Audio Perspectives from an Audio & Video Consultant

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Bio

- Degreed Engineer
- ISF Certified
- THX Level II Certified
- Calibrate about 300 home theater systems annually including video and audio

Topics

- The big problems I see in the field
- Stereo vs. multi-channel sound
- Are any of these room measurements any good?
- The room effect
- Room treatments
- Electronics
- Speakers
- How I would get great sound reproduction

The Big Problems

- The most common problems I see that cause poor sound reproduction are…
  - Poor speaker/listener placement
  - Poor setup of electronics
  - Poor equipment
  - The room
  - Listening at the wrong sound levels

Speaker/Listener Location

- High frequencies are fairly directional
- Walls and other objects can cause resonant behavior.
- Speakers placed too close to seating positions cause large changes with small shifts in position.
- Large distances create problems with distortion from driving speakers harder.

Poor Setup Of Electronics

- Multi-Channel
  - Subwoofer level set TOO HIGH
  - Subwoofer crossovers set poorly causing bass anomalies
  - Subwoofer settings are set poorly
  - Using PCM instead of bit stream for sources
  - Using large instead of small speaker size for bass management
  - Re-equalization exaggerating high frequency deficiencies
  - Poor use of equalization or tone controls
  - Speaker levels set wrong
  - Speaker delays set wrong
  - Ground loops
  - Gain mismatch causing audible noise and distortion

Poor Setup Of Electronics (Cont.)

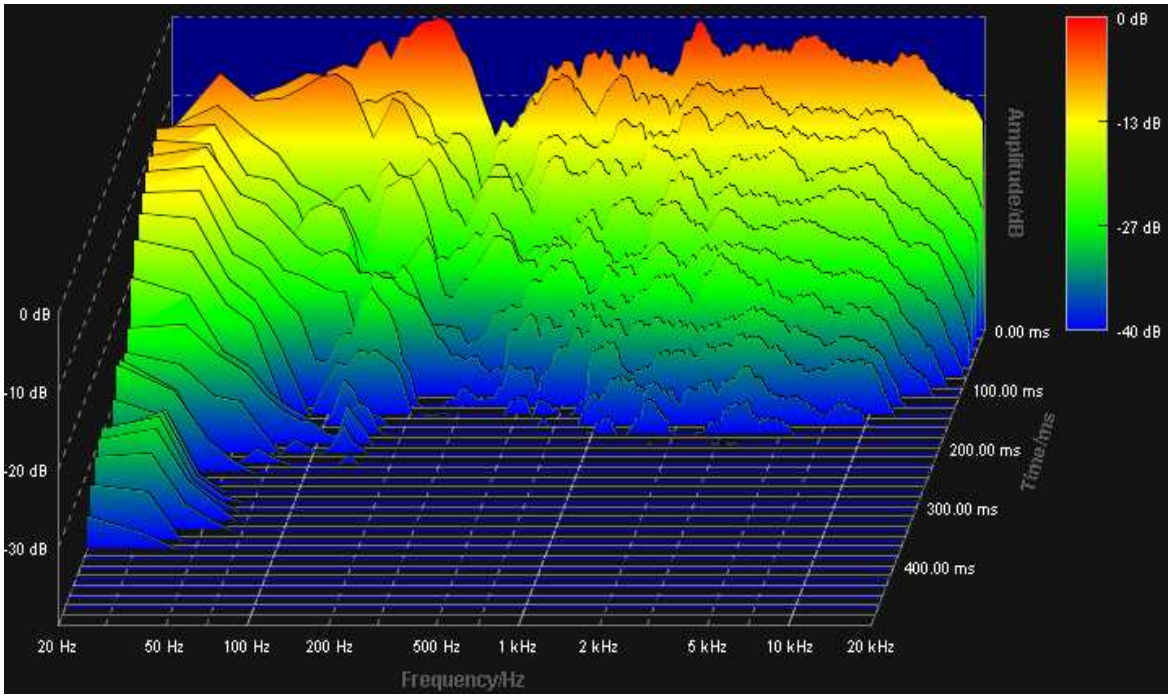
- Stereo
  - Poor subwoofer setup
  - Poor bass management
  - Poor use of tone controls and equalization
  - Ground loops
  - Gain mismatch causing audible noise or distortion

