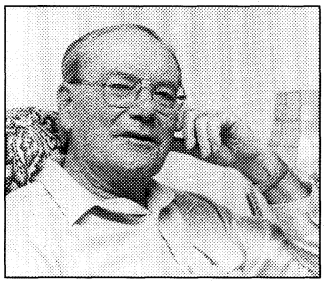

When I Think Back...

by Neville Williams

Dr Ernest Benson: A brilliant career in electronics, academic and practical - 2

While the development of an electronic keyboard carillon might appear to have been a diversion for a committed academic, Ern Benson was no stranger to music. He was already planning construction of an ambitious electronic organ. Ahead lay visits to Woomera; research into hifi techniques, loudspeakers and large scale sound reinforcement systems, television technology and loudspeaker enclosures.

As an ongoing member of an Anglican church family, it was not surprising that Ern Benson should have an interest in organs, and in the possibility of installing one in his own home. As a young man, he'd taken lessons on the classical pipe organ at St Anne's (Ryde) and with his wife-to-be had enjoyed the sound of the State Theatre's Wurlitzer, played by Mannie Aarons.

At a humbler level, I went through a similar phase myself, as described earlier in this series: 'On Organs — Electronic and Otherwise', in *EA* for May 1989.

I made the point then that, musically desirable as they might be, a pipe instrument was neither affordable nor practical in the average home. A so-called 'American' organ or harmonium was smaller and cheaper, but offered a pale 'reedy' sound which was a poor substitute for the rich, 'round' tone of pipes.

In the mid 1930s, however, Laurens Hammond had patented an electronic organ using audio waveforms generated by spinning specially machined steel discs adjacent to magnets carrying a sensing coil (see Fig.1).

By driving 12 or more spindles at selected speeds with a synchronous motor, and fitting to each multiple discs with selected numbers of serrations or 'teeth', it was possible to generate a range of semitones and/or overtones appropriate for an organ. No less to the point, the system could produce waveforms and tones suggestive of pipes rather than reeds.

The production of a practical organ called for the provision of keyboards, waveform filters, drawbars or stop tabs, an 'expression' pedal and so on, to provide playing facilities. Add certain electronic extras such as vibrato/tremolo, synthetic reverberation, variable attack and sustain, and the end result could be a potentially gratifying do-it-yourself instrument, styled for home, church or entertainment venues.

DIY 'Hammonds'

Quite a few enthusiasts at the time considered the possibility of building their own Hammond derivative, but Ern Benson was one of a half dozen of so in the Sydney area who were really serious.

How they all fared I'm not sure, but Ern got his version going circa 1940, biased towards his devotional background. I remember visiting his home in company with the magazine's popular science writer, Calvin Walters. I don't recall much about the finer points of the instrument, mainly because Cal — a party pianist with a repertoire of singalong melodies — was so intrigued that he insisted on playing rather than talking!

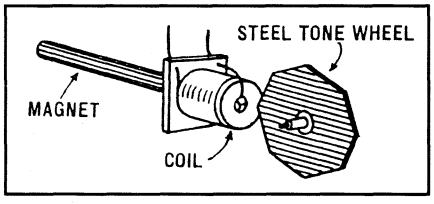

Fig.1: From the May 1989 issue, illustrating the principle of tone generation used in the Hammond electronic organ.

What I do remember is that Ern had installed the rotating mechanism in the basement, where it wouldn't be audible in the mechanical sense. A multi-wire cable carried the source tones up through the floor to the console in the lounge room. I gather that one of the other enthusiasts had crammed the 'machinery' into the organist's bench, boxed and padded to suppress possible rumble.

When I mentioned this to Mavis Benson, who had helped with the construction of the Benson version, she had a wifely reaction: "I used to call it the oily bit; not that it was all that bad, but to me, it didn't quite belong in a carpetted room!"

That the original Hammonds were not impeded by noise or oil, I can only attribute to the fact that they were devised by a clockmaker, rather than by hobbyists following machine shop practice.

Building a keyboard carillon and a Hammond style electronic organ epitomised the practical side of Ernest Benson's capabilities. But as a member of the AWA research staff, he was entrusted with a variety of other assignments, at the behest of top management or knotty problems facing the Production Team.

According to his wife, he made several trips to the rocket range in Woomera SA, to study the nature and effect of

vibration to which miniature valves were being subjected in that environment. This was before the development of solid-state technology. He also did round-the-world tours to study television, and later, sound reinforcement in operatic venues.

