Room
Adaptive
Bass
Optimization
System

R. A. B. O. S.™

Infinity

Matching the Loudspeaker to the Room – "Room Friendly" Loudspeakers and the Room Adaptive Bass Optimization System

(R.A.B.O.S.)

By Floyd E. Toole

Introduction

One of the many complicating factors in the world of audio, for both consumer and manufacturer, is that the listening room has such a powerful influence on what is heard. For the consumer, it means that opinions formed about a loudspeaker in one room may not translate to another. For manufacturers, it means that the performance of their loudspeakers will be significantly changed, for better or for worse, by the choice of listening room.

The Loudspeaker/Room System – Low Frequencies

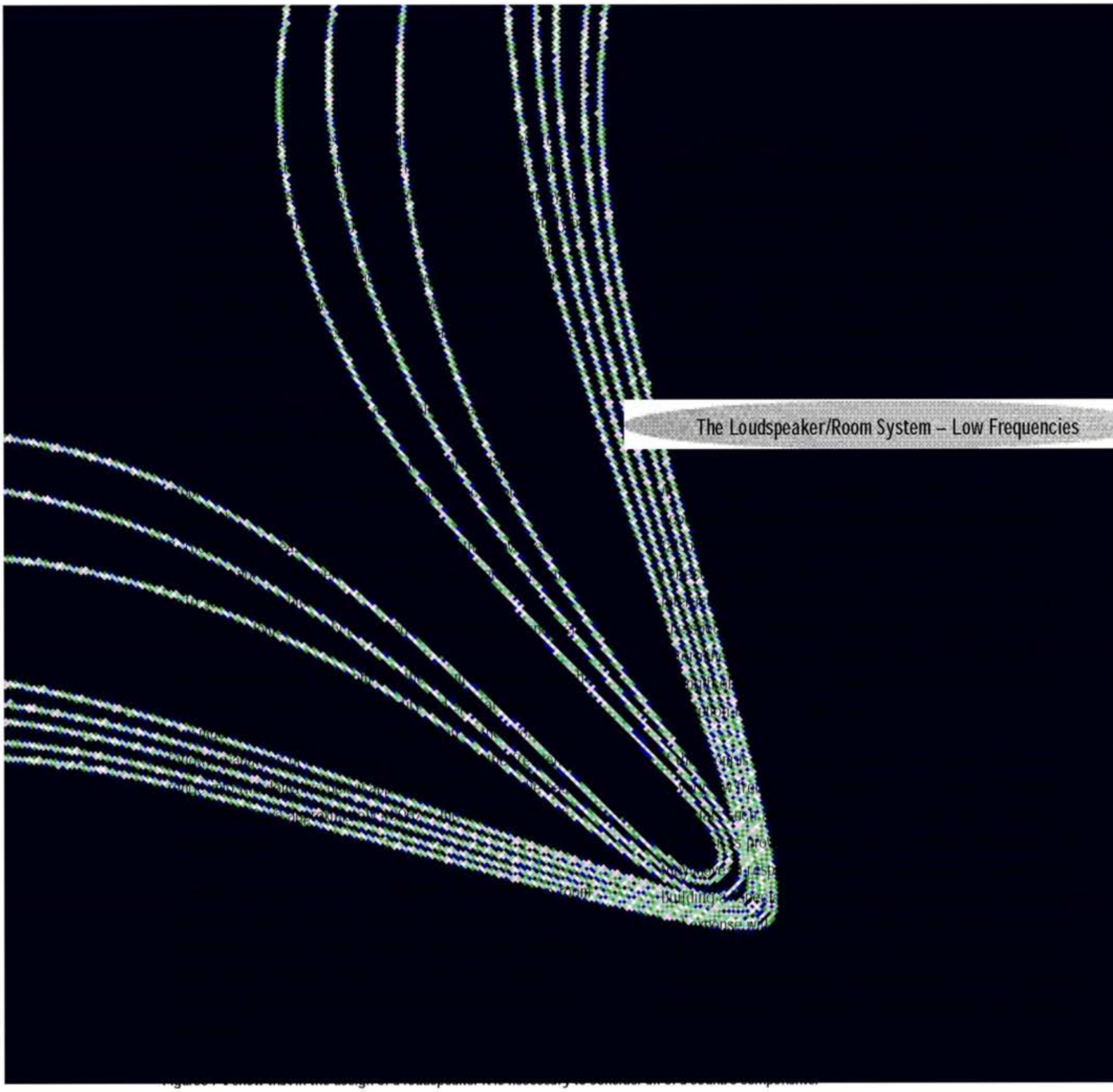


Figure 1. The direct sounds, the first sound from the loudspeakers to reach the listener. Usually described by the on-axis frequency response of the loudspeaker.