Poor Equipment

- Speakers
  - Distort at high sound levels
  - Poor frequency response
- Electronics
  - Do not function as expected
  - Distort at high sound levels
  - Not flexible enough to fix major sound problems
  - Automatic calibration made things worse

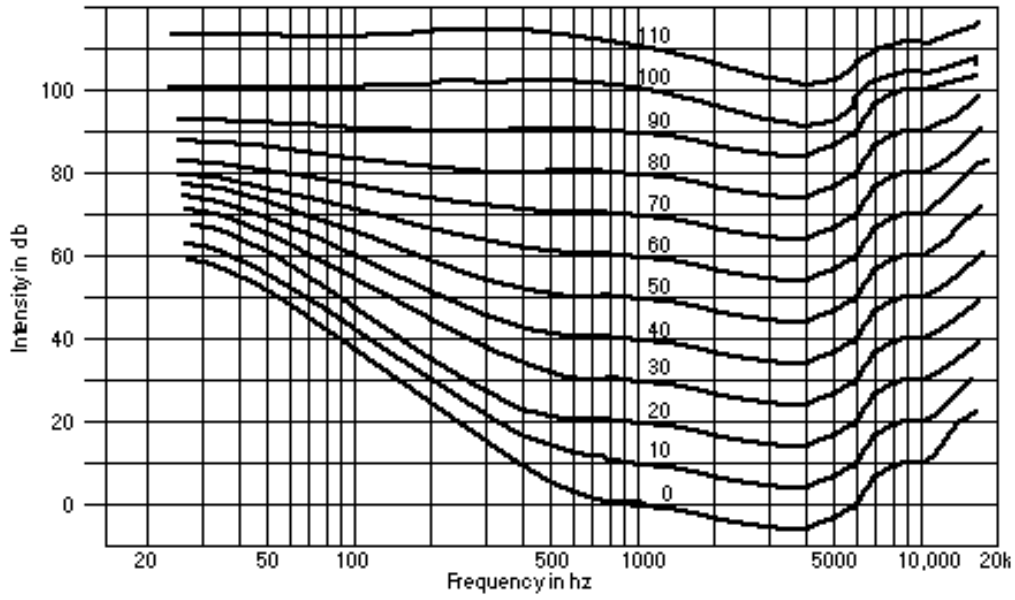
Problems With The Room

- Too resonant
- Too dead (very rare)
- Too big
- Too reflective



Problems from listening at the wrong sound level

- Listening at too low of sound level reduces low frequencies
- Listening at too high of sound levels causes excessive distortion



Stereo vs. Multi-Channel Sound

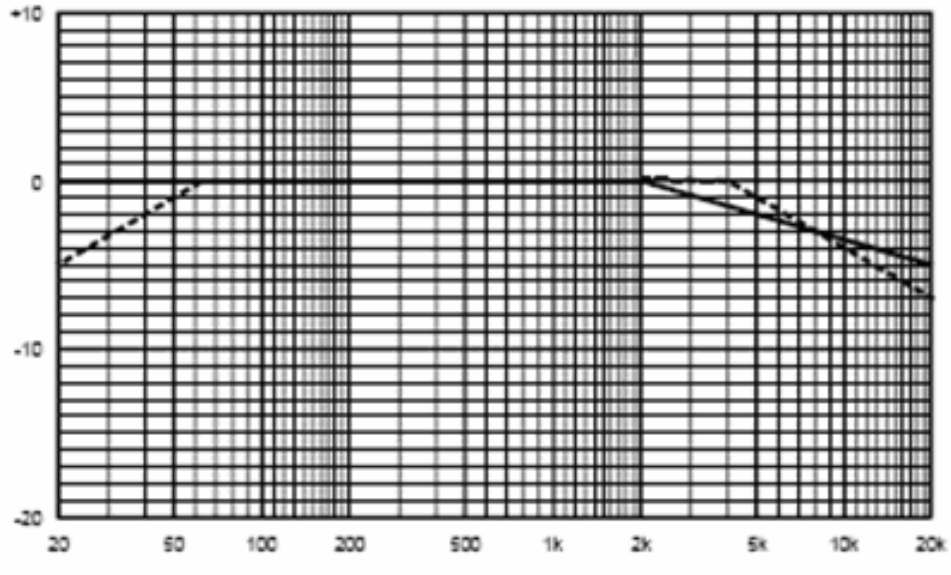
	Stereo	**Multi-Channel**
Setup Complexity	Low	High
Subwoofer	Optional	Required
Ambience	Room is a major component	Built into recording

Are any of these room measurements any good?

