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ACOUSTIC PLANNING OF AUSTRALIAN INNER CITY AREAS – AN INNOVATIVE APPROACH

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ABSTRACT

Australian CBDs are undergoing massive re-development. In particularly more and more people are choosing to live in or near the CBD, usually in high density or high rise developments. With this fundamental shift in the demographic comes the potential for conflict between lifestyle and the intrusion of existing or future noise sources in the community. In this paper, an integrated approach to noise control in Australian cities is discussed. This approach includes producing 3-D acoustical models of Australian cities, with Melbourne presented here as an example. Detailed computer modelling can be used to identify potential areas of high noise as well as existing areas of tranquillity. A computer model is particularly useful in the case of new development, because educated planning decisions concerning noise can be made at the same time as developmental decisions. This approach contrasts markedly with cities that have been built "organically" with no prior overall noise plan. The cost effectiveness of planning decisions made with prior knowledge of the noise environment is qualitatively addressed. The overall aim of this presentation is to suggest an appropriate methodology for modelling the changes now taking place in Australian CBDs using proven technology. By selecting appropriate standards from Europe, noise limits from around Australia, and state-of-the-art software, an integrated approach to noise control for cities is suggested.

KEYWORDS: Acoustic Planning, Noise Mapping, Noise Modelling

INTRODUCTION

Noise mapping of cities is a relatively new discipline. To date, only a handful of cities in the world, all from Europe, have been modelled. The purpose of building acoustic models of these European cities is to document and standardise noise conditions in urban centres across the EU. Planning decisions based on these maps can then be made to retain tranquil areas and set noise limits. Also, noise maps enable investigations into noise impact on existing populations by possible infrastructure expansion such as road, rail and aircraft. Europe is working towards, but is yet to finalise, a standardised approach to noise mapping.

Australian cities are now looking to the future with master plans such as in Melbourne [1], where the population is due to increase by up to a million by 2030. Australian CBD noise studies would differ from the European experience, in that the noise model could primarily be an integral part of the city

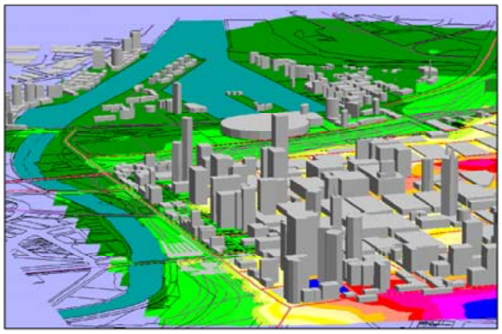

Figure 1. A 3D computer model of Melbourne

planning and design process, rather than a post-construction activity. Computational modelling could be used to test infrastructure and building placement impact, *prior* to construction, and in an integrated fashion. For example, placement or orientation of one building might have an unintentional yet significant acoustic effect on a completely different area of the city development. Using predictive tools, city planning can be optimised to provide best acoustic amenity, and identify noise problems at an early stage.

A common mistake made by city planners is the attention to detail with outdoor visual amenity while ignoring the acoustic impact. There are few criteria for outdoor park design, whereas many standards have been written to protect residents and office workers from excessive noise penetrating a building façade. Outside areas of tranquillity are very important from an occupational health and safety standpoint [2]. A major outcome from this study is to develop the ability to identify tranquil areas within Australian cities, and enhance and protect those areas using simple design rules.

THE EUROPEAN STANDARD

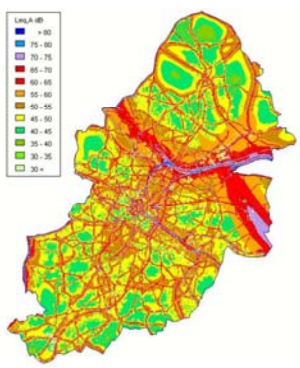

Figure 2. Noise map of greater Burmingham

European countries have, in the past, created noise maps for whole cities [3] (Fig 2) using their own national noise standards. It became apparent, however, that as Europe moved towards a closer social and economic union that issues such as environmental noise impact should be also standardised. The European Union at present is the only political force in the world that is working towards using whole city noise maps in a standardised way. In fact, the EU intends to release a standardised approach to noise by early 2003 [4].

