Challenges in our changing soundscape

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ABSTRACT

Many changes have occurred in the last seventy years, not least of which are the changes in our environment and interdependently our intellectual and technological development. The problems that faced our predecessors at that time were quite different from those of today, perhaps not as great but, with the limited tools at their disposal, no less demanding - particularly so in the economic and political situation of the time. The difficulties they faced were mainly technological. It was the developmental period of acoustical measurement and assessment, and they provided the basis on which we rely for our present day work. The one thing technologically that was not solved is the lack of accuracy in the measurement of sound. No doubt this too will be solved in time but a still greater challenge faces us today - perhaps the most difficult acousticians have ever had to face. Our problems not only involve sound, but also culture, possibly genetics, and the side-effects of developments in communication and mobility.

THE BEGINNINGS 1915 TO 1935

In the early part of last century, the study of sound was given a large boost by the American Telephone and Telegraph (AT&T) Company's research headed by Harvey Fletcher at Western Electric to improve reception in the telephone, and by E. C. Wente's invention of condenser microphone (Wente 1917). Dr I B Crandall must also be given some credit. He was Director of Research and Harvey Fletcher's mentor in acoustics, but died before the work was completed. From Harvey Fletcher (whom this author is very privileged to be able to have called a friend) and the research on the reactions of (it is believed) 23 of his colleagues to sound in a telephone earpiece generated by an a.c. voltage, came the idea of a "sensation unit" SU which was based on a power series compared to the voltage that produced the minimum sound audible. Harvey initially called this the "Loudness Unit" (Fletcher 1923B) but changed this later following his work with Steinberg (Fletcher and Steinberg 1924)] on loudness. As a ratio it was not really a unit, but nevertheless was called as such, following the use of the "Transmission Unit" noted below. With the AT&T development of the Wente microphone, an instrument to measure sound in sensitivity units could be developed based on the voltage that produced the minimum audible sound for Harvey Fletcher's research subjects. The idea of an "intensity level" meter was born – as was the idea of an acoustical society: The Acoustical Society of America founded in 1928 holding its first meeting in May 1929 (ASA 1929).

The Western Electric Laboratory as the name suggests was engaged primarily in electrical research and development. Acoustics was only a small facet of its work and the development of acoustical measurements occurred on the back of electrical developments by the Laboratory. The Laboratory had been engaged for many years in the development of a means to measure an a.c. voltage. This was not easy and the Laboratory had to utilize a root mean square in order to always achieve a positive value for the moving coil meters then in use. In those days the unit for resistance was 1 mile of standard cable, which varied with frequency and temperature, and for measurement of a.c. power to make it independent of frequency and temperature, it was convenient to use a power (or logarithmic) series for its description based on the power developed by a one volt sinusoid across a mile of standard cable. This measure was called the Transmission Unit TU (Martin 1924).

In the mid 1920s there were suggestions of renaming the Laboratory after Alexander Graham Bell who had recently died, and on February 8th 1924 AT&T and Western Electric created the Bell Telephone Laboratories or Bell Labs as it was called from then on. In 1927 there was a further suggestion to call the Transmission Unit the "Bell", but after some consultation with telephone engineers in France, it was decided instead to call it the "Bel" with a tenth of it called the "Decibel" (Martin 1929). It is understood the French engineers objected to the word "Bell" because it was too close to the French word "Belle" (Marsh 2005). Later, of course, by international convention "deci" and "bel" are always lower case, with the bel abbreviation as "B" - hence our use of dB in electrical work. The Director of Research at AT&T - H. D. Arnold - had developed the vacuum tube and electronic amplification was becoming available to measure small values of power, which is of course proportional to the square of the voltage. In such work, a logarithmic measure was also quite useful in that when amplifiers and attenuators are connected in series, power levels could be added or subtracted arithmetically.

