



UTILISATION OF PSYCHOACOUSTICS IN TECHNICAL PRACTICE

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Abstract

Psychoacoustics is currently a powerful tool for optimizing the acoustic properties of sounds of machines, equipment and products in industry and in the home by thorough analysis and subsequent correction of psychoacoustic parameters (such as roughness, sharpness, volume, sound color, etc.) in order to achieve acceptability for man. It should be noted that the perception of sound (noise) by man is of a subjective nature and heavily depends on a particular person and his current disposition. The psychoacoustic parameters (roughness, sharpness, volume, color, tone, fluctuation force, subjective duration, and sound height) provide the foundation for solving many technical problems in practice. With respect to the application of psychoacoustics in practice, a relatively new scientific department has created a so-called acoustic product design that aims to optimize the acoustic effects of products on its potential users and their surroundings. Its important role is to objectively assess the sound quality of the product, which is a certain acoustic product card, even it can be seen as the product's image. Acoustic quality can be understood as the adequacy (soundness) of the product's sound, in terms of its useful value and function. Adequacy of the sound of a product is important from the point of view of its users, required as low noise level as refrigerator, washing machine and others. Also as a product sound feature that allows the user to identify the presence of the product, its kind, brand, operating status, or malfunction. As well as the sound of the product (so-called "loudness") to the user and his surroundings, for different user groups (in terms of age, gender, social status and other criteria), it is often a completely different sound. Psychoacoustics are currently most used to solve noise-related problems in areas such as the automotive industry, the design and manufacture of telecommunication products, the design and manufacture of home appliances and other areas.

Keywords: *acoustic, noise, psychoacoustics, psychoacoustic parameters, properties of sounds*

1. INTRODUCTION

The term psychoacoustics has been used exceptionally in the past. Psychoacoustics, as a relatively new area of acoustics, focuses on the subjective perception of sound, its effects on humans as well as the analysis of its possible effects. An important area of psychoacoustics is experimental psychoacoustics, which assesses the subjective response of a human being to the sound studied. The human body perceives noise not only through the hearing organ, but also throughout the body. The nature of the noise determines the level of the body's load. An important role plays the frequency, the width of the sound spectrum, the volume, the color, the roughness, the sharpness and other sound parameters. [6]

Noise acts negatively not only on hearing but also on the central nervous system, the vegetative system, and through them also on sight, heart rate, blood pressure, digestive system,

and so on. Noise reduces the possibility of speech communication and thus increases voice effort, adversely affects the psyche, stresses, exhausts and stands in the background of many psychosomatic diseases. Noise also disrupts concentration, social relationships, and leads to sleep disorders in humans. This issue also deals with psychoacoustics. [1]

2. THE USE OF PSYCHOACOUSTICS IN THE AUTOMOTIVE INDUSTRY

Sound engineering in the field of automotive research, development and production is a link between physics, design characteristics (vibration and transmission) and psychology, expressed through acoustic comfort, a sense of health and well-being. Acoustics are considered to be a component of successful vehicle development in connection with the transmission of noise and vibrations to the interior of the car but also to the outside environment. At the same time, new quality criteria are emerging with regard to societal changes, which should be taken into account when developing a car. If pragmatic, material and functional criteria were originally crucial, in recent years the emotional and sensory demands and appetites of car users have been stepping up. The style, character and value of the vehicle can only be achieved through a consistent, balanced and consistent overall image.

A high level of overall driving comfort is essential for its crew from the point of view of driving comfort. Comprehensive thinking and planning is required to make the final product - the car - to provide passengers with versatile comfort and good driving pleasure. It is not sufficient to partially optimize the noise of individual car components. The acoustic quality of a car must be solved as a whole, and also the interaction of all generated noise.

The focused development of vehicle acoustics is a highly complex, integrated task assignment in terms of driving comfort. The perception of the comfort characteristics of a particular vehicle is basically carried out as perceiving the effect of these properties through one or more human perception channels.

