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REAL TIME NOISE CONTROL OF ROCK CONCERTS

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INTRODUCTION

There are very few occasions when such large amounts of noise are generated, over such long periods as occur at open air rock concerts.
Although modern methods of control such as those developed at READING ROCK have, to a great extent, minimised the external environmental problems, there is still a great need for accurate and informative noise monitoring, both to analyse the performance of the noise reducing systems and regulate the band's output during the concert. This paper addresses itself to a method of such control using the lessons learnt over the last 12 years. In particular, it attempts to demonstrate how the new technique of "SHORT Leq" can give enormous benefits in real time control. Short Leq, with its carefully defined time periods and exact acquisition of data in very large amounts, requires a computer to operate on and process the data.

BACKGROUND

Before any serious rock concert a lot of acoustic preparation is done. Indeed, the success or otherwise of the control measures hinges to a large extent on this preplanning.

If during the duration of the concert all relevant factors remained constant and the pre-tests were to specification, problems should not occur. However, conditions do change, people do take silly decisions and as a result problems occur in great numbers and very rapidly they can turn success into disaster. In fact the speed at which things can start to go wrong is almost unbelievable until it starts to happen.

At Reading, for example, the effect of weather has become the most prevalent problem and we can do little to alleviate this problem. Reading lies by the Thames in a bowl formed by the surrounding hills and is subject to unpredictable wind shear. (This is defined as the wind in one place travelling in a different direction to wind immediately adjacent). It is also subject to severe temperature inversion. (This is where a layer of cold air sits on top of a layer of warm air). While temperature inversion takes some time to occur, say over half an hour, wind shear can happen in seconds.

Now, the speed of sound and the attenuation over distance are both effected by the wind speed and direction. Thus, when wind shear occurs the sound transmission will be, to say the least, unpredicteble. The boundary between two air masses of differing temperatures, and therefore density, will tend to refract sound, which was designed to be radiated harmlesly upwards, back down to the ground. This often increases levels by 10-15 dBA in unexpected places.The object of having upwards radiating lobes is to ensure that any interference patterns left after speaker placing, only annoy the birds.

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The well known Elmers law clearly states that the inversion occurs after dark, when the audience is suffering from threshold shift and a surfeit of alcohol and the noisiest and most exciting bands are playing. Thus the highest noise levels coincide with the worst possible transmission conditions. Also it is after dark when the required noise levels need to be at their lowest, as children will want to sleep and normal domestic social activities take over from the working day. Indeed the GLC code demands a level reduction after 20.00 hrs.

The human element does, as you would expect, have considerable bearing on variations of noise emission.

There is always a tendency for noise levels to increase during the performance if left unchecked. This may be due to threshold shift, or as in the case of one-off concerts, the natural desire of the main band to provide greater impact than the supporting groups. Also, naturally, in a "farewell" concert there cannot be the same pressure to conform to external limits as there would be for a band who intend to continue touring. Similarly, a new band wants to make it's presence felt and a high noise level is the simple way to do this. Fortunately, the band at the "top of the bill" will usually actively help in controlling the lesser bands.

These effects are impossible to predict and therefore efficient real time monitoring and control is essential. Thus the noise control must be continuous and total. No lunch breaks, trips to the bar or other important activities can be allowed to come before constant and careful control.

This paper is not directly concerned with the methods of noise control at source, but rather with the rapid acquisition of noise data from the concert and the surrounding area, in order that adjustments may be made to the noise generators i.e. the speaker stacks. Speed is the key; correcting for what happened ten minutes ago is no good; it takes only a few seconds for a resident to pick up a phone and complain. Thus any system of control must happen in as near to real time as is possible. Clearly this does not allow for long discussions or arguments. Someone must take decisions rapidly and firmly. Apart from the speed required, discussion is very difficult in an ambient level of up to 100dBA and if more than two people are involved it becomes a farce. Indeed, non-cooperative sound mixers know this only too well and will try to put off the time when they have to reduce the level by 'discussing' the matter. It should not be assumed that they have the same commitment to noise control as do the local council or even the organisers. The sound crew are there to sell their services to the groups and keeping the level down, for some unperceived reason, is not going to do this. Thus at best, they are reluctant allies, at worst very clearly the enemy.

LOGISTICS.

Traditionally, the noise control team is divided into three groups:-
One group at the concert site (the control team) in communication with the concert organisers, the police, the mixing tower, a travelling team and the sound crew. It is the function of this group to gather the information

generated by the above parties and decide on any action to be taken. This is the group where the buck stops. At times, for example during the last few songs of a concert, the team leaders in this group go onto the mixing tower. This is because the normal control measures are by now not as important as keeping the levels down and only by 'sitting' on the sound mixer will this be achieved.