- Measurements are useful, but do not replace the human ear.
- Without good measurements it is more difficult to identify and fix performance problems.
- You need to have the proper goal to get good results.

What is the Goal?

- Frequency Response
  - Flat 20 Hz to 20 kHz
  - House Curve
  - ANSI/SMPTE 222M (SMPTE-X Curve)
- Room Resonance
  - RT60 (time to 60 db drop in sound is 200 to 500 ms over a wide frequency range)



Characteristics Of A Useful Audio Test

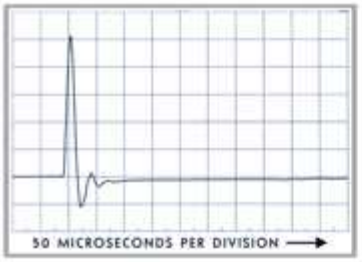
- Test measures as much of system performance as possible
  - CD or DVD source for test signals
- Accurate test signal
- Accurate measurement system
- Accurate analytical tools
- Changes based on test improve sound performance

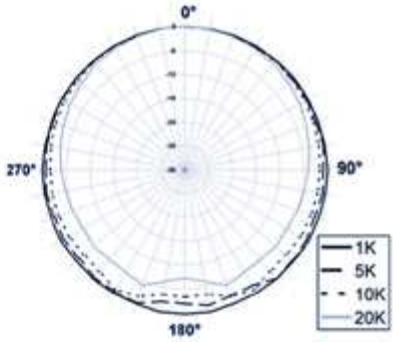
Common Test Signals

- Pink Noise
  - Useful for RTA, impulse response and waterfall charts
  - Not the best test signal for low frequencies
  - Susceptible to background noise
- Sinusoid Sweeps (Chirp)
  - Useful for RTA, impulse response and waterfall charts
  - Not the best for high frequencies
  - Susceptible to background noise
- PRBS/MLS (Pseudo Random Binary Sequence/ Maximum Length Sequence)
  - Useful for RTA, impulse response and waterfall charts
  - Not the best test signal for low frequencies
  - Structure makes it much less susceptible to background noise than pink noise when used with software that is designed to work with this type of test signal
  - Sounds like pink noise

What Factors Constitute A Good Microphone?

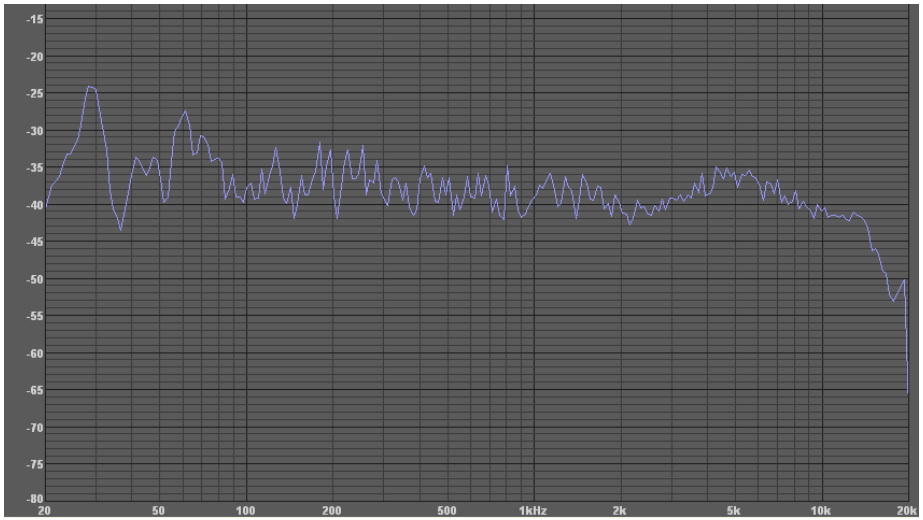
- Omni directional – small capsule
- Flat frequency response
- Fast response to support room resonance measurements
- Performance confirmed against standard