During the 1920s, quite independently there were similar studies being carried out in Europe with similar results, except that the Europeans (with the exception of the British) used a naperian logarithm series that resulted in development of the "neper" – the natural logarithm of a power ratio (CCUI 1927). It is understood this pre-dated the decibel (Lang 2005), but this author has been unable to find any reference to the development of a valve-voltmeter or wattmeter utilizing nepers and it is interesting to note that Georg von Békésy in his experiments in hearing (Békésy 1960) used the decibel for his research at the Royal Hungarian Institute for Research in Telegraphy. Professor Erwin Meyer of the University of Göttingen preferred the decibel for all his work in the 1930s and his colleague Arnold Schock wrote a small book on Acoustics in which only the decibel was used (Brűel 2005). Békésy later worked in the Department of Telegraphy and Telephony at the Royal Institute of Technology in Stockholm and this may account for the use of the decibel in Scandinavia after World War II.

The first sound level meters were large, consisting of a condenser microphone, an amplifier with thermionic valves and a valve-voltmeter with a logarithmic scale covering the voltage range of one sensation unit split into 10 segments.

Almost immediately it was found that something had to be done to the meter to make the movement of the needle readable, and some damping was inserted so that the needle would move over the whole scale in 1 second. The (logarithmic) scale had a range of one bel divided into decibels with a reference level of 10^{-16} watts/cm^2 (Fletcher 1953). At the same time, the first audiometers started to appear with voltage settings linked to sensation units (Fletcher 1923A). Speech clarity and hearing studies were the main acoustics focus of the time. The sound level meters and audiometers were research instruments only and used for comparison studies. There were no standards to give the reference power or voltage - indeed some researchers used 10^{-13} watts/m^2 and some used 10^{-12} watts/m^2 (GenRad 1963) - and accuracy was questionable. So the next step was to try to get some order, and a standard by which everyone could work. Such a standard was not to appear until 1936 when the Acoustical Society of America published the first embryo standard for sound level meters. (ASA 1936).

In conjunction with CBS and NBC, Bell Labs explored the way to describe audio power levels in recording and broadcast studios, and developed the “volume unit” (VU) based on a reference power level of 1 milliwatt into an impedance of 600 ohms. The metric was labeled dBm and a standard produced in the late 1930s (Chinn et al 1940).

So a good structural base had been set for the development of acoustics research in an era of a relatively quiet environment for most people. There were very few cars on the road and even fewer aircraft to upset the noise environment. The main transportation was by steam train supplemented by horse and cart in country areas and by the omnibus and bicycle in towns. Certain industrial processes such as stamp mills were abominably loud and the noise in textile factories and mills much more than experienced today. In general, however, the home and school were quiet places with no televisions, no stereos, no telephones, no radios – indeed, few houses had electricity and those that later had a radio, ran it from a lead-acid “accumulator” about one third the size of the modern car battery. But children were still employed in factories and Harvey Fletcher even in those days noted the large number of children with hearing loss (Fowler and Fletcher 1926). The main challenges for acoustics in those days were in the development of measurement instrumentation at a time when electronics was in its infancy, and the choice of materials limited.

THE DEVELOPMENTAL YEARS 1935 TO 1950

The early work of Fletcher and Wegel (Fletcher and Wegel 1922) and Fletcher and Munson (Fletcher and Munson 1933) into auditory thresholds and sensitivity clearly showed that the reading on a sound level meter did not represent a measure of how loud or intense the subject sound might be. Something was needed in the meter’s circuitry to give a measure of loudness. Initial work produced the A, B and C frequency weightings (ANSI 1961).

Sometime in this period - this author has been unable to find out exactly when - the decibel became the official measure for sound pressure level. It is popularly attributed to Harry Olsen, the Chief Engineer of RCA who, when talking about electrical sound recording, said he could see no difference between acoustics watts and electrical ones (Wallis 2005). Whatever the source, by the end of World War II, the decibel was in use for the description of sound, and was adopted by IEC when Technical Committee 29 was formed in 1953. It is believed that ISO Technical Committee TC 43 was also formed around this time and the decibel adopted by them also (Rasmussen 2005).

