An Introduction to Sound Quality

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Thirty years ago a Singer Company Vice President asked me why people seemed to prefer the sound of a Bernina sewing machine over that of a Singer machine. That got me started on the subject of sound quality (SQ) because our measurements showed that the Bernina was actually louder than the Singer machine. A combination of noise measurements and listening panels (Figure 1) showed two important aspects of sound quality: certain mechanisms could get louder without making the SQ worse, others had to get quieter for the SQ to improve. In some ways, we have continued to follow the same approach of tying SQ perceptions to mechanism choices in our jury studies since that one 30 years ago.

Jury studies that correlate SQ to design modifications are appealing to a designer since they support the incremental changes that are normally made in the design process. For example, how many pulses should be applied to the piezoelectric lighter of a gas stove to give confidence that the burner will light but not so many that it is annoying? As another example, is the pulse width modulation applied to the drive motor of a washing machine preferable (or at least equally acceptable) to a more conventional PSC motor drive? Or, is a geared shaft drive better or worse than a timing belt drive in a golf car as far as sound is concerned? In each case, the designer may be thoroughly comfortable with the mechanical aspects of these design alternatives, but the 'subjective' (I prefer 'perceptual') aspects of sound may be daunting. Properly designed and carried out, SQ jury studies are an applicable tool to dealing with this issue.

Two concerns about jury studies are their cost and the time they require. Product managers might feel that every time a design is changed (which may be often during development), they have to undertake a new jury study to see if an improvement in SQ has been achieved. Also, the turnaround time for a jury study may be several weeks. Naturally one asks, "Why can't we just have a SQ button on the sound level meter?" Many SLMs now have a Loudness output, why not 'acceptability,' 'perceived reliability,' or 'annoyance'? Isn't that what "SQ metrics" are all about?

The article in this issue discusses the development and applications of SQ metrics and I will not go into that subject here, except to note that they are actually algorithms for measuring certain physical aspects of a sound signal, and their ability to anticipate perceptual aspects of SQ is not well established (except for loudness).

My concern about jury studies is a little different. These studies tell us how to make incremental changes in the product as we manipulate component choices. But they do not give us a more global view of how we might benefit from substantially different designs. About three years ago, RH Lyon Corp (RHLC) began research supported by the National Science Foundation (NSF) on a new approach to product SQ that is based on the concept of "acoustical sensory profiles" (ASPs), an idea borrowed from the field of sensory testing as used in the food, beverage and personal care industries. The ASP describes a product under test that on one hand can be related to the perception of SQ. On the other hand, it can also be related to physical measures of the sound.

We call the system that embodies this approach SQSys™. It consists of a group of software modules combined functionally to perform various tasks. A block diagram for this system is shown in Figure 2. One function includes creating sound files and processing them according to various algorithms or metrics. Another function uses the sound files for presentation to an expert listening panel to develop ASPs, or alternatively, to a consumer jury for SQ evaluation using a module that creates an experimental design appropriate to each.

Finally, the functional relations between the metrics (a metrics profile or MP), the ASPs and the SQ judgment values are estimated and are used to predict SQ values. Changes in SQ can then be anticipated (predicted is probably too strong) from either a new set of measurements (the MP) or a new ASP as changes are made to a prototype, obviating the need for a new SQ jury as each change is made. The system can also be used to determine these vectors (MP, ASP and SQ) and their relations for marketed products in competitive analysis.

The research supported by the NSF has developed the modules shown in Figure 2 and we are now in the process of developing SQSys™ as a product. Partnering arrangements are being implemented to bring the system forward as a marketable product in a two-step process as indicated in the chart. The first step is the placement of prototype (beta) systems in the design and product management groups of product companies. These partnering companies will work with RH Lyon Corp to gain experience in using SQSys™ and evaluating any modifications in its design. The second phase involves providing a final product to each partnering company.

Figure 1. Whimsical illustration of a listening jury.

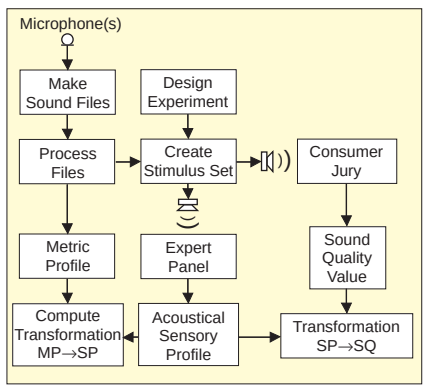

Figure 2. SQSys™ module layout and connections.

SQSys™ Beta System Lineup Supplied by RHLC: processor and display; A/D and D/A with filtering (2 channel); listening panel response keypads w/interface; SQSys™ software; training and review; and license for SQSys™ product (2nd phase).

Supplied by user or by RHLC: microphones and/or binaural head with preamplifiers; loudspeakers (2) and/or headphones (8) w/distribution box; and power amplifier (2 channel).

If you are interested in participating in this project, please contact: rhlyon@rhlyoncorp.com.