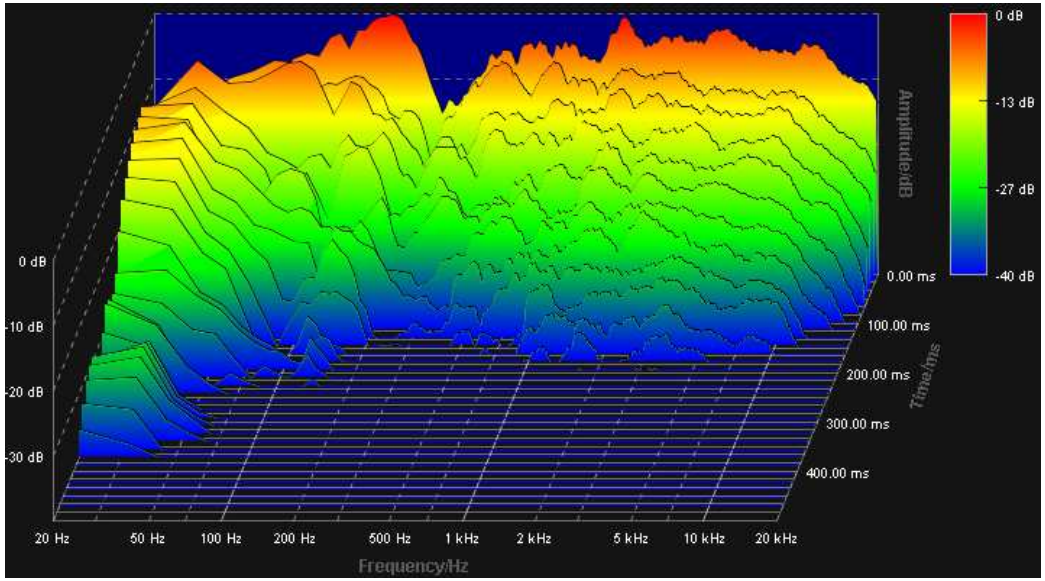
RTA – Real Time Analysis

- Useful for examining frequency response
- Does not separate direct sound from indirect sound
- Does not match human ear response characteristic
- Susceptible to problems with background room noise
- Analysis time effects frequency response



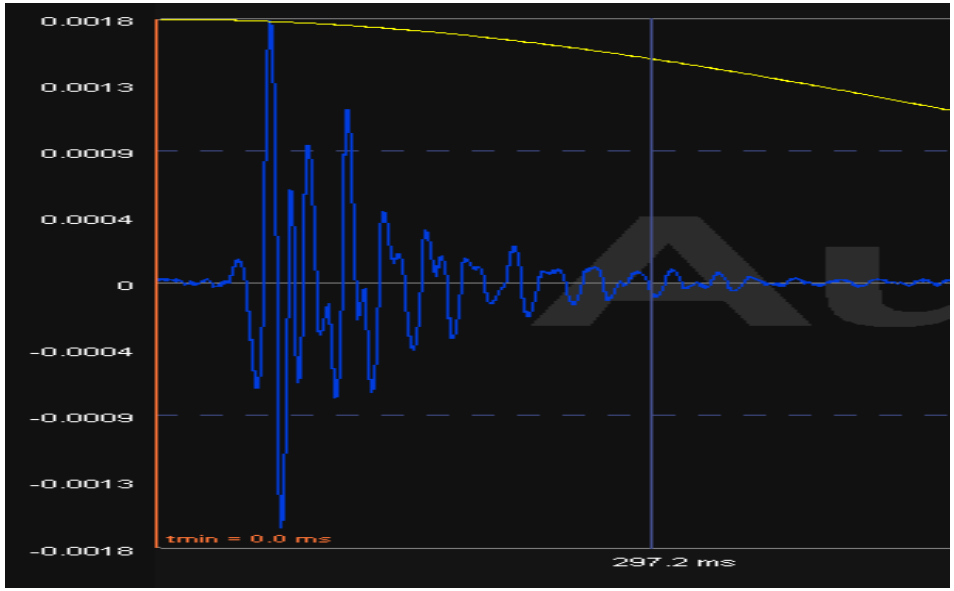
Waterfall Charts

- Useful for examining frequency response
- Does separate direct sound from indirect sound
- Measures room effect on system frequency performance
- Does not match human ear response characteristic
- Susceptible to problems with background room noise