In different ways the Great Depression and World War II had a profound effect on developments in environmental acoustics. The Great Depression made research money very hard to get, and the World War funneled all research into those areas that would help the war effort. Sound propagation, acoustic ranging and echo location became priorities with studies on human reception, and the effects of exposure, put aside for another time.

Clearly of great use at the time was a study of sound propagation in a jungle environment (Eyring 1946). Outside the jungle, trees and bushes are very poor noise barriers, providing very little attenuation as a result of shielding (Piercy & Daigle 1998). Their roots do provide some ground attenuation by keeping the soil porous under certain conditions and this may well provide the main extra attenuation to that of spherical spread (Dickinson & Doak 1970) but the foliage of the trees and bushes provide little attenuation at all - indeed at night, when photosynthesis is not in operation, the reverse may happen. The increased carbon dioxide around the plants may form an acoustic lens, and an increase in sound result (Dickinson 1978). Nevertheless Eyring’s attenuation through trees was eagerly accepted after the War as representative of the sound absorbing properties of trees in the semi-urban environment, and was used in a number of prediction models. Even today, there is the concept with most people that trees attenuate sound, and psychologically if some people think trees do this, then to those people if you plant a tree between them and the noise source, from the author’s experience, their reaction to the noise will be reduced.

Rapid developments in electrotechnology, as a result of the War effort, spawned a number of companies producing sound level meters in the late 1940s, and the formation of the International Electrotechnical Commission which in 1953 formed Technical Committee TC/29 to develop and establish performance standards for acoustical instrumentation (Rasmussen 2005). The first international performance standard for acoustical instrumentation (IEC 123) did not appear until about 1960, when it became possible to buy sound level meters off the shelf, enabling researchers to study environmental noise and develop ways of describing it.

THE AGE OF SURVEYING 1950 TO 1975

Following World War II and the introduction of jet aircraft into commercial travel, environmental noise levels rose to such an extent that people started to complain. Military air bases, in particular, faced attack by local residents for making too much and quite unnecessary noise. Some air bases responded by placing large notices at their boundary saying “Listen to the Sound of Peace and Security” or “Hear the sound of safety” etc. Whereas the Military might well get away with the noise, commercial airports were much more vulnerable and moves were made to restrict the noise emission to reasonable levels. And in order to find out what was a reasonable level of noise (in government’s eyes of course) surveys were made around some of the major airports of the day, (for example the Wilson Report 1963). In each the occupiers of certain picked residences were interviewed about their reactions to the noise outside which latter was measured very simply with a short series of instantaneous measurements of A-frequency weighted sound pressure level (although it is believed no survey ever admitted it). Inevitably the study came up with a relationship between the residents’ reaction and the environmental noise, involving some obscure metric that no one could measure, and hence prove the researchers or the government wrong. And with the obscure metric, compatible land use policies were developed (Galloway & Bishop 1970) with which the local territorial authorities were expected to comply, whereas no control was placed on the airports or airfields to reduce the noise emission.

Relating the respondents survey answers to the given noise level outside seemed often to have political overtones. For example: The surveys around London (Heathrow) Airport produced a relationship called the Noise and Number Index (NNI) where:

$$\mathrm{NNI} = \overline{\mathrm{PNL}} + 15 \log \mathrm{N} - 80$$

Where $\overline{\mathrm{PNL}}$ average perceived noise level in PNdB
N is the number of flights per day.

This was readily accepted by the British Government and regulations involving maximum levels permitted by aircraft were introduced into law in the late 60s. Noise insulation grants were given to residences receiving (or at least predicted to be receiving) more than 35 NNI. Everyone was led to believe the government had accurate figures for the noise exposure, but not only could the local people not measure the noise in PNdB, neither could the government officers. They (We) simply made an A-frequency weighted measurement in decibels and added 13. A system of noise monitoring stations were set up around the airport with noise limits in PNdB that the aircraft were obliged not to exceed.