The proposed standards used in Europe will all be based on new Nordic methods. Weather effects are also included, including wind and inversion effects. Most importantly, the propagation and screening equations for road, rail and industrial noise are *standardised*, meaning predicted values of noise from all three types of sources can be added together to give a single noise metric. This method contrasts markedly with current standards used in some member states of the EU, some of which have been adopted already by Australia, and based on a single noise level (in dBA). Standards such as in Cortn for road noise, and the older Nordic Kilde (1985) for rail noise, are currently the standards of choice in most states of Australia. These standards do not include weather effects, are wholly empirical in nature, and the predicted noise metrics are not comparable. The movement towards a standard output metric is an attractive alternative.

The aim of the European standard is to arrive at a yearly value of noise parameter for every place of interest within a given city. This yearly predicted value includes contributions from cars, trains, aircraft and industrial noise sources. The European project to integrate noise modelling across member states is called "*Harmonoise* IST-2000-28419" [5] (www.harmonoise.org) and is funded by the European Commission. It consists of 19 government and private partners within 8 member countries of the EU.

NOISE LIMITS

Cities intended for the modelling in the *Harmonoise* project are well established, and as in most European cites, consist of relatively low-rise buildings. Australian CBDs, by contrast, are experiencing very high levels of urban renewal, including a great deal of residential high rise development. This difference in fundamental design of this city areas poses the question: "What noise limits are appropriate for Australian cities"

At present, two noise *indicators* for the EU have been chosen but limits of which are yet to be precisely defined. The first indicator is based upon a day-evening-night exposure, L_{den} averaged over a year. This noise parameter is an indication of the annoyance from long term exposure to noise. The second indicator is L_{night} which is an overall night time indicator and related to "sleep disturbance" criterion [6]. These two indicators are calculated for all source types as well as include weather effects. L_{den} and L_{night} are based upon existing indicators, $L_{Aeq,T}$ which are already calculated by many accepted noise standards. There are a number of current limits for $L_{Aeq,T}$ throughout the world based on:

1) location (residential or industrial), 2) noise type (road, rail, aircraft, industry), 3) time of day (day, evening, night), 4) country. Although it is proposed that the Australian model be built on a method that will eventually be the EU standard, it is suggested here that the noise limit criteria should be based upon a current limits already used in Australia, for each particular noise type. In the interim, it would be instructive for whole city modelling to be based solely on L_{Aeq} for different noise source types. There has already been some work in Britain to convert road traffic $L_{10(18hr)}$ into L_{Aeq} [7], which could be applied equally as well in Australia. Of course there are many cases where a single value of noise metric is just not applicable, such as in semi rural areas where background noise levels are very low. It is suggested here that these cases are unavoidable and limits should be intelligently chosen from existing noise regulations [8,9]. For the purposes of whole city modelling in an urban context, however, a single metric involving all source types would give great insight into the acoustic amenity of a city. When the European method has been finalised, it would be a simple matter to convert predicted Australian L_{Aeq} models for road, rail, and industry to a standard *Harmonoise* model for comparison with mostly low-rise European cities.

NOISE MODEL

A computer model based on the Melbourne CBD has been built using SoundPLAN environmental software [10]. Building designs can be imported directly from CAD (Computer Aided Design) packages, making the transfer from "design to test" as efficient as possible.