Individual perception of sound is very subjective. It can be objectively described only using purely physical, objective, measurable variables. On the one hand, it depends on the characteristics of the vehicle being watched or on a certain situation, and on the other hand, on the socialization of the assessment and the surrounding environment in which the assessment takes place.

The driving comfort provided by the vehicle to the driver and the passenger is therefore different, due to different customer expectations in different world markets.



Figure 1: Measurement of psychoacoustic parameters in an automobile interior

Customer requirements for driving comfort and thus vibration and vibration-acoustic properties - so-called NVH (Noise, Vibration, Harshness) - Vehicles have been steadily rising in recent decades and are still considerably higher. [4] The subject of research is also the external sound of the vehicle, which is an acoustic message for neighbours, through which information on the significance of values and quality is conveyed.

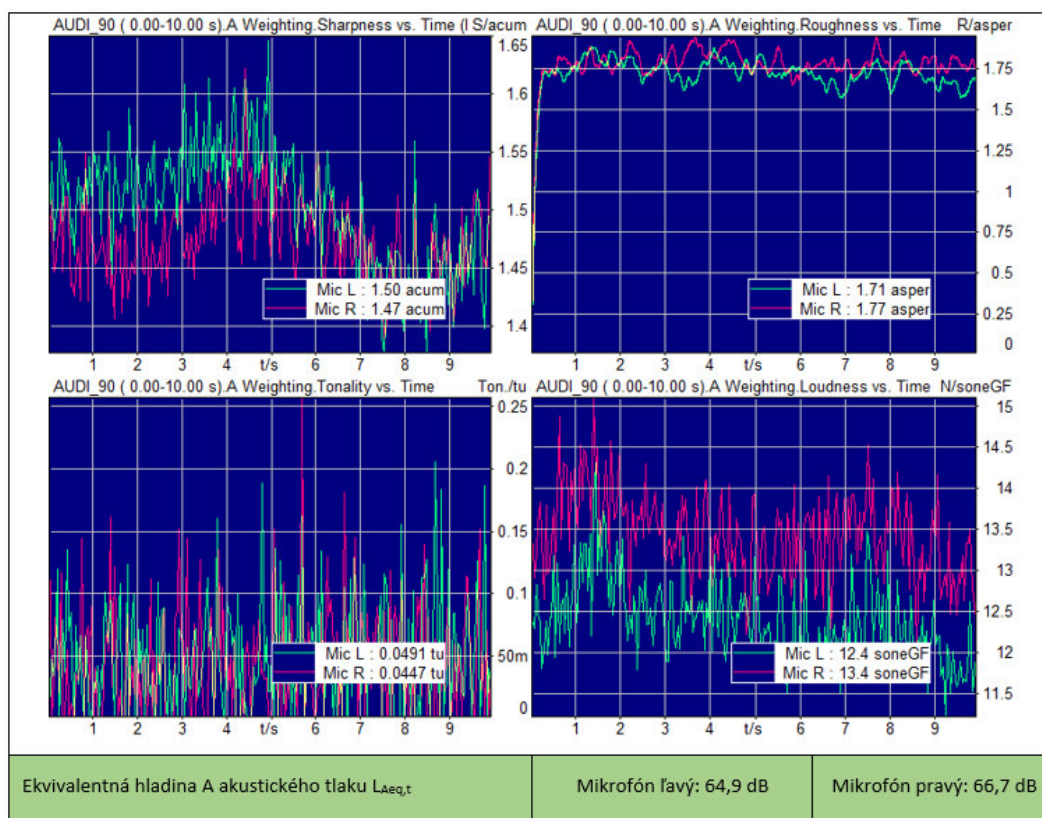


Figure 2: An example of measuring psychoacoustic parameters in an automobile interior

Therefore, the car manufacturer should also deal with the vehicle's external noise from its perspective as an "acoustic advertiser" and should partly transfer the determination of acoustic target values from the interior of the vehicle to external noise.

