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TRENDS IN TRAFFIC NOISE RESEARCH OVER 25 YEARS

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ABSTRACT

By the early 1970s, the impact of the noise from traffic on the surrounding communities was recognised as a problem. In order to continue to provide extensive road networks, governments and authorities sought methods for minimising the noise annoyance caused by traffic. This demand for information led to support for research into the effects of traffic noise, the development of appropriate criteria, consideration of the various parameters of road traffic noise and the appropriate methods for abatement. The goals were to reduce the overall noise levels and annoyance while maintaining traffic volumes. In this paper, the trends in road traffic noise research will be examined by categorising and reviewing the papers presented at the Inter-noise conferences over the last 25 years. The trends may give some indication of the directions that traffic noise research is taking as the end of the century approaches.

1. INTRODUCTION

This is the twenty fifth conference of the Inter-noise series. Its theme, "Noise Control - the Next Twenty Five Years", reinforces that this is an important time for looking to the future. In order to determine the directions that research should, would or is likely to take, it is important to take into account the current and future needs but it is also necessary to look to the past to determine what has been done. This provides the background information which can be coupled with the knowledge of the needs for information to determine the directions that the research should take. In this paper, the trends in road traffic noise research will be examined by categorising and reviewing the papers presented at the Inter-noise conferences over the last 25 years. The trends may give some indication of the directions that traffic noise research is taking as the end of the century approaches.

2. RESEARCH ON TRAFFIC NOISE

Selection of Data Base

The findings of studies on traffic noise can be published in a number of different forms such as papers presented at Conferences, papers in research journals, research reports from research or consulting agencies or government publications. The Inter-noise series of Conferences has achieved an excellent reputation for international participation and for the presentation of research information. Therefore the proceedings of its conferences should provide a good data base of research on the various aspects of road traffic noise. The papers presented over the last twenty five years should provide a good record of the types of research that has been undertaken and from which the trends can be determined [1].

Categorising of the Papers

The first task was to determine the categories for the compilation of the data. This was done with a view to using keyword searching via computer data bases. Due to a limitation in the compilation of the computer data bases, it was not possible to use this method for searching and the determination of the number of papers was ultimately done manually.

A number of schemes for categories were trialed using some representative years of proceedings and it quickly became clear that a few broad categories would be the best. For the compilation of the data the following categories were used:

- **vehicle and engine noise** - this category included anything relating the noise from a single vehicle itself
- **tyre and road noise** - this category represented the effect of moving the vehicle on the road surface
- **traffic streams** - this category included all papers on the effect of a stream of traffic
- **prediction** - this category included all papers using prediction or modelling to estimate the noise from road traffic
- **barrier** - this category included papers which investigated the effect of some form of barrier to reduce the spread of road traffic noise. There were many papers on the effects of barriers for a variety of applications but only those papers specifically addressing the effects of barriers for road traffic noise were counted.
- **effect** - this category included papers which investigated the effect of road traffic noise on humans or animals. There were many papers on the effects of various forms of transportation noise and of community noise but only those papers specifically addressing the effects of road traffic noise were counted.
- **interior** - this category included papers on the noise inside vehicles, usually with the goal of reducing the noise for the occupants rather than for the others in the community.

3. FINDINGS

Total Number of Papers
From Figure 1 it can be seen how the total number of papers, on all topics, printed in the proceedings has increased over the twenty five years. The different infills for the bars indicate the location of the conference and, as would be expected, this had some effect. The locations have been grouped as: America, which includes USA and Canada; Europe; and other, which includes Japan, China and Australia. This coding is used for the following graphs on traffic noise.

Percentage of Papers on Traffic Noise
This is shown in Fig 2 and while the total number of papers on all aspects of road traffic noise may have increased over the years, the percentage of the total number of papers at the conference has been commonly between 7 and 10%. The percentage of papers peaked in the 1970s a time when freeway construction was becoming popular. Comparing the data for the UK and the USA [2-4], the number of Km of road surface has only increased from around 330 thousand in the early 1970s to around 360 thousand in early 1990s for UK and from 5.8 million to 6.2 million for the USA. The major change has been the proportion of the total road network which has been improved to principal or motorway standard. It is in the total number of vehicles using the road network that the increase is most noticeable. Fig 3 shows the data for the UK and the USA (note that on this Fig the two sets of data have different scaling values). The increase in road usage and hence generation of traffic noise has not been reflected in the increase in traffic noise research papers.