In later life, according to Neville Thiele, he was involved in the work of Standards Australia (SA) on electroacoustics, and had served as a chairman for the International Electrotechnical Committee (IEC). He was a Fellow of the IREE (Aust), the IEE and the IE (Aust); also a member of the Audio Engineering Society Inc., (AES) and Australian Acoustical Society (AAS).

The television era

After the war, when television loomed on the Australian horizon, it was evident that AWA would need to develop wide ranging expertise in the subject — from systems and standards to possible participation in TV programming and transmission; then on to the production and marketing of domestic receiving equipment. Over and above his overseas tour, Ern Benson was encouraged to work through the questions and appropriate responses likely to concern Australia.

This he was happy to do because religious bodies such as the C of E Synod, with which he was connected, were also seeking practical and social information about the new technology. But more about this later.

In the early 1950s AWA gave a tangible clue to company thinking by purchasing a Marconi 625-line 50fields/s camera and developing a prototype receiver to the British standards — obviously in preference to the American technology based on 525 lines and 60f/s.

In February 1954, the equipment was used to televise the arrival of Queen Elizabeth II at Sydney Cove, from Mrs Macquarie's Chair. For the occasion, the equipment was set up in an old Arnott's biscuit van, which had been repainted to serve as an 'OB' (outside broadcast) van.

The signal was conveyed by microwave radio link to a receiver at the Spastic Centre in Allambie Heights. Although a closed circuit system, the occasion was publicised as Australia's first outdoor TV telecast. AWA also provided the PA system for the occasion, using Benson-designed loudspeakers.

Later, using their own resources, AWA telecast the opening of the NSW Parliament to the nearby Sydney Hospital. Moving to Canberra, they also telecast the opening of the Federal Parliament, the Royal Ball and a Returned Soldier's Function.

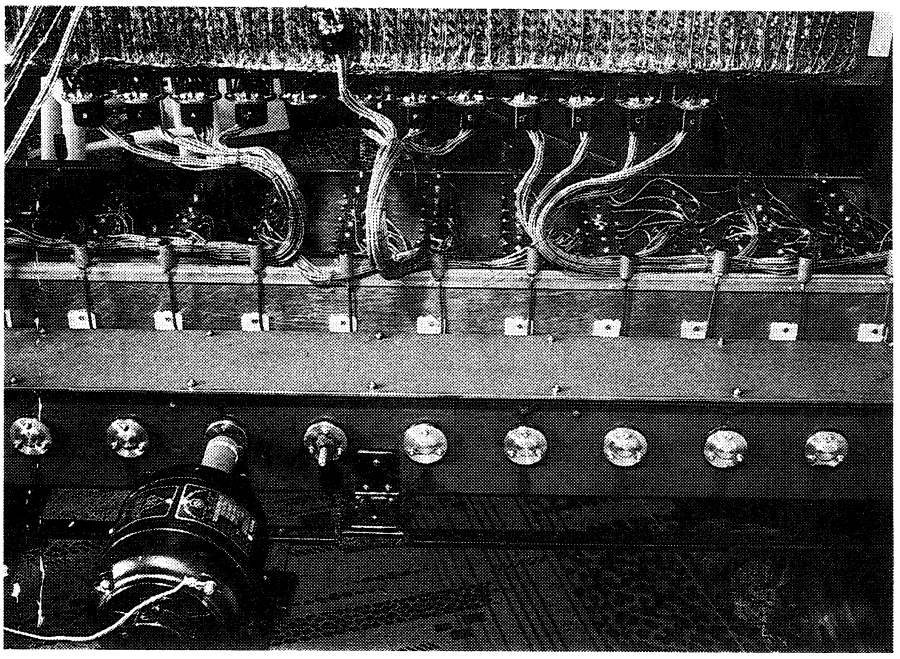

Fig.2: Dismantled following Ern's death, this is the only remaining photograph of his Hammond-style organ. The drive motor is in the foreground, with the housing (centre) containing the tone generators. Leads at the rear were anchored on terminal boards before passing to the console, drawbars and keyboard switching.

In both Sydney and Melbourne, lecture/demonstrations were arranged to show that television could be used to give medical students a more detailed view of operations in real time than was otherwise possible.

