

RH LYON CORP

Leader in Quiet Product Design

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NEWSLETTER

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New Developments in Product Sound Quality

Perceptions of pitch and loudness. Predicting how people both perceive and respond to sounds was one of the earliest activities in acoustical science and practice. Correlating those



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perceptions to physical measurements of sound has been the driving force behind much of the development of acoustical instrumentation. The ubiquitous sound level meter (SLM) that is the first purchase of most groups who want to make acoustical measurements has incorporated in it an A-weighted measurement mode that attempts to mimic some important aspects of human perception.

The perceived frequency of a sound, called pitch, is similar to, but not identical to, the physical measurement of the frequency. Nevertheless, as a result of much effort, a correlation has been developed, and one can now predict subjective pitch from physical measurements involving both frequency and amplitude of the sound signal. Similarly, the subjective strength of a sound, called loudness, is not the same as the physical intensity or “level” of the sound; but again, a combination of physical measurements of amplitude and frequency allows us to predict subjective loudness quite well.

Higher order perceptions. The reaction of people to sounds of products has many dimensions other than loudness or pitch, including emotional responses (annoyance or delight) and conveying information. We call these *higher order* perceptions because they are affected by the attitude the listener has about the sound (my own stereo versus my neighbor’s air conditioner), expectation (a car door closure should not rattle), and context (mid-day versus midnight).

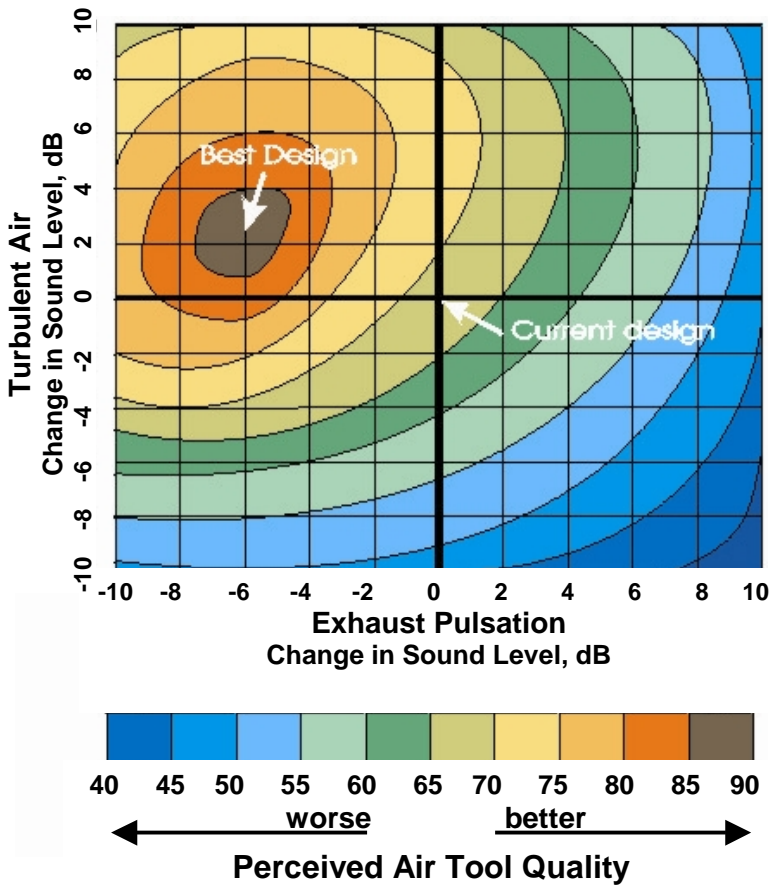
A scale of annoyance and an associated measurement protocol for jet aircraft flyovers was developed in the ‘50’s and ‘60’s to predict how people are annoyed by these aircraft as they land and take off. The procedure worked well as long as it was applied to airport noise problems but did not

work outside of that context, probably because the attitudes, expectation, and context are different in other situations.

Other physical measures of the sound (fluctuation strength, sharpness) are reported to correlate clearly with perception for particular products (automobiles, air conditioners) listened to in particular situations (while driving, while conversing). But the question remains, is there a more general and broadly applicable way to anticipate how acceptable the sound of a product will be?

Sound listening panels (juries) as a design tool for sound quality. In the early ‘70’s, the Singer Sewing Machine company became concerned with how their machines sounded relative to some European machines. Even though the European machines were louder, users seemed to prefer their sound. They asked Dick Lyon, President of RH Lyon Corp, for help. The result was a method that uses listening tests on a series of “virtual products” to determine how to design the product for a better sound.

The procedure developed for Singer has become the standard way that RH Lyon Corp gives guidance to companies for improving the sound quality of their products. It anticipates the changes in component sounds that are possible in design and determines the changes that are possible from the standpoints of both cost and component availability. A range of design options is presented, among which one can choose the best option based on non-acoustical factors. The tool for doing this is called the Qualitor™ diagram. A hypothetical example is shown on the next page.

