Airport Noise Assessment - Simplicity and truth will help

Paul Schomer

Schomer and Associates, Inc., Champaign, IL 61821, USA, Email: schomer@SchomerAndAssociates.com

Introduction

Over the past several years, several authors have fit simple relations to DNL data in order to establish so called "dose-response" relations. One such relation advocated by the US Federal Interagency Committee on Noise (FICON) [1] is shown in Figure 1, along with the latest amalgamation of worldwide noise attitudinal survey data developed by Fidell [2]. The FICON relation explains only 19 percent of the variance; a value that is typical of any single curve fit to the ensamble of transportaion noise attitudinal survey data. Miedema and Vos (1998) split the ensemble of survey data into three groups: airports, road traffic, and railroads. This division of the data improved the percent of the variance explained by the noise variable considerably, but still less that half the variance was explained by the noise variable.

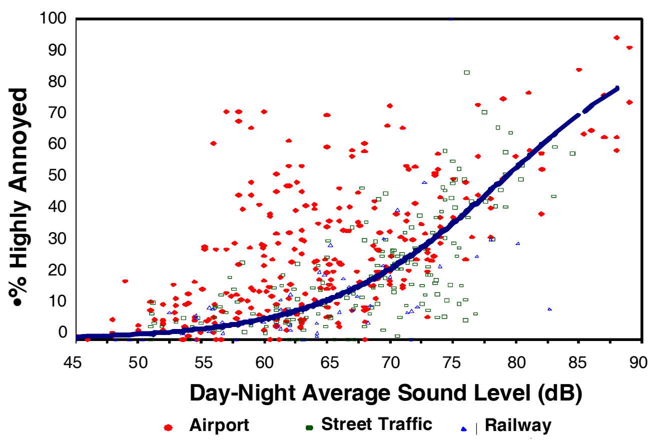

Figure 1: A recent amalgamation of noise attitudinal survey data. The blueline is the FICON fit.

There are at lease two obvious sources that can potentially explain much of the remaining variance. These can be termed "measurement error" and "response bias." Measurement error can mean such things as computed tone corrections or more robust metrics than A-weighting. Response bias relate to items that can *never* be measured acoustically no matter how "accurate" the measurement. We divide response bias into two categories herein: community expectations, attitudes, and beliefs; and noise sensitivity. This paper concentrates on just community expectations, attitudes, and beliefs.

Community Expectations, Attitudes, and Beliefs

Community expectations are general beliefs as to what the environment should be. For example, at least in the USA, the strongest belief about rural living is peace and quiet. This belief is held more strongly than low crime or strong families. Thus, the same noise in a rural setting may be found to be "more annoying" than if placed in an urban setting. The community simple expects a quieter setting. In turn, they have a lower threshold for annoyance.

Fields [3] lists a set of attitudes that are important modifiers of annoyance. These include "noise prevention beliefs," "beliefs about the importance of the noise source," "fear of danger from the noise source," and "annoyance with non-noise impacts of the noise source." To these, we add a factor found by Borsky [4] and others: "a belief that it is un-patriot to complain about a government activity."

"Noise prevention beliefs" are sometimes termed misfeasance, and the opposite of misfeasance may be thought of as "good public relations." In total, this factor can be thought of as "public relations," and it can range from *very good* to *very bad.* "Beliefs about the importance of the noise source" can range from *very important* to *totally unimportant.* "Fear of danger from the noise source" can range from *none* to *great,* as can "annoyance with non-noise impacts of the noise source." Certainly "beliefs about if it is patriotic to complain" can exhibit a wide range. Thus, it is clear that the state of three of these beliefs, "public relations," "importance," and "is it patriotic," can *increase* or *decrease* annoyance, and the other two, "danger" and "non-noise impacts, " can *increase* annoyance or leave it unchanged.

Beliefs are something that can change with education and with good public relations. Simplicity and truth are two attributes that can improve public relations. Unfortunately, our standard aoustical measures are NOT simple and thus they create confusion and distrust. Sometimes, our environmeontal assessments are clearly biased creating further distrust.

Simplicity

It is common to use the day-night or day-evening-night *average* sound level (DENL) to assess and describe noise environments. There are at least two items that keep this concept from being simple: it is not an *average* and it uses decibels.

When we compute DENL, we really compute the Total Day-Evening-Night Sound Exposure (TDNSE). Sound Exposure (SE) is the integral over time of the square of the event A-weighted sound pressure; a measure that is proportional to the sound energy. As equation (1) shows, TDNSE is the sum of each single event SE_i (e.g., an aircraft flyover, a truck driveby) multiplied by a time-period weighting.

$$TDNSE = \sum_i SE_{Day,i} + 5\sum_i SE_{Evening,i} + 10\sum_i SE_{Night,i} \qquad (1)$$

Usually this is a long-term average such as a year, so we compute the Yearly average TDNSE.