The monitoring stations were set up very carefully in prominent positions and this author recollects the pilots were very worried about being prosecuted for making more noise than the limit. They all kept very carefully to the allocated flight tracks, little realizing that this was all the monitoring system was set out to accomplish. It too only took A-frequency weighted readings in dB and added 13. The outdoor microphone systems were prone to corrosion, and several (somewhat questionable) methods were used to keep out the wind and the rain - all of which must have rendered the system way out of calibration. At one major airport, not in England, hydrophones were used to overcome these problems. Several other countries came up with their own aircraft noise measures, and monitoring systems, and it is believed all used metrics in which no-one outside of government could measure - and nor could the government officers, but this was never publicized!

Not all noise surveys targeted major airports. The reaction to noise in a number of major cities was also surveyed. The Greater London Survey was one of the first noise surveys, predating the airport noise surveys, and differed from almost all the rest by the introduction of a metric that the general public themselves could measure - the "percentile level" - but then it did not include a (government) sensitive facility such as a major airport. From the author's own recollections, the metric stemmed from a meeting over morning tea between four British representatives at an ISO meeting in Paris (circa) 1955 including Peter Parkin, George Vulkan and Hugh Humphries. Who raised the question cannot be remembered, nor who answered, but on being asked "What do you think would be the best way to describe the background noise level?" someone answered "The level that is there 90% of the time." The others thought this an excellent idea and suggested that the noise during the remaining 10% of the time was the "nuisance noise". Unfortunately someone who was not a mathematician termed the measure the "Percentile Level" and it stuck for some years until someone dared to suggest that the L90 was mathematically the 10th percentile level and the L10 the 90th percentile level. At the time, few people listened, but eventually the measure became known as the "Centile Level". Although a very poor measure of community reaction (Schultz 1982) it was all that was really possible with an instantaneous reading sound level meter and the methodology was simple. Although really obsolete in modern day technology, the measure still lingers on in a very few places that wish to resist change.

Occupational noise also came under target. Although it had been known for more than a hundred years that some noisy activities caused a hearing loss (Fosbroke 1831, Barr 1886) nothing was done to correct the situation in the workplace until in the mid 1930s Walsh and Healey made it the subject of their political campaign to get seats in the United States House of Representatives. And, unlike most political promises, they actually did something about it and the Walsh Healey Act was brought into operation in 1938. With the exigencies of World War II, however, it was not until the 1960s that its effects became general throughout the United States. It resulted in industry being obliged to limit the noise received by their workers to no more than 90 dB over an 8 hour day, or the equivalent exposure. The 90 dB was a purely political decision, it being the level that government thought could be economically achieved by 90% of industry - and the equivalent exposure ranged from 3 dB per doubling or halving of time as a pure energy relationship would suggest and as used by IEC and ISO, to 4 dB (US Department of Defense), 5 dB (US Occupational Health and Safety Administration OSHA) and even 6 dB (US Air Force). The rationale for this has not been found, although to give the administrators the benefit of the doubt, it might stem from uncertainties of the quality of the noise instrumentation used and the results achieved by the researchers using those instruments.

Of equal importance, but in environmental terms: The US Federal Aviation Administration FAA and the International Civil Aviation Organization ICAO introduced noise certification for all new aircraft entering service in Europe and the United States after 1972. Again politics was involved in that the first step (to Stage 2 or Chapter 2 aircraft noise certification) would be achievable by 75% of the civil aircraft then extant. Looking at this another way: 25% of the aircraft then flying were too noisy to meet even this first step. The next step (to Stage 3 or Chapter 3) was to be achieved by 1976, and all member countries of the International Civil Aviation Organization were advised to adopt this for all civil aircraft using their airspace. Although some countgries still allowed Chapter 2 aircraft well into the 1990s, the overall result is that aircraft individually are much quieter than they were and public reactions noticeably reduced. For example at Wellington International Airport New Zealand, in the 1980s there were hundreds of complaints every month about aircraft noise. Today, aircraft noise emission is only a tenth of what it was, and complaints are very few. Some monthly records each year register no complaints at all.