Besides the typical acoustic characteristics of the vehicle, such as the sounds of the vehicle in the interior and the exterior, the sounds of the full load, partial or continuous driving, the sounds of the tire when riding in different road conditions, wind sounds and the like also play an important role operating sounds such as window trigger sounds, sound when positioning seats, and so on. However, even spontaneous sounds such as whining, snapping and whistling also create a quality impression of driving comfort perceived by motorists.

3. USE OF PSYCHOAKUSTICS IN THE DEVELOPMENT AND MANUFACTURE OF TELECOMMUNICATION EQUIPMENT

Psychoacoustics are now increasingly used in the development and production of telecommunication devices such as mobile phones, wired and wireless phones, as well as communication devices in cars, households, companies, special purpose equipment such as, for example, emergency eCall, etc. [3] The main aspect of all communication devices is call quality (audio transmission). Speech quality assessment in mobile phones is relatively demanding due to various types of signal processing (eg echo cancellations and noise reduction algorithms, various types of speech enhancements, speech processing, transmission delay, etc.). All of these aspects have a significant impact on speech quality. Using hardware and software tools, HEAD Acoustics GmbH, Herzogenrath, Germany, it is possible to evaluate all aspects of the speech quality attributes after the effects of using various mobile devices and carriers, for example, in cars.



Figure 3: The use of psychoacoustics in the development and production of telecommunication devices - mobile phones

Application area in communications, respectively. Telecommunications is also optimizing radio reception. Incomplete reception of the radio may cause undesirable customer experience. In this context, auditory subjective and objective methods of assessing (testing) the quality of the received audio signals.

In connection with the implementation of the so- smart areas of flats, offices, hotels and more, comes to the fore in the natural language. Many elements in buildings, doors, blinds, air conditioning, lighting and many more can now be controlled by voice.



Figure 4: Binaural sound measurement in space

Psychoacoustics in this context can help analyze all relevant aspects of speech quality and optimize the communication process. Speech quality and speech recognition for internal communication systems can be tested. Speech recognition, wireless and wireless communications tests, hardware and software tools make it possible to perform binaural measurements of the sound generated by different audio techniques in 3D space to optimize the sound quality.

4. THE USE OF PSYCHOACOUSTICS FOR THE DESIGN AND PRODUCTION OF HOUSEHOLD APPLIANCES

Today, many household appliances are used in the home. Modern households and without them can be very difficult to imagine. Helping, facilitating work and shortening work time.

These devices also cause daily harassment because they are the source of noise. Many people see this noise as annoying, unpleasant. The degree of inconvenience is influenced not only by the sound pressure level but also by the psychoacoustic noise parameters such as sharpness, roughness, colour, tone of sound and more. Acoustic design is becoming more and more popular with many manufacturers that are required not only to reduce the noise level of household appliances, but also to optimize (sound) psychoacoustic sound characteristics (parameters). [2]



Figure 5: Examples of selected types of household appliances

An example of the measurement of these psychoacoustic parameters, such as the roughness, sharpness, tone and volume of selected household appliances, namely the Bosch, AEG, Miele and Samsung brands, as well as an example of the final output of a particular psychoacoustic parameter measurement in a washing program called centrifugation is shown in the following figures, [6] Measurement of psychoacoustic parameters was performed in a non-waste chamber using technical devices.

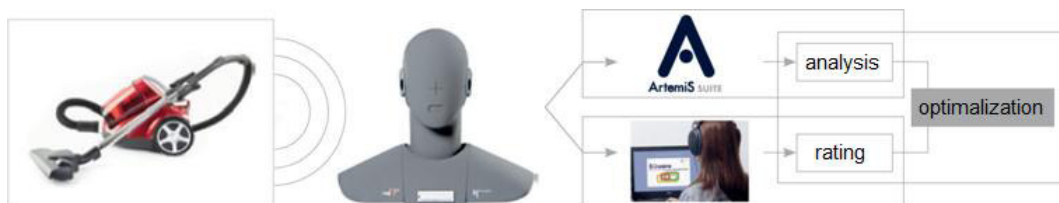


Figure 6: Optimize the sound of home appliances



Figure 7: Measurement of psychoacoustic parameters of washing machines in a wireless chamber

Noise reduction issues and solutions to acoustic product design are now the focus of global home appliance manufacturers. It is a significant advertising and business phenomenon.