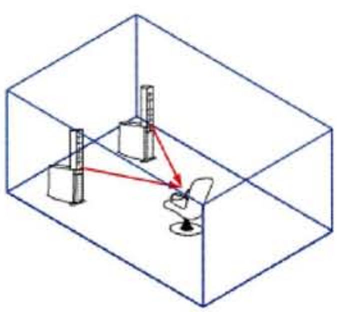


Figure 2. The early-reflected sounds, which reach the listener after a single reflection from the room boundaries – the floor, walls and ceiling. These are described by measurements made at many, sometimes large, angles off axis.

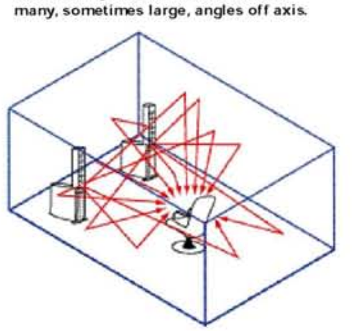
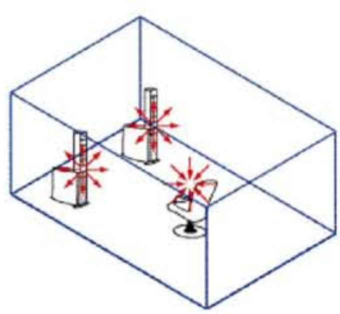


Figure 3. The reverberant sounds: all of the sounds that arrive at the ears after multiple reflections. The technical measurement of sound power is the best correlate of this component of room sound.



have a tendency to be "boomy." The exact nature of the problem, and its severity, will be determined by how effectively the woofers couple their energy to the room resonances – i.e., the locations of the woofers in the room – and how effectively the resonant energy is coupled to the listener's ears – i.e., the location of the listener in the room.

In the real world, within the constraints of good stereo or multichannel imaging and the demands of appearance, there are severe limitations on where we can put loudspeakers and listeners in a room. Not many of us are willing or able to have a custom room designed exclusively for our audio pleasure. So what do we do if we find we have a problem? We equalize!

R.A.B.O.S. – A Better Equalization

We call our form of equalization, R.A.B.O.S. – Room Adaptive Bass Optimization System. The difference between this equalization and the kinds that have given equalization a bad name is that here we are not going to allow it to venture into areas that are likely to give us more trouble. R.A.B.O.S. consists of a single parametric filter built into the electronics of the powered subwoofers. As such, it is restricted to addressing only those problems within the range of the subwoofer – up to about 100Hz. It is designed as an attenuation-only filter, so it cannot be used to attempt to fill frequency response dips caused by acoustic cancellations, usually a futile task, resulting only in dynamic limitations and distortion. It is parametric, so that with care it can be tuned to the specific frequency of the most serious problem and adjusted to match the bandwidth of the resonance. Figures 4 and 5 are an example of the improvement R.A.B.O.S. offers.

In most rooms, the quality of bass that we hear is determined more by the room than by the loudspeaker itself!

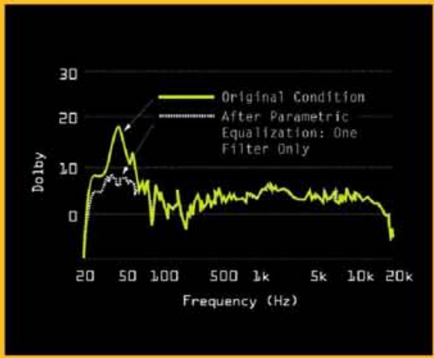


Figure 4. Measurements in a room before and after a single band of parametric equalization was used to attenuate an extremely powerful room resonance. The improvement in sound quality was nothing less than dramatic, with the bass being transformed from boomy, fat and flabby to clean, tight and articulate.