University research at this time also benefited in having government research money readily available for studies into people's reactions to noise, and a multitude of frequency weightings appeared to describe the sound produced by different sources. Indeed, until a stop was called internationally in 1973, more than a hundred different frequency weightings had been produced for sounds ranging from those of different types of jet aircraft, to that of noise in pipes, or the barking of different types of dog. None were significantly better than the original A-frequency weighting and so, by international agreement, all were dropped by ISO and IEC except for the A-frequency weighting. One other, the C-frequency weighting, was temporarily retained to provide a lower and upper cut-off frequency when measuring peak levels so as to avoid recording any high levels of environmental sound outside the audiofrequency range.

Modern sound level meters now employ a Z-frequency weighting to provide such cut-off frequencies (IEC 61672).

Of great importance during this period: A team in the US Environmental Protection Agency under the direction of Dr Simone Yaniv produced its work on environmental noise levels for the protection of public health, (USEPA 1974) and used a metric that anyone could measure.

There were exciting developments also in the sound recording industry. The new plastics allowed the development of the reel to reel tape recorder to quite sophisticated levels with Ampex, Grundig, and above all Nagra producing some exceptional recording machines that could be used in conjunction with the instantaneous reading sound level meters to store sounds for future analysis. But a little known company called "Soundstream" led by Dr Thomas Stockham arguably produced the most important advance in acoustics since the work of Harvey Fletcher in the early 1920s - that of the flash card and digital recording and analysis. Sadly Tom died trying to protect his invention from piracy by big business, but the advantages he gave to the acoustics industry was a quantum leap forward at a time when computers were in their infancy and RAM almost an unknown quantity.

The world at last had a reliable way of measuring environmental sound and well researched guidelines for planning the home environment to protect residents from the adverse effects of too much noise.

THE AGE OF MODELING 1975 TO 1995

With the advent of the computer in even its most rudimentary form, a chance was seen to model sound propagation from any number of sources and to develop programs to predict the sound received anywhere in the surrounding area. Aircraft at that time were the most obvious loud sources of sound and in the late 60s and early 70s a number of prediction models were developed. Initially they had little or no memory and that used by the British Airports Authority for its London (Heathrow) Airport and others throughout the Country, and by the Port of New York Authority for its three airports (Dickinson 1973), took 8 hours of central processing time, and produced only a grid of sound exposure levels from which noise contours could be drawn by hand.

Since that time computer models have proliferated, and derivatives of that first model now produce very attractive contour patterns in colour in just a few minutes. All share the same problem, however - for comparing one scenario with another, all other parameters being unchanged, they work very well, but in giving an absolute prediction for a range of conditions their accuracy leaves very much to be desired. This is not so much a fault of the model, but of the environment being so complex and so changeable that one cannot describe all the parameters at any particular time. Nor can we predict what those parameters are going to be even in a few minute's time, yet alone at some time in the future. We can predict absolute sound levels just as well as we can predict the weather at the next total eclipse of Jupiter.

Many governments, nevertheless, modeled noise contours around noise sensitive establishments and told the local residents what sound they are receiving, usually in some obscure metric, and what they or the local territorial authorities should do about it. And there appeared to be no redress possible until in the 1980s the World Health Organization developed its Public Health Guidelines on "Noise" giving local people the chance to measure their sound environment and to compare it with that recommended by WHO. This has resulted in law suits costing many millions of dollars around some major airports. Many places are now monitoring the sound exposure in some derivative of Leq and getting the local people on side for any developments that may result in a change in the noise situation. Long term measurements are far more substantial than any computer prediction.