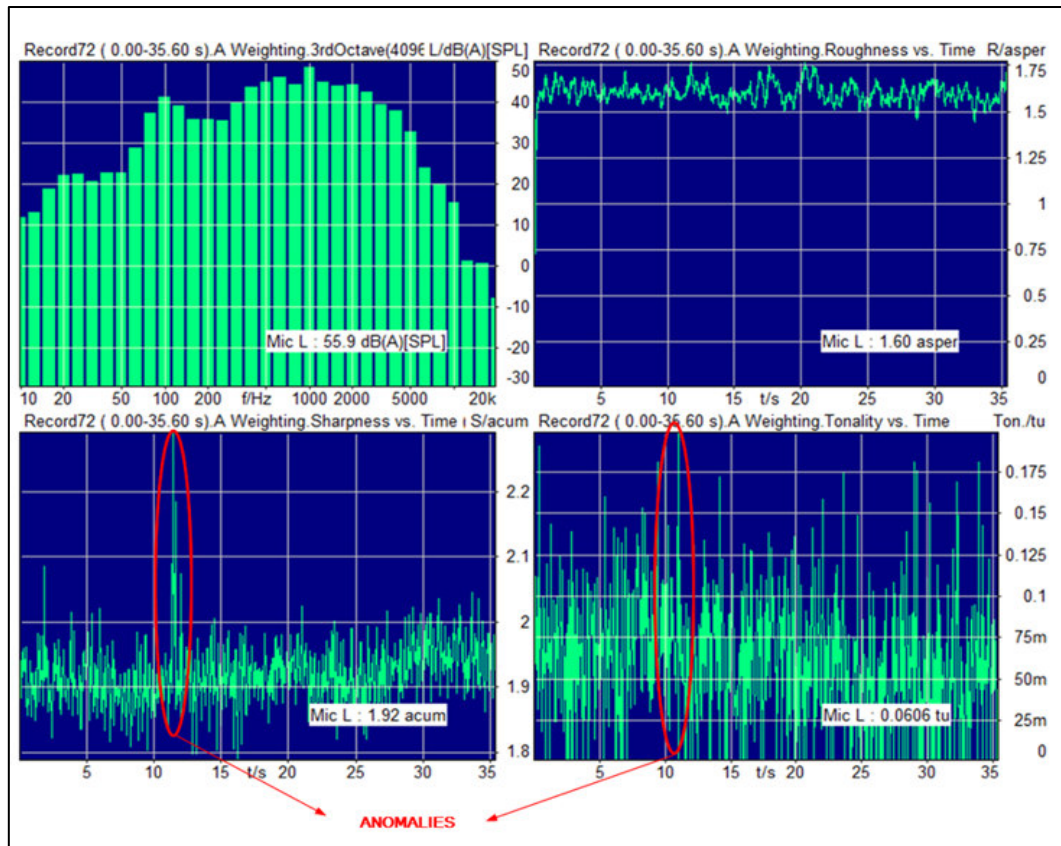


Figure 8: Example of washing machine results (centrifugation phase)

Conclusion

Noise surrounds us all around us, at home, at work, during relaxation or sleep and constantly affects us by its negative influences. In order for a person to be able to withstand all the negative effects of sound, he must know the sound based on common physical parameters such as acoustic intensity level, sound pressure level or sound power level, or also psychoacoustic parameters. From the engineering point of view, it could be said that these parameters could be less "trusted" due to their subjective nature, but their existence was proved experimentally. It is important to emphasize that psychoacoustic parameters play a very important and important role for a person as they directly affect his / her hearing perceptions. [5]

Psychoacoustics as a disciplinary discipline identifies, quantifies and examines the impact of individual psychoacoustic parameters on the overall hearing of a human being, on the chain of its psychoacoustic reactions to the sound stimulus, thereby helping to model the sound design of products to suit the psychoacoustic properties of most target group consumers.

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