EIA – HOW THE MATRIX METHOD HAS DEVELOPED

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1 INTRODUCTION

Acoustics practitioners have been aiming to satisfy the requirements of Environmental Impact Assessments for many years. The USA formally established the practice in 1969 and by the mid 1980's many countries had followed their example, including in 1985 the European Union with the introduction of Directive 85/337/EEC[1].

In determining the significance of the noise impact of a scheme, and in the absence of formal guidance, practitioners have over the years developed an increasingly complex array of matrix methods in order for their assessment to be traceable and repeatable. This paper examines how these methods have developed, how they can assist to balance situations where there are winners and losers, and how they can be influenced by other non acoustic factors.

2 WHY DEVELOP A MATRIX?

The aim of environmental impact assessment (EIA) is to identify the 'significant' effects of a scheme, and for acousticians this relates mainly to noise, and to a lesser extent vibration. However, noise and vibration cannot be described with a simple, single descriptor that adequately covers the complex nature of the effects in the context of what might be considered 'significant'. Despite this difficulty, the acoustician is still obliged to offer their opinion on whether the noise and vibration effects of the scheme are significant. The matrix method provided a potential solution in how to relate multiple factors together in order to inform the decision making process.

3 THE PATH TO LEOPOLD

At the basic level, the matrix was used to relate environmental effects to noise effects of the scheme. A noise change equated to an effect, but with no definition as to what would be considered significant, the early matrix solutions merely highlighted that noise effects could be observed on a scheme.

A large leap forward in the development of the matrix method came in 1971 with the work of Leopold, Clarke, Hanshaw, & Balsley. "A Procedure for Evaluating Environmental Impact"[2] gave birth to the Leopold matrix method. Most modern matrix methods can trace their routes back to Leopold.

One of the advantages of the Leopold method was to predict the effect of a project on the environment by considering it on a numerical scale from -10 to +10. Rating the importance of the impact of each activity on each environmental factor is rated on a scale from 1 to 10. For the first time, practitioners had a qualitative and traceable way to account for several variables, and to make the distinction between magnitude of impact and significance.

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[1] Directive 85/337/EEC - Council Directive of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment

[2] Leopold, Luna B.; Clarke, Frank E.; Hanshaw, Bruce B.; Balsley, James R. (1971). A Procedure for Evaluating Environmental Impact. Geological Survey Circular 645. Washington: U.S. Geological Survey.

Table 6 Leopold Matrix Explaining the Impact of Mining on Environmental Parameters Presented in Terms of Weightings

Project Actions / Environmental Characteristics	Blasting Drilling	Surface Excavations	Mineral Processing	River Transport	Surface Transport	Ocean Transport	River Dumping/ Loading	Pumping of Mine Pit Water	Ocean Dumping	Solid Waste Disposal	Total
Soils	2 / 3.5	8.5 / 9	2 / 2.5		3 / 2			1.5 / 2		7.5 / 8	24.5 / 23
Land Forms	3 / 4	8 / 10			1 / 1.5					7.5 / 10	19.5 / 25.5
Surface Water			6.5 / 6	4.5 / 6			3.5 / 4	3 / 4		4.5 / 4	18 / 24
Ground Water		7.5 / 7						4.5 / 6		1.5 / 2	13.5 / 15
Ocean Water						1.5 / 3			1 / 1		2.5 / 4
Air	3 / 4	3 / 4	1.5 / 2		4.5 / 6						12 / 16
Erosion	1.5 / 2	5.5 / 7	1 / 2					1 / 1.5			9 / 12.5
Deposition/ Sedimentation			3 / 3	3.5 / 4			3 / 4	2 / 2		4.5 / 5.5	16 / 18.5
Flora	2 / 3	7 / 8.5	1.5 / 3	2 / 3	2.5 / 3	1.5 / 1.5	1.5 / 2		2 / 1	5 / 6	25 / 31
Fauna	2.5 / 2.5	5 / 6	1 / 1	1.5 / 2		1.5 / 1	1.5 / 2		1 / 1	1 / 1.5	15 / 17
Agriculture			4 / 6		1.5 / 2.5			3 / 4		4.5 / 6.5	13 / 19
Noise	3.5 / 4	2.5 / 4	2 / 2	1.5 / 2.5	3 / 4		1.5 / 1.5	1.5 / 1.5			15.5 / 20.5
Asthetics		7.5 / 9.5			4 / 5.5		1 / 1	1.5 / 1.5		9.5 / 9	23.5 / 26.5
Social Health & Safety	4.5 / 4.5	3 / 3			5 / 6						12.5 / 13.5
Total	18.5 / 27	57 / 64	22.5 / 27.5	13 / 17.5	21.5 / 40.5	4.5 / 5.5	12 / 14.5	17 / 22.5	4 / 3	45.5 / 52.5	

Figure 1 Example Leopold matrix

The most important aspect of the Leopold matrix was the ability to separately describe the magnitude of an effect to it's importance or significance. The two are not always directly related, especially so for noise where a scheme can have both positive and negative effects.

An example of where this arises can be seen in most road bypass schemes, where a new road takes traffic away from a busy village or town centre, and puts the traffic into fairly quiet, rural countryside. It is often the case that a large number of properties in the village will experience large noise decreases, although at the same time a small number of properties adjacent to the new bypass would experience large noise increases. In the absence of other factors, one might conclude that the scheme were beneficial overall, as there are more winners than losers.

4 OTHER FACTORS

Of course road traffic is considered in policy terms as a steady noise source, and other schemes are not so lucky. The matrix has therefore evolved further to account for other factors such as:

- Temporal (time of day, frequency of occurrence, temporary or permanent, etc.)
- Character (spectral content, tonal, etc.)
- Fixed thresholds
- The sensitivity of the receptor

The above list is not exhaustive, but highlights the main areas of consideration. One of the most debated aspects is the use of fixed thresholds. In the UK, there is more information available than in other countries, although this is still lacking in clarity on some issues, such as noise levels in external spaces. Practitioners and stakeholders alike also look to the world health organisation for guidance, where the guidelines for community noise and night noise guidelines are commonly cited.

In other less developed parts of the world, lenders criteria are commonly used in the absence of local legislation. The World and European banks have their own environmental noise criteria for schemes, and these less onerous limits are commonly applied to EIA's in these cases. Noise limits of up to 70 dB LAeq have been applied to residential properties, just because the land is zoned as industrial in planning terms. The justification for the less onerous criteria being applied in these countries is that generally the economic need for the new power plant or road linking major cities far outweighs the noise impacts for some of the population.

In reality, acousticians are making those judgements and determinations on all their schemes as part of the assessment process, just not as obvious as the World Bank example. Returning to tthe bypass example, and if the bypass were to pass through or close to a protected quiet zone (we may get some as part of the environmental noise directive some day), then perhaps the result of the EIA would be different!

There are other aspects of the matrix method that can be a disadvantage too. For example, if representing a developer and setting out a matrix for one site with a particular set of circumstances. The case that you have presented could be used against you on the next project where you might be representing a Local Authority.

5 SUMMARY

The matrix currently appears in many forms, and looks to be with us for the foreseeable future, whether it can be tamed and standardized remains to be seen.