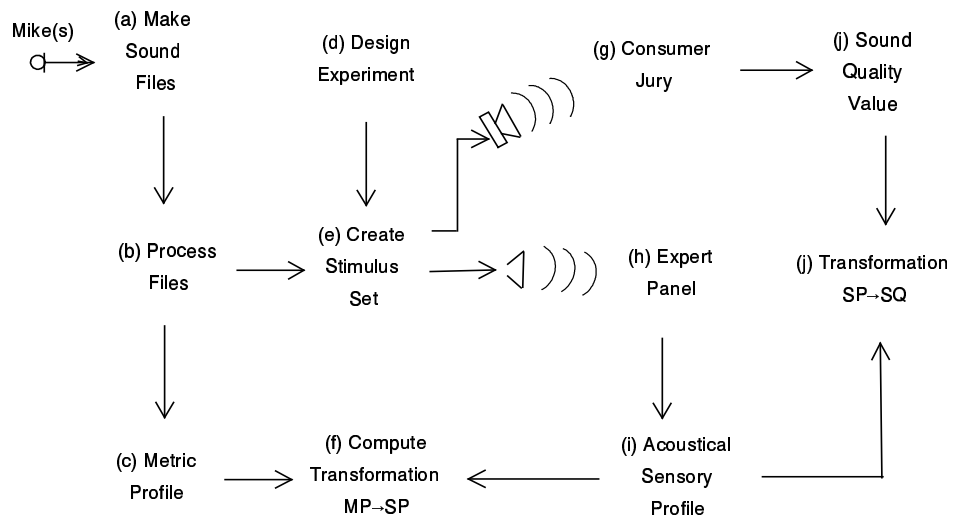


the sound quality had been made without requiring new jury studies.

With support from the National Science Foundation, RH Lyon Corp has carried out research as the basis for a new sound quality evaluation procedure termed SQSys™. This procedure employs “Acoustical Sensory Profiles” (ASP’s), which are basically structured descriptions of the sound that are related to physical measurements of the sound on one hand and with jury listening tests on the other.

Part of our method is borrowed from food, beverage, and perfume industries that use sensory profiles to evaluate product acceptability on the basis of texture, odor, appearance, and taste. The difference is that in acoustics we can also correlate the ASP with physical measurements of product sound. Correlating physical measurements with sensory profiles for foods, beverages, and perfumes has turned out to be very difficult. The various modules that are components of the SQSys™ product are shown below.

New developments in sound quality evaluation and prediction. The Qualitor™ diagramming procedure allows one to say how an existing product design should be modified to produce an improvement in its sound quality. But after a round of changes is made, one might have to repeat the jury listening tests to go the next step in improvement. It would be much better if physical sound measurements could be made on a new prototype to determine directly if an improvement in



The SQSys™ Beta system project. The SQSys™ product is being developed through an industry consortium made up of those participants who are beta system users. Beta system participants have agreed to purchase a final version of the system. As part of that purchase agreement, during the beta period, both training and consultation are provided without additional charge. If interested in this possibility for your company, contact Dick Lyon, 617-864-7260. rhlyon@lyoncorp.com

Active Noise & Vibration Control

The flurry of interest, investment, and activity in active noise and vibration control (ANVC) of a few years ago seems to have abated. Consumers can purchase noise canceling headphones, and a few other products have been announced. But it is clear that the hype promulgated about this technology was overplayed.

ANVC was first conceived of in the '30's; however, it took nearly 50 years before improvements in both instrumentation and electronics made it practical. But ANVC is not a general solution for noise and vibration problems. We think of it as "a target of opportunity." There are many (most) situations in which it is not practical, but there are particular situations where ANVC may be the *only practicable solution* to a noise or vibration problem. The trick is to know which is which.

We intend to illustrate some of these latter cases from our files in these Newsletters. For this issue, we will review a minivan driveline gear noise example. Gear noise was audible inside this popular van at certain speeds. An analysis showed that the frequency corresponded to the gear mesh frequency of the pinion-crown gear mesh in the final drive. It also showed that a

particular resonant mode of the driveline (propeller shaft and rear axle) was set into vibration by the gear mesh forces at a particular speed. This vibration resulted in a whining sound in the interior of the van.

This example gives strong clues about when ANVC can be applied with success. First, the control system needs a strong unambiguous signal that represents the disturbance (in this case, the gear mesh or some equivalent like the propeller shaft speed). The number of degrees of freedom (or independent variables) to be controlled cannot be too large (in this case the number of driveline resonances involved). By placing vibration actuators on the axle and suppressing the resonance, the noise was reduced.

We have some other examples of ANVC appropriately employed. We plan to include several of them in future Newsletters.

RH Lyon Corp News

The Company has been awarded an SBIR (Small Business Innovative Research) Phase II contract by the U.S. Air Force to develop a system for the active control of vibrations in a spacecraft. Disturbances can arise from thrusters and other mechanisms and cause vibrations that limit the performance of optical devices. RH Lyon Corp previously had a Phase I contract with the Air Force to show feasibility. A Phase II contract has the goal of coming up with a prototype design and taking initial steps to commercialization.

Dick Lyon, RH Lyon Corp President, will be receiving two prestigious awards in 2003. In April, he will receive the Gold Medal of the Acoustical Society of America, its highest award. In October, he travels to India where he will receive a Gold Medal from the Indian Acoustical Society.