Percentage of Papers on Engine and Vehicle Noise
Fig 4 shows the percentage of the papers within the broad area of road traffic noise that have been on the noise from an individual vehicle or its engine. The papers have been about 20% with somewhat of a resurgence in the recent years. This has represented an increased interest in the standards for motor vehicle noise and the application of modern techniques for the reduction of the output noise.

Percentage of Papers on Tyre/Roadway Noise
From Fig 5 it can be seen that there has been a great variation in the number of papers on this topic over the years. There has been a consistency over the last three years and this may indicate that the benefits to be gained from a thorough understanding of the processes involved may lead even more reduction of this source.

Percentage of Papers on Traffic Stream Noise
This category included all the papers which considered the noise generated by the stream of traffic and it was a popular topic area in the early 1970s as shown on Fig 6. At that time it was important to quantify the noise levels that were produced by various road systems. This information was necessary for the establishment of the major parameters, for the setting of assessment criteria and to provide the information for the prediction methods.

Percentage of Papers on Prediction of Traffic Noise
This category shows a cyclical nature with approximately a ten year cycle, Fig 7. The nature of the papers on prediction have changed. In the early 1970 the prediction methods were largely empirical methods based on large amounts of measurement data. In the recent years the papers have applied sophisticated modelling techniques which utilise the increased processing capabilities of modern computers.
Percentage of Papers on Barriers for Traffic Noise
The impression in Fig 8 that the interest in this topic is decreasing is perhaps misleading. The papers included in this category were only those that specifically mentioned the use of barriers for road traffic noise. In the 1970s and 1980s there were many papers on the effectiveness of barriers, complete with measurement data. In recent years, the papers on barriers have tended to be more fundamental with the use of sophisticated modelling techniques and with application to a range of noise sources.
Percentage of Papers on Effects of Traffic Noise
There is a clustering of the papers on the effects of road traffic noise, Fig 9, on particular years. This is likely to be due to the effect of the particular interest in the location for that conference. Throughout this period there were many papers on the effects of community noise in general, of which traffic noise may be a major component, but these papers were not counted as the prime purpose was not to determine the effects of road traffic noise.
Percentage of Papers on Interior Vehicle Noise
This would appear to be an area with potential for growth, Fig 10. In the special session on this topic at the 1992 Conference, the papers dealt with aspects such as subjective evaluation for acceptable criteria and sound quality as well as modelling to determine and reduce the transmission pathways.

4. FUTURE

The first conclusion that can be drawn is that traffic noise is still an issue for research. While the increases in the number of Km of road network are small, the increasing numbers of vehicles on these roads will inevitably lead to higher noise levels in the surrounding areas unless there are further reductions in the noise either at the vehicle itself or in the pathway to the receiver. While a lot has been achieved in the understanding of the important parameters, there is still considerable research being undertaken on the control of the noise from the vehicle itself. The new emphasis on the control of the noise in the interior of the vehicle will also help in the better understanding of the generation of the noise and so its reduction. This will include the noise from the engine and from the interaction of the moving vehicle with the air and the road surface. The application of modern sophisticated modelling techniques to the prediction of road traffic noise, its propagation and the effects of barriers would appear to be a growth area.

References
[1] "Inter-noise proceedings", International Institute of Noise Control Engineering, Noise Control Foundation USA (1972-1995)
[2] "Transport Statistics Great Britain 1993", Dept Transport, Welsh Office (1973)
[3] "World Transport Data" International Road Transport Union, Department of Economic Affairs, (1980, 1985 and 1990)
[4] "Selected Highway Statistics and Charts", US Dept Transportation, Federal Highway Administration (1990)