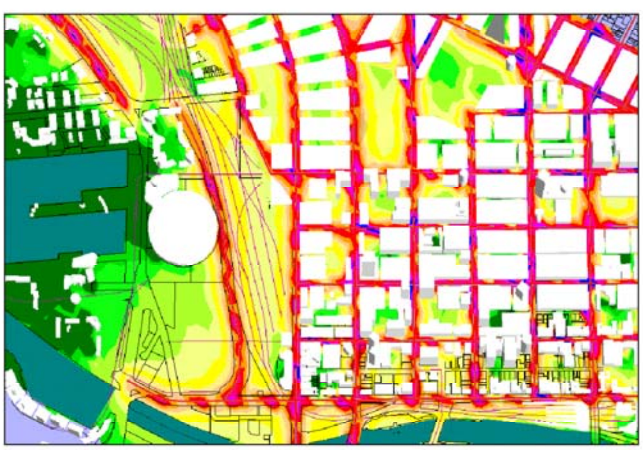

Figure 3 Melbourne City – Example of Noise Spapshot

Noise contours have been plotted using the Nordic Traffic Method for hypothetical traffic volumes on some Melbourne Roads. The contour maps presented here do not represent accurate values of noise but are examples of computer modelling and the information that such models can quickly convey to planners and designers. High noise values are represented by red and blue contours, while lower levels are shown in green. For all intents and purposes, areas in dark green could be identified as "areas of tranquillity" while areas in red or blue indicate excessive noise.

In Fig 3, it can be seen that some areas around dockland are very effectively screened from city traffic noise. Other areas of lower noise in the city might be deemed suitable, for instance, as outdoor tranquil areas for parks or restaurants. Alternately, the design philosophy used in the buildings that are shown to provide very good acoustic shielding may be applied to other parts of the city. In any case, a noise map of a city can immediately show a noise profile that would otherwise have to be laboriously measured.

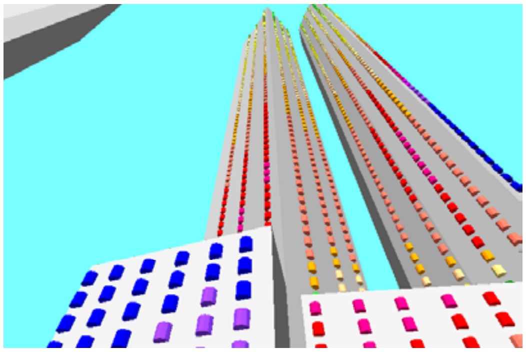

Figure 4 Noise levels for office tower design

Office towers shown in Fig 4 have had colours assigned to each window to represent the noise impact on the façade. Using such an output from the model, an engineer can quickly evaluate the window requirements for the whole building, as well as optimise the glazing requirements according to the height. In the example above, noise levels in the taller parts of the towers can be seen to be less at lower height because of screening by the protruding mezzanine. The noise levels rise again at higher floors when screening diminishes then drop away again at the top as distance from the road increases.

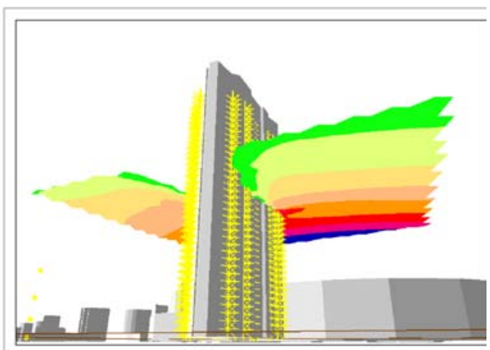

Figure 5 High rise Apartment in Melbourne

An example of active acoustic design is presented in Fig 5, which shows an apartment building design in Melbourne. The apartment block is located close to the CBD and in front of a large stadium. By adjusting the shape of the apartment building footprint, the impact of the stadium noise can be kept to a minimum. Visual design features of the building can double as noise control, and the building shape adjusted so that the noise essentially drifts pass, without direct impact on the façade. With judicious planning, noise issues within all Australian CBDs could be identified and ameliorated even before construction. In addition tranquil areas could be built into the master plan, actively coupling acoustic and visual amenity.

CONCLUSIONS

1. Using noise standards from Europe and noise limits from Australia, a noise strategy suited to CBD development is presented.
2. A digital model of Melbourne CBD has been used to investigate noise issues.
3. Hypothetical examples of noise modelling have confirmed the usefulness of computational modelling as a companion to the design process.
4. An integrated approach to noise provides information necessary for cost effective building planning, while avoiding noise problems at the earliest possible opportunity.
5. A considered and thorough integrated approach to noise issues in Australian cities could guarantee that they remain some of the most pleasant urban environments in the world.

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