ENVIRONMENTAL ACOUSTICS – FROM 1974 TO THE FUTURE

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1 FORTY YEARS AGO

The laws of physics governing how sound is created and propagates are about the only aspect of acoustics that have not significantly changed over the last 40 years. Sources of sound are very different, as are the types, levels and character of sound produced. In addition to this, people are very different now, with different experience, expectations and priorities, all of which affect how the sound we hear is perceived.

The Institute of Acoustics emerged in 1974 into a world where The Wilson Report (Noise – Final Report, by the Committee on the Problem of Noise, 1963) provided wide ranging guidance relating to noise. This identified sources of noise such as: motor vehicles; railways; aircraft; boats & hovercraft; industry; construction & demolition; entertainment & advertising; mineral workings; agriculture, forestry & gardening. Noise was identified as potentially affecting: health (by direct damage such as occupational noise, but not mental health, despite causing much annoyance and sleep disturbance); communication (including teaching); working efficiency (at very high levels of noise); occupants of buildings such as dwellings, factories, schools, hospitals and offices.

The Wilson Report identified domestic noise as the largest single cause of complaint (25-30%), followed by motor vehicles, factories etc., and entertainment/ advertising, all of which were of similar magnitude (~20% each). Aircraft and construction & demolition each accounted for around 5%, with railways, boats and agriculture totalling less than 1% of complaints. In towns road traffic noise predominated at 84% of survey points, with industrial noise being dominant at 7%, railway noise at 4%, building operations at 4%, and 1% being unclassified. The report includes the following statement which provides a further benchmark: ‘There is a considerable amount of evidence that, as living standards rise, people are less inclined to tolerate noise. On the other hand, a noise nuisance has to be very great before most people will take it upon themselves to make a formal complaint to a local authority, the police or a magistrate’.

In 1963 The Wilson Report tentatively suggested the following criteria for LA10 levels in living rooms and bedrooms:

Situation	Day	Night
Country area	40dBA	30dBA
Suburban (away from main traffic routes)	45dBA	35dBA
Busy urban areas	50dBA	35dBA

In 1967 the first version of BS 4142: Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas was issued. This applied 5dB penalties for industrial sound that was tonal or impulsive and 10dB if both characteristics were significant. A Corrected Criterion was used, together with the Background Noise Level (if this could be measured), ranging in value from 40dBA to 90dBA. The highest value applied for old established factories which were completely in character with the area in which they were established, being predominately industrial with few dwellings, only operating on weekdays between 8am and 6pm during the winter (the Corrected Criterion for non-winter operation was 5dBA lower).

Sound levels were measured using analogue instruments either visually estimating the average or background level (using the slow time weighting to help with this), or possibly by plotting the output using some form of chart plotter (provided this did not affect the sound level measurements).

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All of the sources of noise identified in The Wilson Report remain significant, although their relative predominance has changed. Other sources of noise resulting in significant numbers of complaints have arisen such as: barking dogs; and neighbour noise, including electrical switches in neighbouring flats. This highlights a few non-acoustic changes during the past few decades. For a variety of reasons including cost, thermal efficiency and ease of use, building construction now makes use of much lighter materials which, although capable of good airborne sound insulation if used correctly, has resulted in the transmission of structure borne energy such as the clicking of light switches from interconnected premises. The prevalence of double glazing has also resulted in better façade insulation and lower noise levels (when windows are closed), potentially increasing the sensitivity to noise from other parts of the building and of low frequency noise breaking in from outside.

It is now recognised that noise affects health, not only directly due to occupational exposure but indirectly, with a correlation being established between high environmental noise levels and stress related medical conditions such as hyper-tension and heart attacks, resulting in reduced life expectancy in particularly noisy areas.

Other changes such as building design and construction; teaching methods; lifestyle; types of work and work patterns; household equipment; noise from transportation; and legislation have all significantly altered the levels, character and pattern of sound to which people are exposed and the acoustic environment in which we live, work and relax.

Equipment is generally much quieter than used to be the case for the same absorbed power. In some cases this has been offset by the use of more powerful equipment and in others by much greater use of equipment. Technology has also played a significant part, so that a problem with electrically powered cars is that they can be too quiet, no longer providing an audible warning to pedestrians that they are about to be run over. Whilst road traffic remains a major contributor to environmental noise and is a major concern, necessitating substantial expenditure on mitigation, a current concern is what additional noise should electric cars produce? Sound engineering is also focused not only on reducing noise exposure but on creating the right quality sound. Historically this was mainly concerned with auditorium acoustics for venues such as concert halls and theatres. Now it applies to cinemas (including home cinemas), a wide range of music venues, and for other sources such as the quality of noise produced by car engines, car doors and even vacuum cleaners.

Our expectations and perception of sound have also significantly altered during the intervening decades. As noted in The Wilson Report, living standards have continued to rise and people are less inclined to tolerate noise. Awareness of noise is now much greater, people feel more able to complain about noise and the complaint process is more straightforward, as a result of which people are far more likely to complain about noise than was the case when The Wilson Report was produced.