Adjusting to TV

Back to the social aspect: apart from the Anglican Synod, Ern Benson also had access to the World Council of Churches. Meetings and conferences, including one at the Central Methodist Mission (Sydney) were addressed on the general subject of churches rising to the challenge of the new technology. In January 1953, Ern took part in a discussion broadcast by 2CH with Rev Bill Hobbin of the Methodist Church and Ray Watson — later Judge Watson of the Family Law Court.

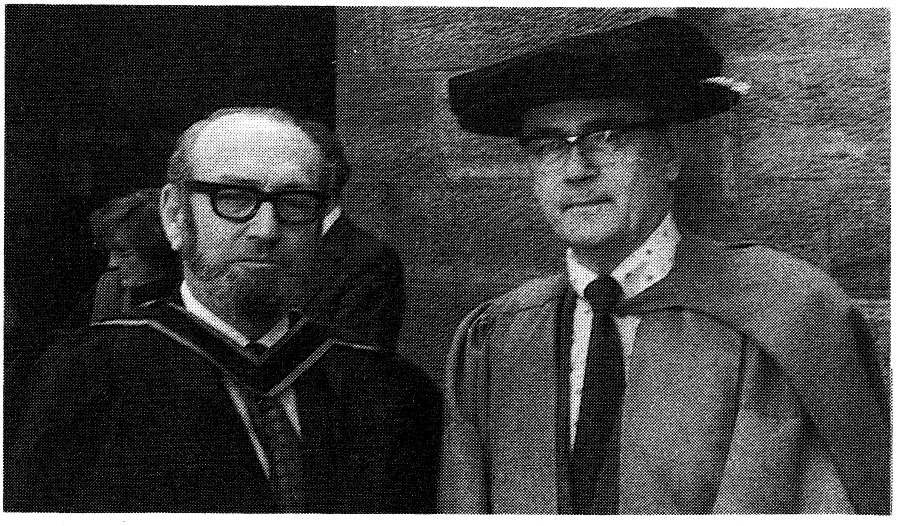

Fig.3: Graduation ceremony at Sydney University. Ernest Benson is on the right. With him is Cyril Murray, perhaps best known in the industry for his research into high quality audio power amplifiers.

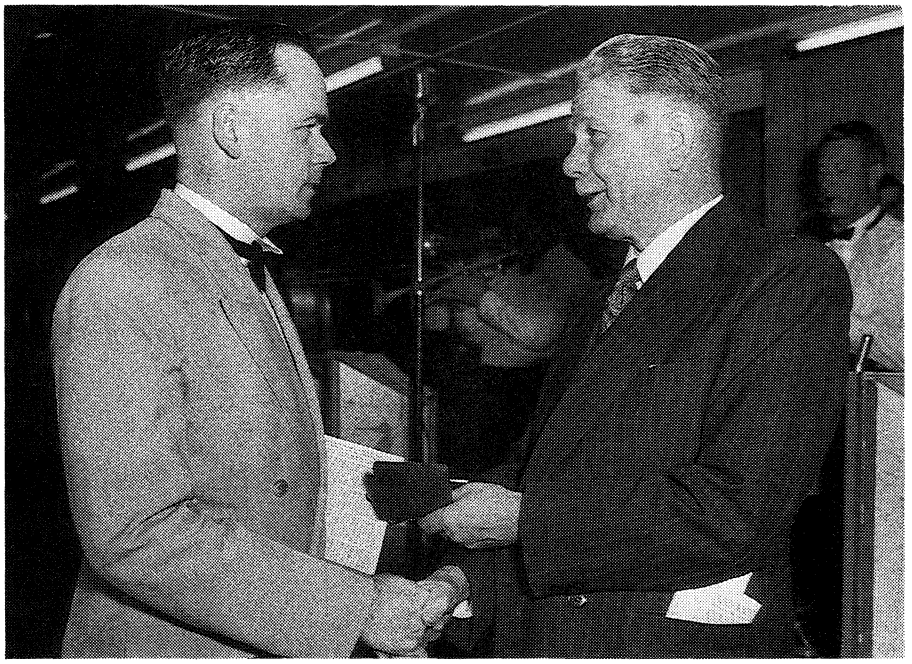

Fig.4: A young J.E Benson receives the IREE N.W.V Hayes Award for 1952 from A.S. McDonald, Chief Engineer and Assistant Manager of AWA. The award, refereed by the British Institute of Radio Engineers, was for Benson's paper on the Colorimetric Principles of Colour Television.

