the HEARing CRC.

The site also detailed HEARworks and HEARing CRC commercial products until these activities were moved to an independent site in 2014.

HEARworks
(www.hearworks.com.au)

The new HEARworks site features products and services more prominently and facilitates online purchases. This will ensure effective promotion and ease of sale for HEARing CRC innovations, both now and in the future.

HEARnet online
(www.hearnet.org.au)

Launched in 2012, the HEARing Education and Research Network (HEARnet®) website is the HEARing CRC’s key translational vehicle, designed to achieve high-level impact for our research outcomes and to centralise communication activities.

The HEARnet website provides easily digestible overviews on hearing health and technologies, and aims to inform the community about hearing loss, hearing technology and the risks of noise-induced hearing loss. It also acts to aggregate information for the field, linking out to relevant websites containing further, more comprehensive information.

The resource, which ranks highly on the Google search engine, has been well received by organisations and individuals working in the field and is being accessed by an ever increasing number of individuals.

HEARnet Learning
(www.hearnetlearning.org.au)

HEARnet Learning was launched as a pilot in 2012, and officially released in February 2014 with improved accessibility (Mac and PC, tablets and smartphones) and expanded content.

It is the professional development area of HEARnet that provides online training modules in the form of interactive lectures and pre-recorded seminars. It provides a conduit for HEARing CRC research outcomes to be communicated to clinical users, as well as material from recognised sources. It currently boasts in excess of 800 registered users and 19 modules, 10 of which are accredited for professional development points by Audiology Australia.

See also page 15 of this report.
APPLYING OUR OUTCOMES

Application of our research outcomes is the final step in delivering HEARing CRC innovations to people who will use them.

Every HEARing CRC research project has an associated utilisation strategy that anticipates a development pathway for its findings. The pathway may be:

- commercial in nature – often occurring through industry Members directly involved as project participants, but may also involve SME or international industry partners; or
- clinical in nature – requiring communication to our network of clinical and professional Members. See the ‘Getting our Research Heard’ section (page 18) in this report for more information.

Commercial findings are often funnelled into our integrated, in-house, Clinical Trials and Product Development Program. This program tests, and where appropriate, works on the commercial development of findings or technologies.

Some of our successes are detailed in the track record section at the end of this report (page 24) – they include commercialisation of the Trainable Hearing Aid by Siemens Hearing Instruments Pty Ltd, licensing of NAL-NL2 by international hearing aid companies, and HEARLab® through Frye Electronics in the USA. We have also contributed to the development of Cochlear Ltd’s new Hybrid System as well as their next generation implantable electrodes.

COMMERCIALISATION

Innovations are assessed on a case-by-case basis, and individual commercialisation strategies formulated. Where necessary, patent protection is obtained.

In 2013-14:

- 7 patent applications filed
- 6 patents granted
- 88 patents in overall portfolio
- 14 trademarks in overall portfolio
HEARLab is a device that enables a range of audiological tests to be implemented as software modules on the same hardware framework. The first module, Aided Cortical Assessment (ACA), uses brain activity to assess hearing ability, making it extremely useful for those who are unable to communicate verbally, such as newborn babies, and some elderly patients.

This clinical tool was developed by the HEARing CRC and the National Acoustics Laboratories (NAL). Australian Hearing has over 25 HEARLab units in operation across Australia and it is also being used across Europe and the USA.

Principal Audiologist for Australian Hearing, Alison King has seen better clinical outcomes for adults with significant physical or cognitive disability through the use of HEARLab: “This technique has made significant improvements in our ability to provide timely and appropriate amplification to these most complex client groups, as audiologists can now obtain objective measures of the audibility of speech and therefore fine tune the clients’ hearing aids within several weeks of fitting, rather than waiting for months or even years in the most extreme situations” she says.

HEARLab is a HEARing CRC innovation, licenced to US-based Frye Electronics Corporation for world distribution. It is now providing return on investment through significant national and international sales.

Two new software modules for HEARLab are currently in development and are due for release in 2015 and 2016. These will record auditory brain stem responses and cortical thresholds respectively and will aid assessment and fitting of devices for infants or for elderly adults with cognitive decline.

HEARLab has received multiple awards for innovation, including: 2013 Winner of the CRC Association Award for Excellence in Innovation, 2013 Finalist of the Eureka Prize for Medical Research Translation and was a 2013 NSW Government Medical Devices Fund Grant Recipient. In 2012 HEARLab was a finalist for the Kerrin Rennie Award for Excellence in Medical Technology.
EDUCATING THE NEXT GENERATION

We aim to up-skill, empower and enthuse the next generation of researchers, audiologists, surgeons and specialists.