The second group is on the mixing tower for most of the concert. Experience has shown that for security reasons at least two persons should be there. Their task is to monitor sound levels within the concert arena and to inform the band's representative on the mixing desk of the desires of the control team. These formal words belie the actual situation and this team often need to make their wishes known in fairly robust ways. The group in the tower should also make any recommendations they see fit based on noise readings taken within the arena. In other words they have to actually force the sound crew to keep to the required levels. Naturally they normally carry out the team leaders wishes but very often a split second decision is required where there is no time to refer back.

The third group is mobile. In fact, the mobile group is split into at least two parts. One drives around a preset route taking sound measurements and reporting these back to the control team. This is the raw data for the noise 'footprint' maps of the event. The route however may not indicate the occurrence of some ducting effects and in any event may be at the wrong place to pick up a sudden increase in levels for other reasons. Unusual occurrences like these may be spotted during the tours of the other group. Their task is to visit the homes of complainants as well as to try to find the noise. This group, when visiting complainants, should ideally consist of a member of the noise team and a representative of the police or the borough council. They should also be smartly dressed to give some confidence to the complainant. The standard uniform of rock festivals, namely tee-shirt and jeans, is hardly likely to make the householder think his or her complaint is being dealt with seriously.
Voice communication between these groups has always been by hand held UHF radio. Range limitations are not usually a problem. If a radio signal cannot be heard probably neither can the concert, although if communication does fail it is always at the wrong time. However, the operator on the mixing tower does have some difficulty in communicating in ambient levels of some 100dB even when wearing a headset. Initially only one radio frequency was used but this was found to be inadequate. Thus in recent years, two or even three separate 'nets.' were used allowing for both 'public' and 'private' communication. At least one of these has to be the main organiser's system to ensure that control is maintained with the concert director instantly. Nowhere was this more clearly shown than at a recent concert. At the critical time, the noise team found its way to the mixing tower barred by security men brought in by the band to stop any attempt to make them keep to the level required. The direct communication to the main security director brought the organisers own team in to rectify the problem within the first minute. After that it would have been too late, the levels would have gone up and all the planning would have been for nothing.

MEASUREMENT CRITERIA.

Several units e.g. dBA, dBA (max rms), L10, L50, Leq (various periods) have

been tried in order gauge the success or otherwise of the control measures by determining the validity of any complaints and to satisfy legal requirements. Ref 3 discusses the various parameters used at various times. Decisions as to which unit or index to choose are not easy. Consider for a moment why. At Reading for example, the music is spread over three days for 12 hours each day and is therefore set against a changing background of social conditions and ambient levels. The music may be heavily percussive or may be of a nature which would be offensive to the surrounding population even if barely audible! As has been said in a previous paper; rock stars are not known for their sophistication of language. One serious bit of obscenity, particularly on a sunday, can cause many complaints at whatever level, just by being audible.
All practical units have limitations when used as control levels. For example, L10 can readily be affected by traffic, Leq can also suffer from external high levels such as trains etc., while L90 will change for many reasons which may be unconnected with the event we are trying to measure. Previous papers have shown how L50 correlates well with the annoyance of rock noise, but even this is to some extent a little too historical for real time operation.

INSTRUMENTATION

Over the past few years the instrumentation available has revolutionised the data collection process. Initially, in the early '70s, instrumentation consisted of simple sound level meters with team members driving around the area in cars reporting back with sound level readings via radio. These levels being plotted on a map. In 1983, at the Reading festival, this was complimented by a simple 800mHz radio link which was used to relay the actual acoustic signal from a point about 1km away (Battle hospital) back to the festival site. Although set up as part of a research project by Cirrus Research, this system provided continuous sound level data from one of the most sensitive areas. As local authorities began to specify the maximum noise levels using conventional Leq values (usually a 15 minute Leq) so the method of control changed. Now as each new band started playing, the sound mixer could be allowed the first 'number' to adjust the mix. This often exceeded the permitted continuous level for a few seconds. Then the level could be adjusted in order that any 15 minute Leq was not exceeded. At first, this meant a simple Leq meter and a fair bit of rapid mental arithmetic (not easy in 100dB ambient!). In 1983 a microcomputer was first used in real time measurement. In this installation the microcomputer was used to control and analyse the data from an Leq meter within the concert arena, using SHORT Leq acquisition. This allowed not only for easier interpretation of readings, but for a greatly improved working environment for the operator as the computer could be remote from the stage or mixer. The time base chosen was 1 second, which meant that the computer had to work on a maximum of 900 data points at any one time. The computer chosen was an ACORN BBC model B running from a prototype of a new Integrating Sound Level Meter for the Open University. This system of Short Leq means that all of the energy is stored in discrete data "lumps" and each piece of data has no relation to the data before nor that following. Having acquired this data, it is a simple matter to calculate ANY index in real time. Also, and much more important, it is simple to predict what the level would have to be for the rest of the period, in order to keep the level (in Leq) to the limit required. This is a unique situation, a historic index, Leq, being used to control an event in what is effectivly real time.