Impulse Response

- Visualizes effect of room resonance in time domain
- Susceptible to problems with background room noise
- Does not match human ear response characteristic
- Analysis time effects shape of response

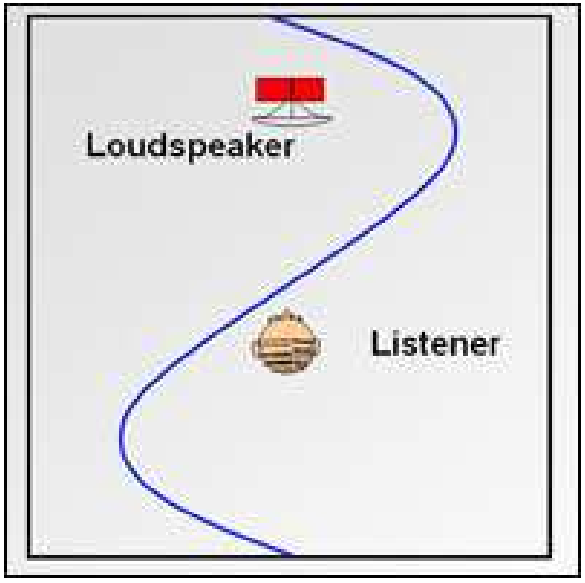


The Final Instrument

- All of the instruments and analytical tools are not the human ear.
- The final arbiter of quality sound should be a human ear.
- The benefit of the previous tools are that they can help eliminate gross problems and allow you and your ear to focus on the more subtle ones.
- A major challenge is that most people are ignorant about what a given recording should sound like.
- Many people also have significant hearing loss that compromises the process.