Perhaps the greatest advance of this time was that of John Holding and the measurement of a true time-average-level based on short Leq measurements (Holding 1987). The computer, of course, had made this possible and from then on high grade sound level meters used computer chips capturing sound exposure in pascal-squared-seconds and then converted to whatever unit or decibel measure was desired. It became possible to log sound level measurements at one second intervals over several hours and obtain a time history of the sound. We now benefit greatly from this, but at a cost: A number of major companies could not keep up with the pace and went into liquidation.

As the development of the computer advanced, so did that of the sound level meter. Electronically the sound level meter advanced to be capable of doing almost anything one wanted, but then other concerns came to the fore.

THE AGE OF UNCERTAINTY 1995 TO 2005

Two things caused much concern in this particular decade. Firstly: The Comité International des Poids et Mesures (CIPM) advised that to conform with the Standard International SI convention, the neper should be used and not the decibel. Their argument was that in expressions such as that for a decaying oscillation

$$f(t) = \exp(-\gamma t)\cos(\omega t) = \mathrm{Re}\,[\exp(-\gamma t + i\omega t)] \qquad (1)$$

it is customary to give the quantities γt in nepers and ωt in radians. As radians are adopted as SI derived units, so nepers should be also (Valdés 1999).

This resulted in much heated discussion and no conclusion could be drawn at the 30^{th} meeting of ISO TC/43 in 2003 although the decision was taken that some existing draft standards should continue to employ decibels (ISO 2003).

The meeting did conclude however that for field quantities, the quantity should be written as

$$L_F = 10 \text{ lg } [F^2/F_0^2] \text{ dB and not as } L_F = 20 \log [F/F_0] \qquad (2)$$

Not until the 31^{st} meeting of ISO TC/43 in Toronto was the problem resolved. Almost unanimous agreement was reached that ISO would retain the decibel as a descriptor for sound (ISO 2005).

The other concern was a directive by ISO and IEC that in reporting all measurements there must be a statement of percentage uncertainty. It is difficult enough for a testing laboratory using carefully controlled environmental conditions to put such a value on its measurements, but for measurements outside it is almost impossible. The problem is always the microphone - how it receives the signal and how it sends on the electrical (or digital) response to the central processing unit of the meter. When we have a fixed signal in a controlled environment, we can expect accuracy to ± 0.7 dB. For the calibrator we can expect accuracy to ± 0.3 dB. So in practice the best we can measure in a carefully controlled environment is to ± 1 dB and the testing laboratory has to achieve better than, say, one third of this uncertainty. How they can achieve this including the microphone in the system must be questionable - purely electrically there would not be a problem.

For field measurements it is a totally different matter: Even the best of us can only manage to measure within ± 4.8 dB or ± 302%. (Kerry & Craven 2001) No doubt, this is the main reason for the retention of the decibel as the metric for description of all things acoustical. The basic unit in sound measurement is the pascal-squared-second and most computerized sound level meters capture and store this data, and then convert to the decibel of choice. So it is not that we have to measure in decibels with all its inherent complications. But clearly stating the uncertainty of a sound measuring system as ± 1 dB, sounds much better than ± 26%.

THE CHALLENGING YEARS AHEAD

Now as we progress into the 21st century, technology has progressed almost beyond our wildest dreams. We have sound measurement instrumentation we would never have thought possible a decade or two ago. We can log sound in third octave bands at intervals of a few milliseconds and immediately read off reverberation times across the entire spectrum, or we can log sound levels at one second intervals over long periods of time and analyse any period at will. We can also store raw data to give measurement results in any metric we like, all with instant graphs in wonderful colours, and have an audio play back as well, if we wish. We can operate a sound level meter by remote control from a thousand miles away while watching the activity through a telelink, and synchronise the recordings of a multitude of noise monitors. We can also record in several channels at once incorporating sound pressure, particle velocity and phase in three dimensions.