POSTGRADUATE EDUCATION

A total of 39 PhD and MPhil students have studied with the HEARing CRC over the last seven years. Of these, 22 have graduated and continue to work in the sector, and 17 are completing their programs. Our students have benefited from having both academic and industry-based supervisors and more broadly from being immersed in an organisation that links research, clinics and industry. In addition, an annual symposium has brought the students together to share findings and build networks; and training activities have offered non-traditional subjects in a format that often introduces our students to influential personnel from Member organisations.

PROFESSIONAL EDUCATION

Our face-to-face and online activities increase clinical capacity in Australia and overseas:

- working with Audiology Australia we assist in the delivery of a Professional Development program;
- working with Cochlear Ltd we have run Cochlear Implant Training workshops since 1992 and contribute to their Visiting Implant Specialist program; and
- in 2013 and 2014 our Australia-China Science and Research Fund Group Mission delivered two workshops on Hearing Impairment and Language Acquisition at the Beijing Cultural and Language University.

WORLD CONGRESS OF AUDIOLOGY

The XXXII World Congress of Audiology (WCA) held at the Brisbane Convention and Exhibition Centre in May 2014, on behalf of the International Society of Audiology was hosted by Audiology Australia and the HEARing CRC.

The Congress attracted 1,780 delegates (488 international) and included 206 oral presentations, 61 oral posters and 52 posters, as well as round table discussions with leading experts in the field:

- Living in a noisy world (Thais Morata)
- Central Auditory Plasticity (Edilene Boechat)
- Auditory Service in the next 10-20 years – what’s changing? (Robert Cowan)

A public exposition and forum “Hear for the Future” brought together hearing health professionals and members of the deaf community, and offered information and interactive experiences around all aspects of hearing loss and its prevention.
Dani Tomlin
HEARing CRC PhD Student, Clinical Audiologist and Lecturer
The University of Melbourne

Dani commenced her PhD studies with the HEARing CRC in 2010. Her thesis titled, *Auditory processing, functional outcomes and cognition in children*, was accepted in June 2014.

“I had quite a few years clinical experience behind me and wanted to take my career on a new path. I had started working in a particular area of audiology where I felt there was a lot of research potential a lot of questions still to be asked - and it just seemed like the natural progression for my career.

“My topic was looking at auditory processing disorders in children because that’s where my clinical interest was. I was working within that area clinically and feeling there were a lot of questions that needed to be answered for the patients that were coming in to see me.

“Having the support of the HEARing CRC has been really valuable, things like the annual student symposium where great, we had an opportunity to deliver our work as well as hear what the other students were doing. Key speakers who would give tips on how they got through their PhDs, or career pathways post-PhD that I found extremely useful.

“I’m hoping its going to open a lot more doors in terms of teaching and research opportunities for me.”

Caitlin commenced her PhD studies with the HEARing CRC in 2010. Her thesis titled, *Patient-practitioner interactions: Older adults and their audiologists* was accepted in October 2014.

“The idea of doing a PhD came to me while I was doing clinical work. My background was health and psychology, before I did audiology, and so I was always very interested in why people make decisions about seeking help. My PhD focused on audiologists and older adult interactions – in other words, what happens in the clinic when an older adult comes to see an audiologist. I was interested in the idea of how is that considered good quality, what is it that makes that interaction work for the older adult.

“I came across the HEARing CRC because they were very prominent in this area and there was a prominent researcher, an expert in this field, who was one of the Project Leaders at the HEARing CRC.

“As HEARing CRC students we’ve had a lot of exposure to mentors and people who’ve been very successful in the field. It adds a greater depth to doing a PhD than doing it straight through a university or another institution. I feel like its given me skills that I would have really had to work to find.

“In finishing my PhD I have a really broad range of skills, largely because of the HEARing CRC, which I hope is going to really make a difference for my future.”

Caitlin Grenness
HEARing CRC PhD Student
Clinical Audiologist and Lecturer
The University of Melbourne
The HEARing CRC: Innovation Track Record

2008
The HEARing CRC worked with Cochlear Ltd on the development and clinical trials of the Hybrid L24 electrode. A thinner, shorter electrode preserves residual hearing and was released by Cochlear Ltd as part of the Nucleus Hybrid System; implanted into approximately 500 recipients.

The HEARing CRC filed the first patent application for the Bilateral Beamformer technology. Beamformer technology will significantly improve hearing in background noise, it has international patent protection and strong commercial interest.

The HEARing CRC worked with Cochlear Ltd on the development and clinical trials of the Straight Research Array. Cochlear Ltd are implementing this into next generation implant systems.