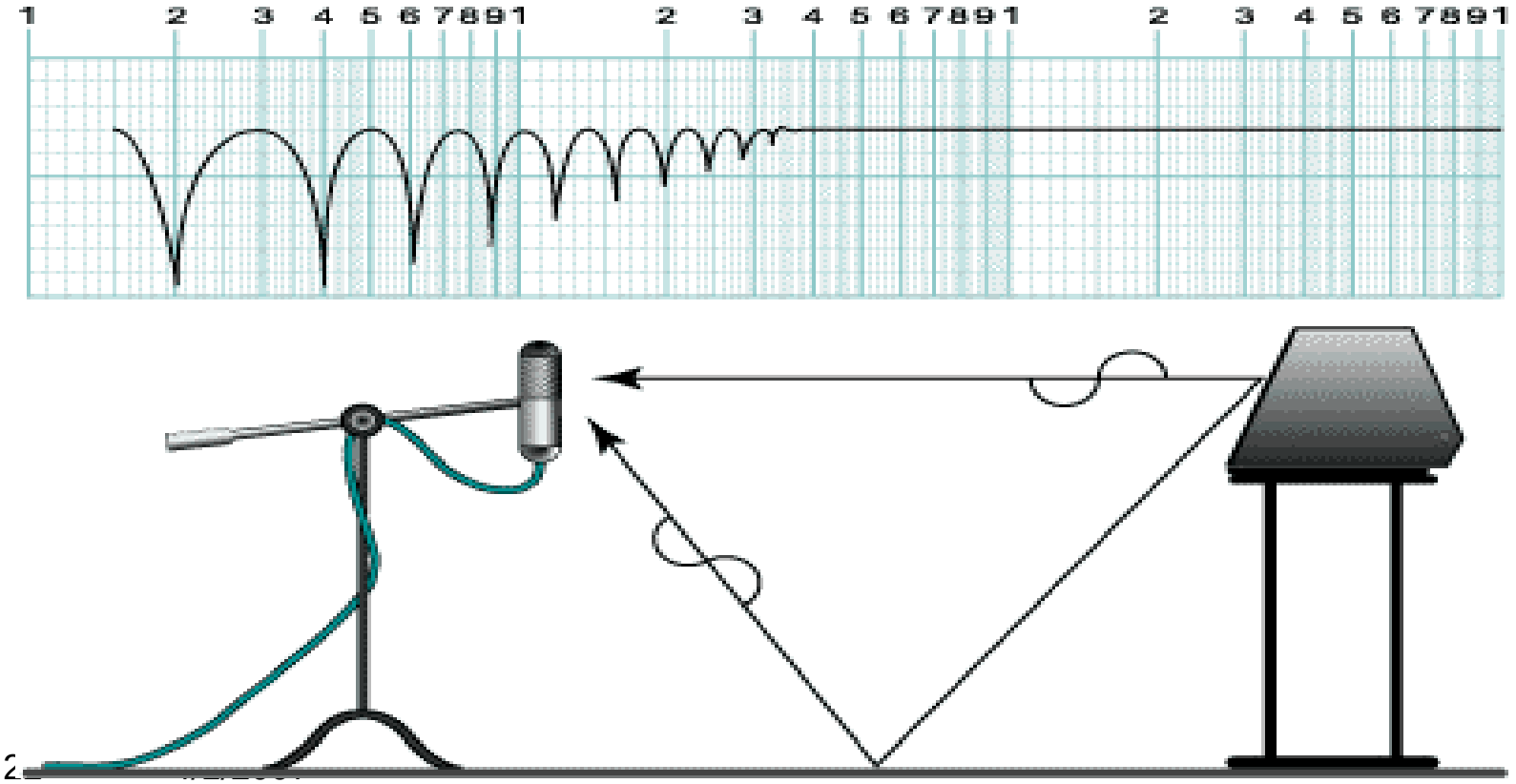
The Room Effect

- A room will reflect sound.
- A room will resonate based on its volume and shape.
- Objects and surfaces in the room will absorb and/or diffuse the sound waves.
- The room can be a major component of the sound of any system.