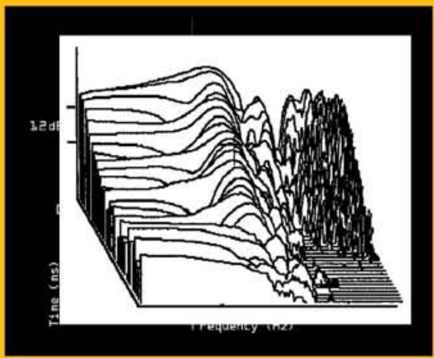
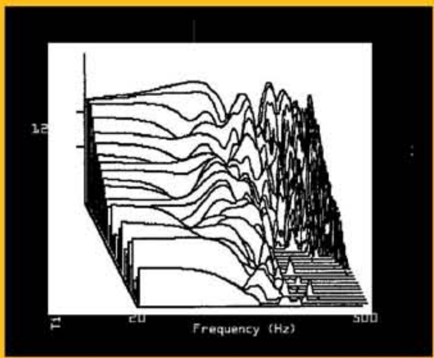


Figure 5. Waterfall diagrams for the before (shown above) and after (shown below) conditions, with the resonance indicated by the arrows. The attenuated "ringing" is obvious in the diagram above, confirming that the time-domain problem is also corrected.



Figures 6 and 7 present another example; this time we isolate the subwoofer in the measurements.

Note that in both of these examples and in any other *proper* application of room equalization at low frequencies, the improvement exists in both the frequency and time domains. The audio folklore, that equalization is inherently "bad" because it "adds phase shift," is based on old-fashioned ideas. Equalizers that change the frequency response do, indeed, add phase shift. What is not always realized is that the resonances being corrected by the equalization *also* have phase shift. Measurements must be done in such a way that offending resonances can be isolated visually, and the parametric filter of the equalizer can be adjusted to match the shape of the resonances. When this is done and the equalizer is then adjusted to flatten the frequency response, the phase aberration is also compensated for. The end result is that errors in the transient response are also corrected. For those with a scientific bent, this is all explained by the Fourier transform, which defines the relationships between what happens in the time domain and what we observe in the frequency domain, i.e., between transient performance and frequency response. However, the final proof is in what the measurements tell us and in what we hear – it works!

The audible improvement in each of these cases was not insignificant yet the remedy – equalization – was simple and straightforward. There are two real-world alternative solutions that can address these problems. The first involves a major acoustical treatment,dramatically changing the appearance of the room and significantly impacting on the bank account. The second involves a major rearrangement of the loudspeaker and/or listener positions – again with significant visual and, possibly, practical consequences. We think that equalization is clearly preferable to either.

Infinity loudspeakers are designed to be listened to *in rooms.*

A reasonable question at this point is whether one parametric filter is enough. In our experience with subwoofers, the majority of installations can benefit from equalization, and the majority of those would achieve most of the potential benefit from a single filter. There are situations where adding more filters could result in a refinement in performance but doing so would require many more measurements, as well as an in-depth technical understanding of filters. This implementation of R.A.B.O.S. aims to deliver the maximum performance enhancement to the customer, with a minimum of installation difficulty.

Another reasonable question is if equalization is not recommended, what then *can* be done about major dips in the frequency response? Usually, these result from the specific locations of the listener and/or loudspeakers; dips are *very* position dependent. Before venturing into the equalization exercise, we therefore suggest that, guided by measurements, users explore the effects of various small positional changes to see what improvements can be made. Movements of just a few inches often can make huge differences in system performance. All of these helpful hints, and more, will be included in the instruction manuals.

Figure 6. Frequency response measurements of a subwoofer, before and after a single band of parametric equalization.