But we do not stop here; we go on to confuse the public. We take the TDNSE and divide it by 86,400; the number of seconds in a day. This is multiplication by a scale factor but we call it an *average* when it clearly is not an average. We would never sum the heights of people in a room, divide by the floor space of the room in m^2, and call this an *average.* But we sum sound exposures, divide by the seconds in a day, and then call it an *average.* Then, to make matters worse, we take a logarithm, add another constant, and call it a decibel. Then, to further confuse the public, we throw three different *decibels* at them: DENL, SEL, and L_A-max. We even talk about "yearly *average* day-evening-night *average* sound level," where in the same title, the word *average* has two very different meanings. And to make things even more confusing, the SEL is greater than the L_A-max, and both are greater than the total environment measure, the DENL. Then we wonder why the public is confused and distrustful.

None of this confusion is necessary. We can easily describe single events by their SE and by L_A-max. The total environment is given by the (time-weighted) sum of the single events. The total is greater than any single event. The effect of single loud events, especially at night, is clear. There is only one kind of decibel, L_A-max. Table 1 shows the approximate relation between TDNSE and DENL. The values for TDNSE are very reasonable. TDNSE equal to one is a very good environment, and TDNSE equal to 100 is a bad environment.

TDNSE	DENL (dB)
1	45
10	55
100	65
1000	75

Table 1. Approximate relation between TDNSE and DENL.

Honesty

All too frequently, assumptions used for noise modeling, stated facts, and the process itself are designed to deceive and disenfrancise the public. This too, like the descriptor issue above, contributes greatly to the belief of misfeasance, and contributes nothing towards an understanding of the importance of the noise source to the community and society. Some examples follow:

At one airport, the landing flight track was drawn not in line with the runway. It was off by 10 degrees, with no explanation, but it did miss a town that was complaining about landing noise. In a public hearing about increasing helicopter operations, one citizen was quoted as saying: "I feel nothing is being done because the city doesn't care." In Los Angeles, the minimum time permitted by law was used for hearings on terminal improvements, 45 days primarily during August when most people would be away on vacation. In Minneapolis, Northwest Airlines agreed to help fund sound proofing of homes in the DNL 60 and above zone, and then worked in secret for a last minute amendment to the Federal Aviation Administration (FAA) authorization to forbid sound proofing of homes when the DNL was less than 65 dB. Recently, at a California airport, United Airlines ignored a voluntary night curfew that had been agreed to and began early morning flights. Even in Figure 1, the FAA predicted percent highly annoyed at 65 DNL is 12 percent when the true average of the data is 27 percent. At 60 DNL the discrepancy is even greater. The FICON prediction is Z percent and the true average to the data is Y percent—more than a fourfold "error."

This list can go on and on. It is no wonder that airport noise is a worldwide issue and that there is great distrust on the part of the public. How can the public believe that the authorities care, that the function is important, that it is safe?

Conclusions

The acoustical measurements of noise explain less than half of the wide variance to the data. "Measurement error" and "response bias" are the two general factors that may explain much of the remaining variance. Two important factors can be included in response bias: sensitivity to noise and attitude towards the noise or noise maker, and attitudes that can be changed by outside forces. Factors affecting attitude include such items as expectations, misfeasance, importance, fear, and non-acoustic impacts.

Public dealings, especially with respect to airpports, have created a great sense of misfeasance, fear, and distrust. Even our metrics and the words we use to describe them, create distrust and confusion. Simple actions could enhance trust, diminish misfeasance and fear beliefs, and enhance the belief about the importance of the noise source. But it will take truth. Simplicity in descriptors is part of that truth.

References

[1] FICON, "Federal Agency Review of Selected Airport Noise Analysis Issues," Federal Interagency Committee on Noise (FICON), Report for the Department of Defense, Washington, D.C., (1992)

[2] Fidell, Sanford, and Laura Silvati, "Parsimonious alternatives to regression analysis for characterizing prevalence rates of aircraft noise annoyance", *Noise Control Eng. J.*, **42**(2), (scheduled for 2004 March-April)

[3] Fields, J.M., "Effect of personal and situational variables on noise annoyance in residential areas," *J. Acoust. Soc. Am.* **93**(5), 2753-2763 (1993)

[4] Borsky, Paul N., *Community Reactions to Sonic Booms in the Oklahoma City Area, Vol. II: Data on Community Reactions and Interpretations,* TR 65-37 (Air Force Aeromedical Research Laboratory [AMRL], 1965)