In February 1953, a Royal Commission was set up to examine the social impact of television and the response of the churches. Ernest Benson spent several months in AWA Head Office, conferring with AWA Managing Director Sir Lionel Hooke on the company submission.

As the date approached for commencement of TV broadcasting in Australia (1956) the Sydney Division of the IREE decided that the time had come to schedule lectures on the subject for their members. Out of the blue, I received a letter inviting me to start the ball rolling with a lecture on, say, 'An Introduction to Television in Australia'.

To say that I was taken aback would be an understatement. I had limited first-hand experience in the subject. The TV sets I had built had been contrived mainly from oddments. For sure, I had delivered lectures and written tutorial articles on other subjects, but television — that was something else. The obvious man to have been invited was Ern Benson! Why me?

Perhaps, with the intensity of pre-TV industry politics, Ern Benson of AWA might have been seen as having a vested interest, and that would never do! Similarly anyone from Philips or, say, Jackson Industries or Admiral (horrors — *they* favoured 21" picture tubes!) Perhaps I had been invited as someone who was 'uncommitted'!

Anyway, I finally accepted — only to realise a couple of weeks beforehand that I simply didn't have enough time to prepare adequate notes and whiteboard illustrations.

Fortuitous strike!

That's when the unions inadvertently 'made my day'. They turned on a strike over an industrial matter, and in the critical week before the lecture I didn't have a job to go to!

So I prepared a lecture instead, resorting to the time-honoured approach of stating facts with which the audience was familiar and enlarging upon them to encompass the new material:

"You are all familiar with a superhet radio receiver. Well, a modern TV set is also a superhet with an RF stage, an oscillator and mixer valve and an IF amplifier. But there are differences..."

"A radio set has to convey sound information involving a modulation bandwidth of around 20kHz, which can be accommodated quite conveniently on a carrier of a few hundred kHz.

For television the bandwidth required to convey a sound moving picture is something over 5MHz and that, in turn, calls for a carrier of at least 50MHz or so. We therefore have to think in terms of a wide-band superhet designed to operate in the VHF and UHF bands..."

So it went on, for a mercifully patient standing room only audience. Afterwards the very first person to thank me for the presentation was Ern Benson! For him it would have been kindergarten stuff, but condescension was not part of his make-up.

Later on, a member of the IREE committee observed — on the side:

"You know who put you in?"

"No..."

"It was Ernie Benson!"

In fact, Ern emerged as a tower of strength to the industry in the months that followed, with his understanding of principles and components and the international standards affecting them. I provided an outline; Ern was one of these who filled in all the hard bits!

Colour television

In truth, Ern's reading and contacts had carried him way beyond monochrome technology to the inevitable next step: colour television — into which AWA's associate in the US, RCA, had sunk so much money as to endanger the very viability of the company. Realising that the technical fraternity in Australia knew very little about the physics of colour, Ern set about writing a paper on the subject for publication in the *Proceedings of the IRE (Aust).*

Published in July and August 1951, it was titled 'A Survey of the Methods and Colorimetric Principles of Colour Television'.

Singled out for special mention in Neville Thiele's tribute I, too, remember it as a landmark paper of value to anyone involved with colour — be they television buffs, photographers, printers, artists or painters.

At the time, the staff at *Radio, TV & Hobbies* knew little more about colour than what we had picked up from art lessons at school and/or casual reading. Paint boxes contained a typical range of hues which could be supplemented by mixing the various pigments. Red, blue and yellow were 'primary' colours, we had been told, because they could be mixed to produce intermediate hues. Blue and yellow, for example, could give a wide range of greens. The principles also applied with paint from the hardware store. End of lesson!

Funny about television: it used red, blue and *green* as the primary colours.

How the heck do they produce yellow out of those? Dunno!

Ern's paper set our thinking straight. Neville Thiele told me how he had commended it's author, confessing how he, personally would have found such a project sheer hard work. Said he: "But your paper flows so effortlessly, so smoothly..."

To which Ern replied: "You weren't there when I was writing it!"

As I remember the paper, Ern mapped out the colour spectrum to clarify optical wavelength and the relationship between the various hues.

He showed that when all are presented simultaneously to the eye as high intensity light, the visual sensation is white. At reduced intensity, the visual resultant diminishes through grey towards black. That's why a black and white film can be routinely reproduced in grey tones on a colour TV set.