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Since 1983 the system has been expanded such that up to 4 Leq meters can be controlled and their data analysed simultaneously. This means that not only can the level be predicted at the mixer but the skew, due to wind or other effects, can be allowed for by the programme. Software for this acquisition was based on the original work done for the EEC by the LNE in France.

Next to evolve was an instrument with 'memory' which could be left in the field during the concert. Whilst not really of value for real time noise control unless connected to a modem, it has definite and clear value for multi-day concerts, for example, in planning the second day. It is also very valuable for legal recordings or simply data evaluation work, if required. Naturally, as data is being collected at a high rate, much information of an historic nature is given by these memory meters. This work assists in the planning of the next event by using computer prediction methods.

Octave band analysis is also a very useful tool. It is now normal to use groups of five speakers covering the frequency bands 20-500Hz; 500-1500Hz; 1500-2500Hz; 2500-4500Hz and over 4500Hz. Each frequency band is driven by a separate amplifier system. Variations in meteorological and musical conditions can cause these frequency bands to be attenuated or amplified by differing amounts. Consequently, it is often possible to reduce the level of just one of these frequency bands in order to maintain the required level. The only thing that suffers is the "balance" of the mix. The octave analyser also operates in real time using sound level rather than Leq as the data base.

Now, for a 15 min period with 4 meters in use, 36,000 data points have to be calculated in real time. Easy for even a simple computer, but mindboggling for a human.

The final point in the measurement chain is the human link. Here, we have reached a very clear conclusion. If the local authority can agree to pool resources and share manpower, in effect to become part of the noise team, the task is much easier. We have found, where the local authority insists on operating on an adversarial basis, the quality of the control and the subsequent noise level presented to the populace suffers. Converaly, where the local authority, the promoters and the noise consultants have reached a good working relationship, results have been much better.

THE FUTURE

All of the above elements have already been used in practice but not always together. In the future the instrumentation used would ideally consist of a large number of 'environmentaly protected' remote meters arranged around the concert site with one or more meters within the arena, all connected via a bi-directional radio link or a modem to a central computer and terminal which can display noise contours of the area. This would then predict ducting effects and the resulting required mixing tower levels in order that the current period Leq is not exceeded. It is the belief of the authors that control over the mixing desk will remain human; the consequences of reducing the level too far, or yet worse switching off altogether, are frightening! At the least there would be a civil disorder; at worst ??. Remember, people who go to rock concerts go expressly to be exposed to a high level of noise; if deprived they

become unpredictable. Members of the noise team will still be required on the mixer to 'enforce' the wishes of the control team as they interpret the computer's data. Also, the travelling noise group will still have a role to play in seeking out the worst noise area and visiting the complainants. It should be remembered that at an event like Reading, the people who want the "music" for three days easily outnumber the static population who may not want it.
There are often up to 40,000 at a festival and the exposed population can be less than 20,000.

CONCLUSIONS

A recent concert of the band Status Quo at Crystal Palace was widely held to be impossible without horrendous noise problems and subsequent legal action by the local authority. A limit of 99dBA (15min Leq) was set by the borough above which a section 58 notice would be served on the football ground. As a previous paper no doubt mentioned, results show that the sound level on the mixing tower, the reference point, never exceeded the limit. However, for the whole time Status Quo played they were never more than 2dB below the limit. Throughout the duration of the concert only one confirmed complaint was received. This would have been impossible without the use of Short Leq and a computer.

Although it might at first be thought that the future of this type of noise monitoring is limited it appears not to be the case. 10 years ago, if rock concert noise had been reduced to the current levels of emission, most people would have been satisfied. In todays environmentally conscious world however the desire is for even less noise. While it is difficult to see how we can achieve this and still allow the audience to enjoy their "music", it is clear that the way forward is along the path of computer control. We believe that this is simpler to achieve using Short Leq than with any other current method. Certainly when it was first proposed by Komorn and Luquet, it was held to be an interesting aberration. Now, with even simple computers like the BBC, it becomes a practical reality and the essential elegance of Luquet's proposal is only now becoming evident.

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