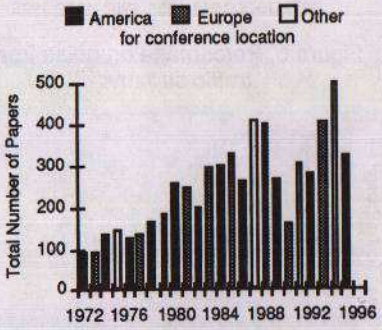

Figure 1. Total number of papers on all topics

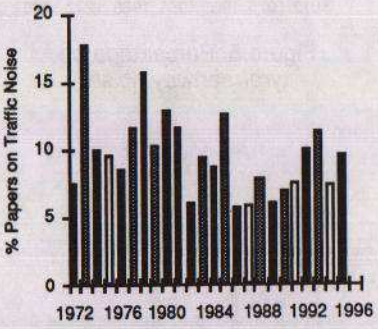

Figure 2. Percentage of papers on all aspects of traffic noise

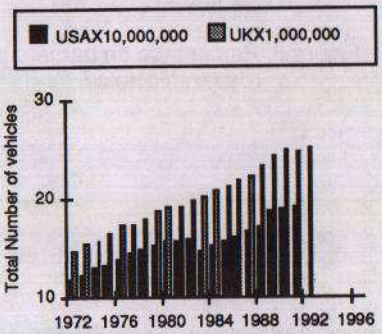

Figure 3. Total number of vehicles

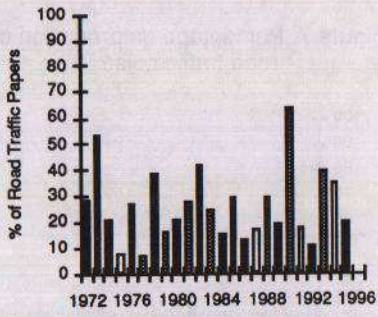

Figure 4. Percentage on engine or vehicle noise

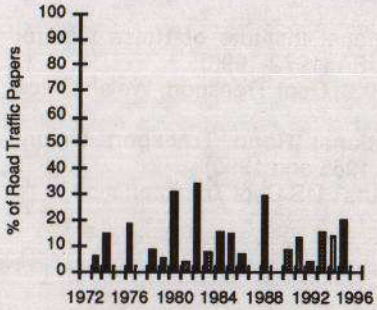

Figure 5. Percentage on tyre/roadway noise

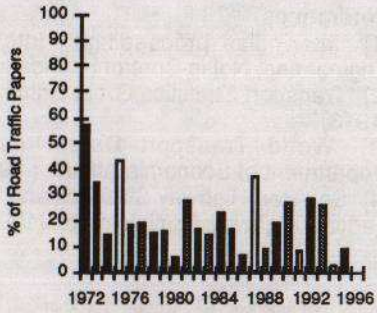

Figure 6. Percentage on noise from traffic streams

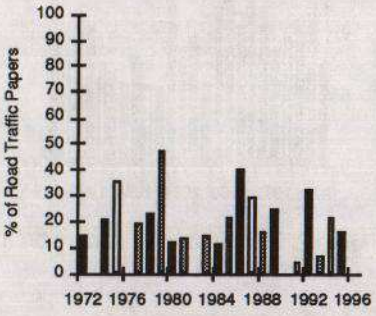

Figure 7. Percentage on prediction of road traffic noise

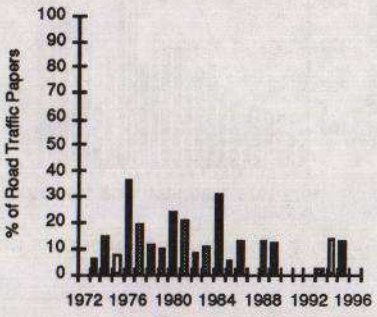

Figure 8. Percentage on barriers for road traffic noise

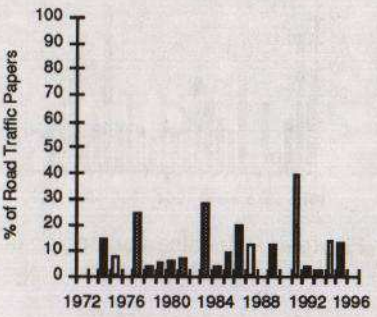

Figure 9 Percentage on effects of road traffic noise

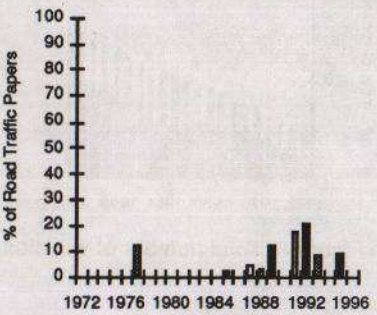

Figure 10. Percentage on vehicle interior noise