How colours mix

A high level of one primary colour and a moderate level of the other two reduces the colour saturation so that, for example, a rose may be portrayed as pink rather than red — virtually red plus white.

Endless confusion has occurred because colour mixing can involve two distinctly different processes: subtraction and/or addition. Subtractive mixing occurs when filters, dyes or pigments have the effect of blocking particular colours. An artist or painter may choose a yellow pigment, without realising that it appears yellow because it has absorbed bluish light and is reflecting only the greenish and reddish rays of the incident white light.

Which brings the reader to the point that the true primary colours for subtractive mixing are not really yellow, red and blue. To be precise, they should be defined as yellow, magenta (a bluish-red) and cyan (a bluish green)

By contrast, *additive* mixing occurs when the component colours from an object or scene are presented to the viewer's eyes simultaneously. This occurs when viewing a scene or a colour image on a cinema or other such screen, or on a TV picture tube.

In the last-named, the picture is presented to the viewer by a myriad coloured lights, each a tiny fragment of luminous phosphor. Each makes its own separate contribution to the image, and although flashing at the rate of 25 times per second, are rendered virtually continuous and simultaneous by time lag of the phosphor and persistence of vision.

As an additive system, the appropriate primary colours are red, blue and green. For all practical purposes there is no other option for television; that's the way it works.

Against this background, it is possible for a picture tube manufacturer to plot the exact locations on a colour spectrum map where a given set of phosphors fall. By joining them up, a so-called colour triangle is produced enclosing the range of hues and saturation levels which can be reproduced on the screen.

So the paper went on, dominating two issues of the *Proc.IREE* and making special demands on the printers — who had to produce (for the reader) credible colour maps using the hybrid methodology that governs their craft.

I should mention here that, for his paper, Ern Benson received not only the plaudits of his Australian readers but also a commendation from the British IRE (Fig.4).

From sight to sound

For good measure during this median period, Ern Benson became progressively more involved in audio, particularly as it involved loudspeakers. We noticed it at the magazine because, in the early days, we used to talk loudspeakers to Max Cutts of Amplion (Aust).

Over the years, however, Amplion became involved with other products and we got into the habit of discussing Amplion loudspeakers with AWA — who had been supplying Amplion, anyway. When the conversation had to do with special applications or quality, the spokesman on the other end of the phone often turned out to be Arthur McClean — or Ern Benson.

In the 1940s, it was Ern Benson who, on behalf of AWA, became consultant engineer to do with the public address system in the Sydney Town Hall. As most readers will know, the main auditorium is quite huge, with a hard floor and hard-surfaced walls supporting a lofty arched ceiling, also acoustically hard.

Across the front is a large elevated orchestral stage, backed by tiered seating for a choir and an array of huge pipes for one of the world's great organs. Galleries around the sides and rear carry further seating. It is a grand building for grand occasions, but it is also a huge, cavernous echo chamber.

When I attended a function there in the 1930s, it had been fitted out with a public address system relying on the use of dozens of small loudspeakers bracketed to the pillars supporting the galleries. Still others covered the audience in the aforesaid galleries.

The result was utter chaos except for the fortunate few in the immediate range of any particular speaker. For the rest, a lone voice from the stage became a babble of amplified voices from all around the hall, randomly time-delayed by distance and muddied by a host of echoes.

Talking it over recently with Harry Freeman, AWA's one-time Commonwealth Manager for Audio Products, he gave as his impression that the system had been installed initially to support banquets and conferences, so