Yet our one drawback remains – the microphone has not undergone the advances we have made in the other parts of the sound level recording systems, and we have not found a way of better capturing a sound wave. The new “Microflown” system (Microflown 2002) shows promise, but for now acoustics must still be considered the least accurate of the physical sciences. We can measure the light from a star millions of kilometres away, we can measure the time for light to travel a distance less than a tenth of a millimetre, we can measure the heat output of a candle more than a kilometre away – all to an accuracy of 3% or better – but we cannot measure a sound, even under strict laboratory control conditions, to better than ± 1 dB or ± 26%. In the open air we do even worse - not much better than ± 300% as reported above. Clearly we need to do better than this over the next few years. This is not however the main challenge that we face in our future development. We have a far more serious problem that involves the development or perhaps mutation of the human race itself.

- More people are deaf and suffering associated social handicap than ever before (ACC 2004; Hearing loss statistics 2005), and sadly almost all could have been prevented.

Our young people today have more personal sound power at their finger tips than any other generation, and already the effects of irresponsible use of this power is showing in the increasing numbers of young people with a hearing loss - even before they enter the workforce (OSH 2004). In modern culture, driven by the media, they don’t stand a chance. Everything they see and hear from the media urges them to show their power by turning up the volume on their stereos at home or in the car, and peer pressure gives them no room to opt out. Computer games and videos are more violent and noisy than ever before, and our modern rock bands do not seem able to play at less than 100 dB. Similarly a car today is considered essential, and cult status is shown by how powerful a stereo can be put in it, and how loud it can sound without redress from the police. So, many of our young people are bombarded by loud sound by choice, as they do not wish to face what could amount to ridicule from their peers.

General behaviour too is changing. From personal experience: People in general are losing their community involvement and are becoming self centred: “Because I am worth it” is a common slogan. The majority of people no doubt genuinely want peace and quiet, but modern culture does not condone corporal punishment, and sometimes does not condone any sort of punishment for ill doing (Education 1989). Unruliness in school and the home is becoming the norm for young people rather than the exception. Periods of boisterous playtime is one way teachers and parents have learned to cope with the problem while the children are in their care, but the modern way of expressing one’s feelings by screaming and shouting at sports activities and leisure events, is perhaps a direct and unfortunate spin-off that we could well do without.

Many of our problems today are a result of modern culture requiring loud sound to show power amongst peers, and illness experience (Chuengsatiansup 1999), cardiovascular problems, and nervous complaints are on the rise. Perhaps the most worrying problem that physicians are beginning to face is a dramatic rise in young people going onto dialysis, as a result of an “unknown disease” (Lyons 2005). One should not be surprised to find this a result of excessive exposure to very high sound levels. It does not take much mathematical calculation to show that our body organs can be excited if we can generate the right frequencies at sufficient power to overcome the impedance mismatches in the passage of sound from the atmosphere into the human body. And such excitation induces empyema and eventual breakdown of the organ. A whole change in culture is going to be required if we are to save this and other health effects occurring in the future.

Then there seems to be some evidence of genetic changes and mutations occurring possibly as a result of continual noise exposure (Massey Wellington 2005) Where this will lead we don’t know.

One thing is clear: If we are not to have a culture that can communicate only by texting, we have to instill in the younger generation that “quietness is cool”, and that allowing oneself to be exposed to high levels of sound is plainly stupid. Some moves have been made: One can organise an outdoor concert or sports meeting where the music or commentary are solely by personal radio headphones that come with the entry price. These have been trialed at Goodwood to much acclaim and have been used also at a Christian rock concert in England in place of the usual high powered loudspeakers (Watson 2005). It was reported that, at the latter, the youngsters could take off the headphones and have a rest from the noise whenever they wanted. Apparently they liked this very much. And such a system is readily available in Australia (Sounddec 2005).

We have the technology to avert the trend towards audio-oblivion if only we can find a way to get the role models in modern society to lead the way. That is our major challenge in this changing environment.

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