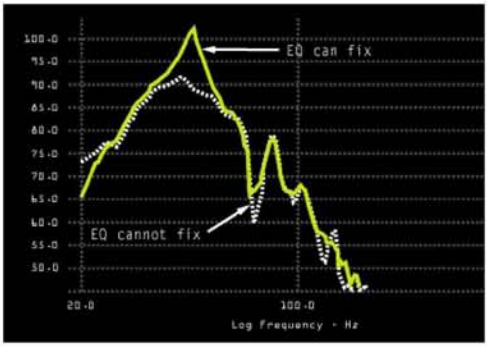
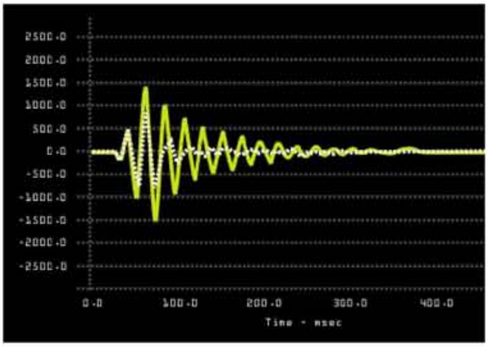
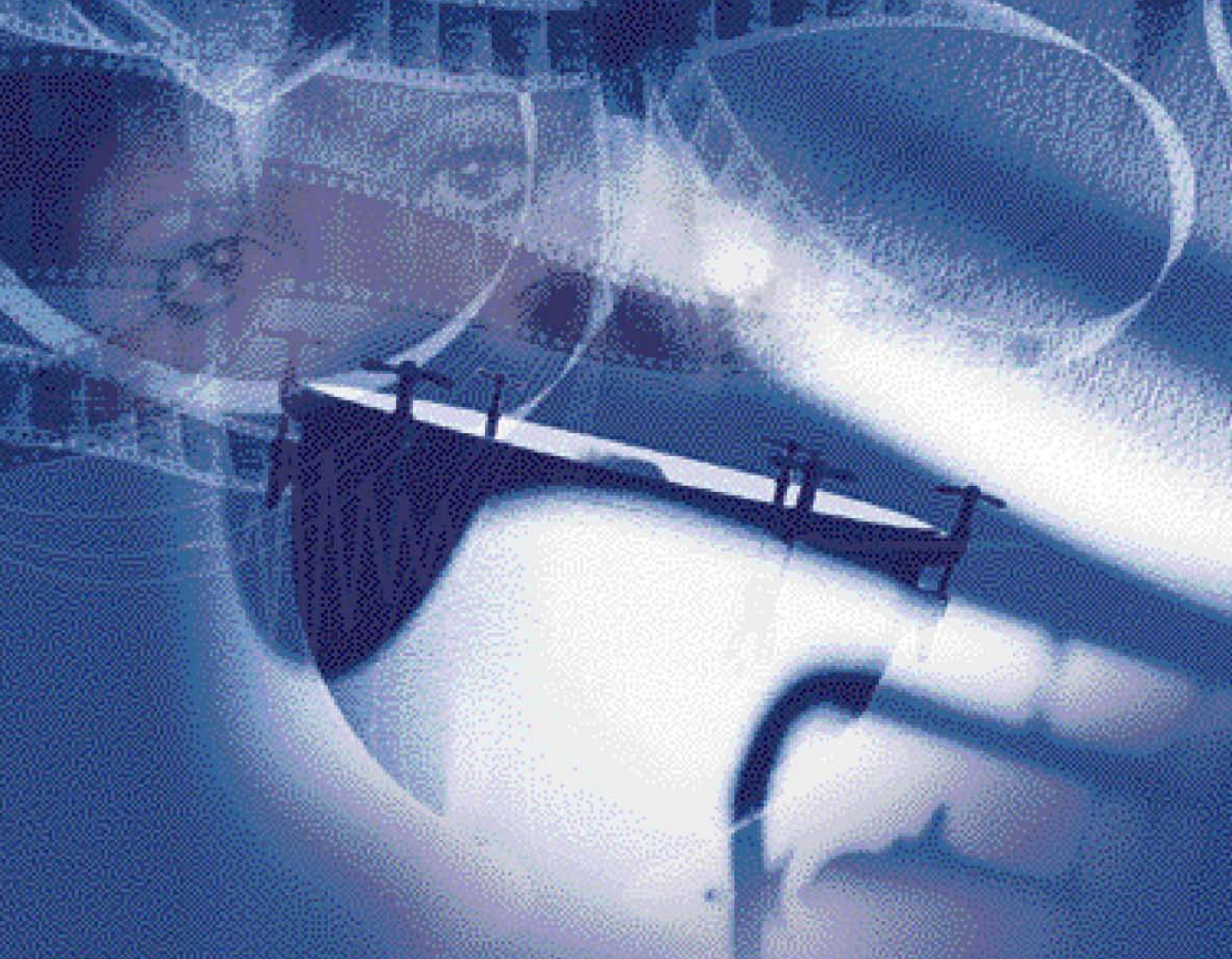


Figure 7. Time-domain behavior (transient response) of the subwoofer, before and after EQ. The energetic ringing (light line) is the "before" condition. The well-damped ringing (dark line) is after equalization.





"Room Friendly" loudspeaker system designs ensure that, regardless of the room, listeners will be treated to the best possible sound quality and spatial imaging. R.A.B.O.S. is the icing on the cake, ensuring that an otherwise elegant listening experience will not be corrupted by a drone of monotonal, "Johnny-one-note" bass, and fat, flabby drums. Our job is not done until the listener hears the right sound.

Infinity

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