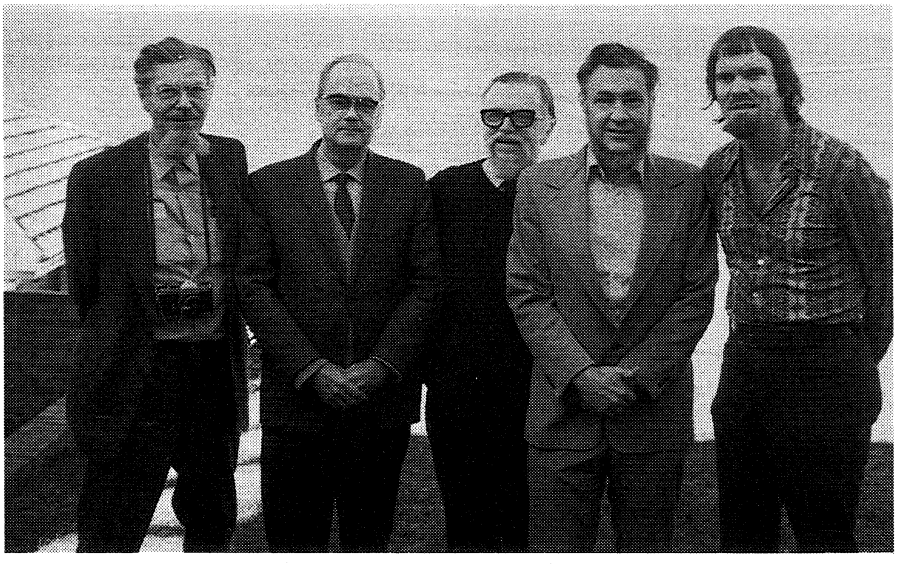

Fig.5: Five audio specialists in a 'talk fest' at the height of Ern Benson's acoustics career in the mid 1960s. Left to right are Paul Klipsch, Ernest Benson, Neville Thiele, Prof Bob Ashley and Dick Small. One overseas visitor later described Ern as 'Australia's Harry Olson'.

that a participant anywhere in the auditorium could hopefully make him/herself heard with the aid of roving microphones.

Improved system

The situation I described came about when the system was used to reinforce a performance on stage. In the 1950s AWA was accordingly asked to suggest a more appropriate installation, and Ern Benson was nominated as their consultant.

Ern's answer was to suggest tall column loudspeaker systems, slim enough and so styled that they could be mounted unobtrusively on either side of the stage and more or less camouflaged by the giant organ pipes.

By its very nature a well-positioned column system tends to project a flat wedge of sound over the audience, above the heads of patrons in the front rows and blanketing those towards the back. An important corollary is that minimal acoustic output is directed up into the ceiling, greatly reducing the resulting — and significantly delayed — echoes.

This, I gather, was the installation that I heard on the next visit, with enormously improved sound. The voice seemed to come from the on-stage performer(s), and the clutter of echoes had disappeared.

But, said Harry Freeman, there was more to the system that met the eye. Ernie had set up a huge column on each side of the stage, supported and camouflaged by the pipe structure and reaching literally from the stage floor to the ceiling. Each comprised a vertical stack of four-column loudspeaker systems, each using four special AWA 12" diameter drivers in Benson's pet twin chamber enclosure.

Each column/stack therefore involved sixteen 12" drivers, making 32 in all. Their role was purely to handle the bass.

The mid — or voice — frequencies were handled by two less pretentious columns, one positioned to either side of the organ console. As best Harry could recall, they used a mix of AWA oval drivers, 9x6" and 7x5", numbering about 42 altogether. Although partially camouflaged by the pipes, these would probably be the columns I had noticed from the audience.

For the high frequencies Ernie had installed a twin array of Goodmans Trebax horns, for the most part heard but not seen.

Fig.6: Louis Challis (right) and Ern Benson (left) were two of the four delegates who represented Australia at the Electrotechnical Commission (IEC) held in Sydney in July 1980.

Electrically tapered

In the course of this work, Ernie realised that there was an inherent conflict in using long columns to cover a wide frequency spectrum, because they would produce an increasingly shallow wedge towards the top end of the range.

His ultimate answer was to decouple the outer loudspeakers progressively from the drive with high frequency filters, so that the column became effectively shorter towards the upper limit of its allotted spectrum. Such columns were designated as 'electrically tapered'.

Harry said he could not remember much about the amplifiers at the Town Hall, except that channel splitting was done at the input end, with separate amplifiers feeding each bank of loudspeakers. They were 'bristling with 807 beam power tetrodes' and the system could be fed in either mono or stereo mode.

Ern had talked in terms of 'hundreds of watts' effective drive, and claimed that the sound pressure level available from the loudspeakers was marginally greater than from the organ itself at 'full bore'.

Harry Freeman said that by way of demonstration, they had recorded a

recital on the organ and could play it back through the above PA system. "With the reproduced sound emanating from among the pipes, it was amazing how little difference there was in the auditorium between the recording and the real thing".

All who heard it were vastly intrigued to hear the elderly organ apparently playing at full bore, with no one at the console!