The Wilson Report's tentative suggestions for noise levels in bedrooms have proved remarkably appropriate, remaining consistent with current guidance such as that from the World Health Organisation and in BS 8233: 2014, which are derived from significant research. However, the day time range of 40dBA to 50dBA in living rooms of dwellings from Country to Busy Urban areas are higher than levels now thought to be suitable. This is perhaps consistent with there being relatively little change to individuals' sensitivity to noise when sleeping or going to sleep, but a significant change in expectations regarding noise levels in dwellings during the day.

A new version of BS 4142 is about to be issued which reflects many of the changes in acoustics since the original 1967 version. Whilst the comparison between the adjusted source (Rating) level and background sound level remains similar, this is no longer taken to be an indication of the likelihood of complaint, but of the potential significance of the impact. However, the context must also be considered as part of the assessment taking account of other guidance where appropriate and also the absolute levels of sound. In 1963 The Wilson Report made it clear that the measurement and assessment of people's response to environmental sound was not a precise science. This will now be recognised in the new version of BS 4142, with a specific requirement to consider the uncertainty of both the measured sound levels and the impact of the sound.

The Institute of Acoustics has seen major developments in acoustic instrumentation and associated systems. In 1974 a sound level meter was calibrated by adjusting the gain using a screwdriver, and was likely to have drifted significantly driving from one site to another. Modern analyzers are now able to identify the expected calibration level, adjust the gain and remain stable for extended time periods, with the calibrator also better able to maintain the correct calibration level. Measuring sound levels consisted of selecting the required frequency and dynamic range, then visually estimating the value indicated by the often rapidly moving analogue needle display. A digital integrating sound level meter will now measure the sound level in all frequency bands simultaneously, generally to a precision of 0.1dB, providing a wide range of parameters such as average (L_{eq}), maximum & minimum (L_{Max}, L_{Min}), statistical values e.g. L_{A90}, L_{A10} and other derived parameters as appropriate. Measurements are routinely downloaded directly into a software package for further processing, sometimes remotely from long term monitoring sites. Analysis, which used to consist of written manual calculations, is now performed by software, which may produce written values, graphs of measurements or contour plots for example. However, there is a tendency for the increased precision of digital systems to be mistaken for accuracy, even by practicing acousticians. Whilst modern instrumentation can be more accurate than old analogue systems the level of variability in source noise and propagation paths remains the same, as a result of which the overall level of uncertainty in environmental sound measurements is probably of a similar order of magnitude as before, although this can be reduced by appropriate methods.

As a whole, society tends to accept digital data as being far more accurate than used to be the case for analogue data. This makes it ever more important for acousticians to understand the limitations of the data they are using and to clearly explain this to non-acousticians, and has become a far greater challenge than was the case 40 years ago.

The Environmental Noise Directive (END) has resulted in the production of noise maps covering a significant proportion of the UK's population. Whilst this cannot be relied upon as a precise indicator of the actual sound levels to which specific premises are exposed due to local sources such as fans or air conditioning equipment, it provides a very useful tool for the quantification of existing environmental noise levels and their future control. Soundscapes are becoming a more significant factor with work now being undertaken to create positive acoustic environments.

3 ENVIRONMENTAL ACOUSTICS IN THE FUTURE?

It seems likely that far more and better quality data will become available regarding environmental sound levels for an ever increasing proportion of the UK's population. This will be aided by technological developments such as MEMS (Micro-Electro-Mechanical Systems) microphones and possibly crowd science/ research, together with legislative pressure such as the END.

There will inevitably be continuing expectation for ever better acoustic environments, in which active consideration of soundscapes will play an increasing part together with a reduction of noise at source and conditioning of sound. If society continues becoming more individualized people are likely to become less tolerant of any intrusion from other sources of noise that affect their ‘personal space’. It seems likely that ‘apps’ and other technological developments will help increase peoples’ awareness of environmental noise, but not necessarily improve their understanding of it.

Acoustic instrumentation is capable of powerful analysis of environmental sound but still cannot match the human hearing system. Whilst this gap will reduce and presumably eventually disappear, the biggest factor affecting the analysis of environmental sound with instrumentation systems is the psycho-acoustic component i.e. how sound is perceived by people. This is made more complicated by the wide range of individual responses to the same sound and even more by the way in which an individual’s response will differ depending upon many non-acoustic factors such as their mood, recent experience, time of day, etc. Outdoor sound propagation will continue to be significantly affected by factors such as weather conditions, seasonal factors such as the condition and type of foliage.

With the amount of variability and complexity together with the relatively limited research in this area it seems likely that there will continue to be considerable uncertainty in any objective assessment of environmental sound. As public awareness and expectations of environmental sound increase it will become increasingly important for acousticians to provide meaningful information that helps people to better understand and make informed decisions regarding environmental sound.