2009
The HEARing CRC successfully mapped the first two paediatric cochlear implants between Sydney and Apia (Samoa) and Nhulumbouy (Arnhem Land, Australia). This type of technology will increase access to hearing remediation in remote areas.

The HEARing CRC released the NAL-NL2 algorithm. Licenced to over 20 international hearing aid and audiological test equipment manufacturers; integrated into hearing aid fitting software for use by over 30,000 audiologists worldwide as the new international standard.

2010
The HEARing CRC developed HEARlab®. Licenced to Frye Electronics for manufacture and distribution, this single-platform hearing assessment and rehabilitation tool was launched with an Aided Cortical Assessment module. Over 60 HEARlab® units are now in use worldwide.

The HEARing CRC developed trainable hearing aid technology. This technology allows the user to train their hearing aid to adapt to the user’s preferred settings for different listening situations. This technology is currently available in Siemens high-end hearing aid range.

2012
The HEARing CRC filed the first patent application for the Thick-film electrode. A game-changing new fabrication process for the manufacture of cochlear implant electrode arrays.

The HEARing CRC launched the HEARing Education and Research Network (HEARnet®) online in association with a pilot of its first e-learning modules on HEARnet Learning.

The HEARing CRC worked with ABC Citizen Science to release Sound Check Australia – the online hearing survey as part of National Science Week.

2013
The Australian Hearing Hub opened at Macquarie University, in Sydney, building on the long-term collaborations established by the HEARing CRC.

2014
HEARnet Learning was launched. It includes 19 e-learning modules, 10 of which have been accredited for continued professional development through Audiology Australia. It has in excess of 800 registered users.

The HEARing CRC co-hosted the XXXII World Congress of Audiology held in Brisbane, Australia. There were over 1,500 delegates who attended.
2014-2019

In February 2014, The HEARing CRC was advised that it had been successful in the Australian Government’s Cooperative Research Centre Program - Selection Round 16, and was awarded a $28 million five-year extension from July 2014.

There will be four research programs undertaken during the extension period (listed below) and a fifth commercialisation program that includes clinical trials and research development.

Program 1: The Listening Brain
Will develop tools that enable clinicians and teachers to diagnose individuals’ specific hearing and/or auditory processing deficits. It will also investigate remediation strategies that can be utilised to address these deficits.

Program 2: The Intelligent Interface
Will develop next generation hearing aids and cochlear implants that improve hearing in noisy environments and overcome the need for manual adjustment.

Program 3: Individualised solutions
Will develop guidelines to help clinicians work with a patient-centric approach, enabling them to more easily match devices and therapies to individual needs.

Program 4: Enhanced Service Capacity
Will develop alternative e-Health hearing healthcare delivery, enhancing access for non-urban populations.

THE FUTURE

It is anticipated that into the future, the HEARing CRC’s research footprint and activities will broaden into a HEARing Education and Research Network (HEARnet), focused at the Australian Hearing Hub. It will utilise existing HEARing CRC facets including:

- HEARworks/HEAR IP for commercialisation;
- HEARnet online for research translation and outreach;
- HEARnet Learning for professional development; and
- HEARsmart for hearing loss prevention activities.

HEARnet will depend on ongoing support from its Members, as well as commercialising intellectual property, incorporating contract research and commercial clinical studies, introducing subscription for some educational activities and accessing direct and/or competitive research funding.

The evolution to HEARnet will also include a HEARnet Partner’s Program, establishing a broader engagement with the hearing healthcare sector and community.

“The next five years are critical for developing an integrated, coordinated and sustainable future for hearing research and healthcare in Australia. By working together we can achieve this and create great benefit for hearing-impaired people worldwide.”

Prof Bob Cowan
CEO of the HEARing CRC
THE HEARING CRC IS A MULTIDISCIPLINARY COLLABORATION OF FIVE CORE AND 21 SUPPORT MEMBERS, EACH OF WHICH CONTRIBUTES SPECIFIC EXPERTISE AND INFRASTRUCTURE TO OUR RESEARCH, COMMERCIALISATION AND EDUCATION PROGRAMS.

Core Members

| Australian Hearing | Cochlear | MACQUARIE UNIVERSITY | SIEMENS | The University of Melbourne |

Supporting Members

| Acoustics Pty Ltd | attune | audiology australia | Bionics | The Children's Hospital at Westmead |
| Hear and Say Centre | hybrid | Murdoch Childrens Research Institute | The Shepherd Centre | The University of Queensland Australia |
| Neuromonics | Royal Institute for Deaf and Blind Children | The Royal Victorian Eye & Ear Hospital | Taralys | Walter+Eliza Hall Institute of Medical Research |
| SCIC | Sydney South West Area Health Service | NSW Health | University of Wollongong | Vicdeaf |