One of the most fascinating experiences, however, was to play one of the early stereo demonstration records containing a steam train segment. The illusion of a full size steam locomotive traversing the Town Hall was nothing short of shattering... (According to Ern Benson's records, the Town Hall system was featured in the *IREE Proceedings* for May 1959)

Sydney Opera House

The work of the AWA/Benson team at the Town Hall made them a natural choice when the Sydney Opera House was under construction. Neville Thiele records that such was the performance of the sound system using Benson's electrically tapered column loudspeakers that the Benson/AWA team received a Duke of Edinburgh Prize for Industrial Design.

In October 1964, at the suggestion of Opera House designer Mr Utzon, Ernest went overseas to inspect typical amplifier systems. He visited Telefunken at Hanover, Prof Cremer at Munich and opera houses at Hanover, Hamburg, Nuremburg, Copenhagen and in American cities on his way home.

Subsquently, Benson/AWA were involved in updating the sound systems in large churches such as St Andrews (Anglican) and St Mary's (Roman Catholic) cathedrals in Sydney. In Canberra, Benson/AWA technology found its way into the new Parliament House.

Ernest Benson retired from AWA in March 1975 but he maintained his technical interests from his home, particularly in the area of loudspeaker technology and sound reinforcement in large buildings.

The Synergetic Audio Concepts *Newsletter* (Vol.16 No.1, 1988) reports a conference in Sydney and a group visit to the then-new National Acoustic Laboratory's Special Acoustic Test Facilities. One of those present expressed the wish to meet Mr Benson (then in retirement), and a visit to his home was arranged.

Mention is made of his unique papers on loudspeaker enclosures (three papers of 240 pages in all, originally published in the *AWA Technical Review*, 1968, 1971 and 1972), and the fact that he had been the examiner for Richard Small's PhD paper.

It goes on to say that he had a unique 5x5 Bessel Array in his laboratory, and also auditioned a pair of loudspeakers in his home "which demonstrated some of the best imaging we have been privileged to hear".

By arrangement, SynAudCon have reprinted the above mentioned papers in a single book for the American market, *Theory And Design of Loudspeaker Enclosures* by J.E. Benson DSc, ME, FIEE. An advance copy has been loaned to me by Mrs Benson, but sadly, Ernest did not live to see it.

In bringing this biography to a close, my mind turns to another incident dating back to the late 1950s which epitomises Ernie, the man whom I knew best in mid-career.

Although I didn't know it at the time, AWA was concerned at the sharp drop in radio sales following the introduction of television. They reasoned that there just might be a niche market for a radiogram that offered special features at an affordable price.

There had been reports in the press about stereo sound, but it seemed to have bogged down, especially in respect to disc records. As an interim measure, somebody came up with the idea of a radiogram that would split mono signals into separate bands and produce a more distributed sound: do-it-yourself stereo!

It was not a new idea, but AWA might — just might — be able to do it better and/or cheaper. So it was, I gather, that the (confidential) proposition ended up in Ernie's proverbial lap.

Meanwhile, our Editor, John Moyle, who had well informed overseas contacts, was doing his best to penetrate the hifi industry smokescreen: where was stereo really at?

Out of the blue, a sample stereo disc arrived in our office. A few days later, an advance sample of a new Cosmocord stereo crystal pickup reached us, via Max Cutts of Amplion. We set it up in John Moyle's lounge room in North Ryde and invited Max Cutts and Ern Benson — both of whom lived nearby — to an impromptu audition next evening. Far from being diffident, Ern was strangely keen to come.

It was an unpretentious crystal pickup compared to John's favourite Ortofon mono models but, to ears conditioned to mono, the stereo sound was sensational and there was no doubt that a new era had arrived.

Ern's reaction was to listen intently, then graciously take his leave with the words — as I remember them:

"Gentlemen, I thank you. What you have demonstrated tonight has just cancelled out plans that we have been pursuing over the last twelve months."

I heard the rest of the story next day, but his reaction that evening lingers as a measure of the restraint and self-discipline that characterised Ernest John Benson.

In her biographical notes, his wife concludes with Ern's transition from a kid in a bush Sunday School to a key figure in the outreach to the community of the Anglican Church and the World Council of Churches; thence on to the Inter-denominational Christian Television Society. Of his own personal philosophy she says:

"As a scientist be found himself an inhabitant of two worlds: the external world of nature, the world of matter — and the internal world of human consciousness — the world of the spirit. In the ultimate 'Matter is itself no longer an absolute reality but another form of energy: not merely matter in motion but waves of energy in space'." ❖