

Comfortable sound design and acoustic analysis

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KONISHI Masahide, Elemental Technology Research Sect.,
Basic Technology R&D Center, Engineering Div.

1 Comfortable Sound Design

As shown in Fig. 1, people may find construction site noise uncomfortable, yet find classical music at the same sound pressure level to be comfortable. This difference suggests that human perception is significantly affected not only by sound volume, but also by sound quality. In other words, human sensitivity cannot be fully determined by sound pressure level alone.

However, product development engineers are often given numerical targets for noise testing, such as “not more than XX dB.” These values do not reflect human sensitivity. Even if engineers successfully develop a low-noise product that meets the target value, it may be rejected for implementation or result in complaints if users find it uncomfortable.

Comfortable sound design is a design concept that focuses on sound quality, intentionally creating product sounds that are comfortable for people. The purpose of comfortable sound design is to provide comfortable sounds as added value, not to eliminate uncomfortable sounds. This approach is gaining attention not only in product development but also in urban environment development and many other fields.



Fig. 1 Sound pressure level and human sensitivity

2 Acoustic Analysis

In order to create a comfortable sound design, it is necessary to accurately identify the physical properties of sound. Acoustic signals are analyzed in the time and frequency domains. The time domain focuses on changes in the waveform, while the frequency domain focuses on spectral distribution. As shown in Fig. 2, acoustic analysis uses measurement data to derive sound pressure levels, frequency analysis, spectrograms, and other graphs, thereby visualizing and quantifying sound structures.

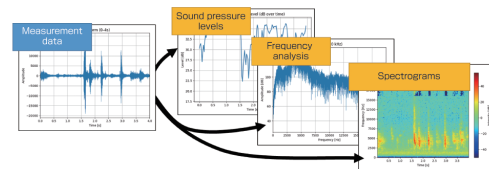


Fig. 2 Acoustic analysis using measurement data

Acoustic analysis is a technique for determining the physical properties of sound, but this is not sufficient for comfortable sound design. To quantify human sensitivity to sounds, such as “pleasant/unpleasant” and “comfortable,” sound quality evaluation indices have been defined. Sound quality evaluation indices are metrics that quantify human auditory impressions based on psychoacoustic models. They are used as a means to objectively evaluate sensory elements that cannot be fully captured by sound pressure level or frequency components alone. Table 1 shows typical sound quality evaluation indices.

Table 1 Typical example of sound quality evaluation indices

Index	Meaning	Expression of impression
Loudness	The psychological perception of sound volume	Loud—soft Strong—weak
Sharpness	The acuteness of sound or the strength of high frequencies	Dull—sharp Low—high
Roughness	The graininess of sound or the speed of its fluctuations	Smooth—rough Stable—fluctuating