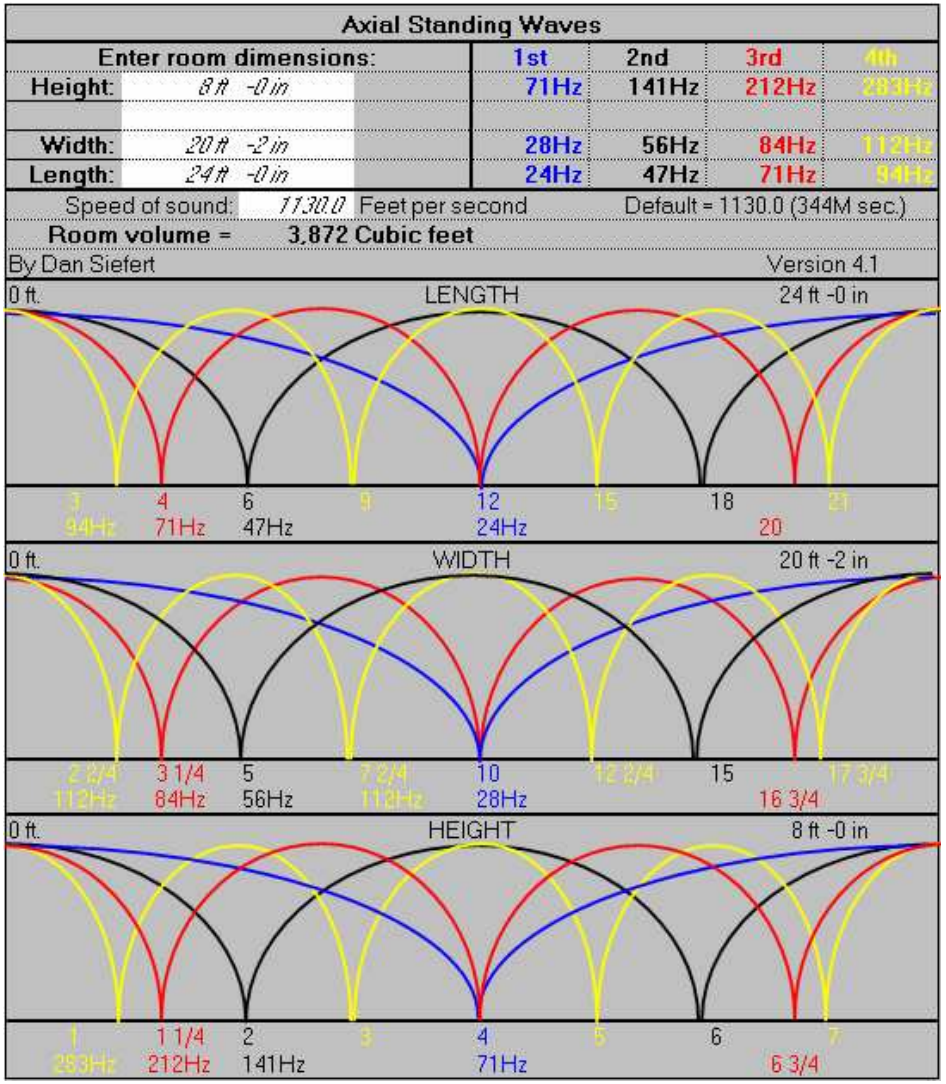
Comb Filtering

- Early room reflections overlap with direct sound to make frequency anomalies.



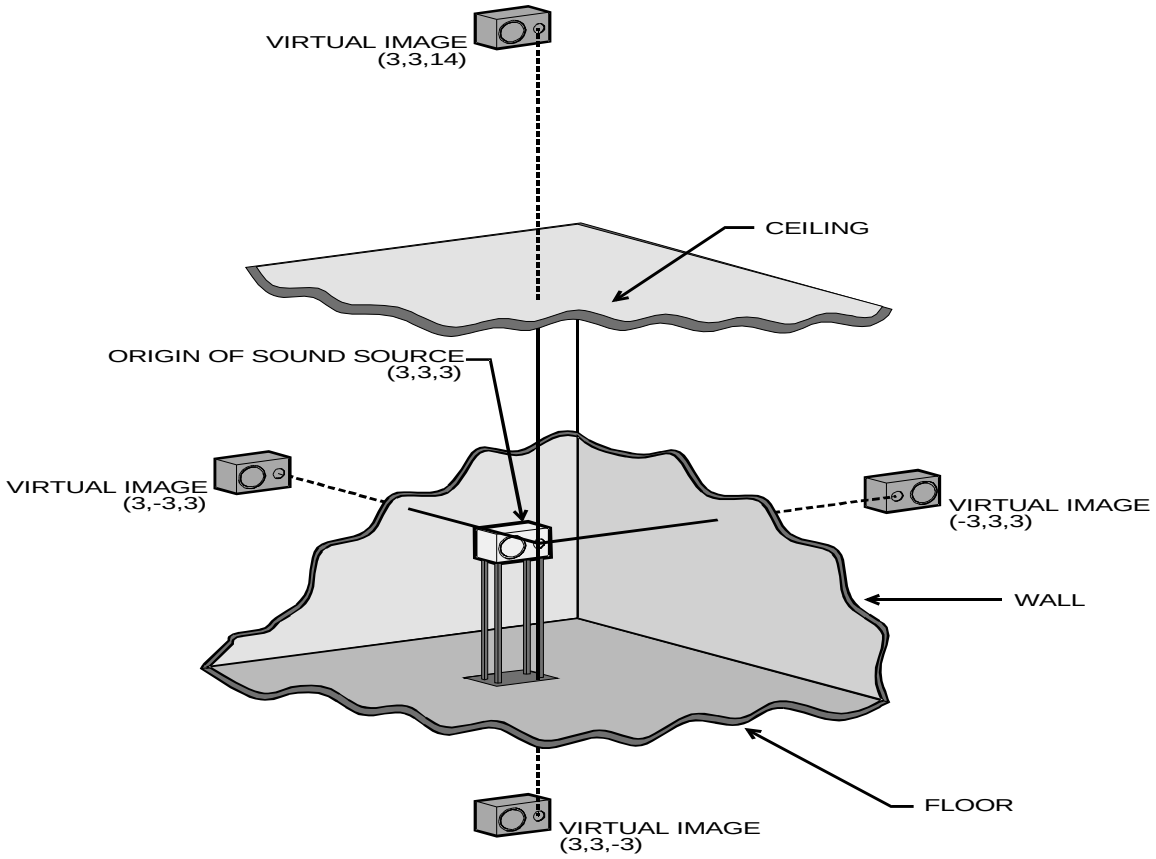
Room Modal Coupling

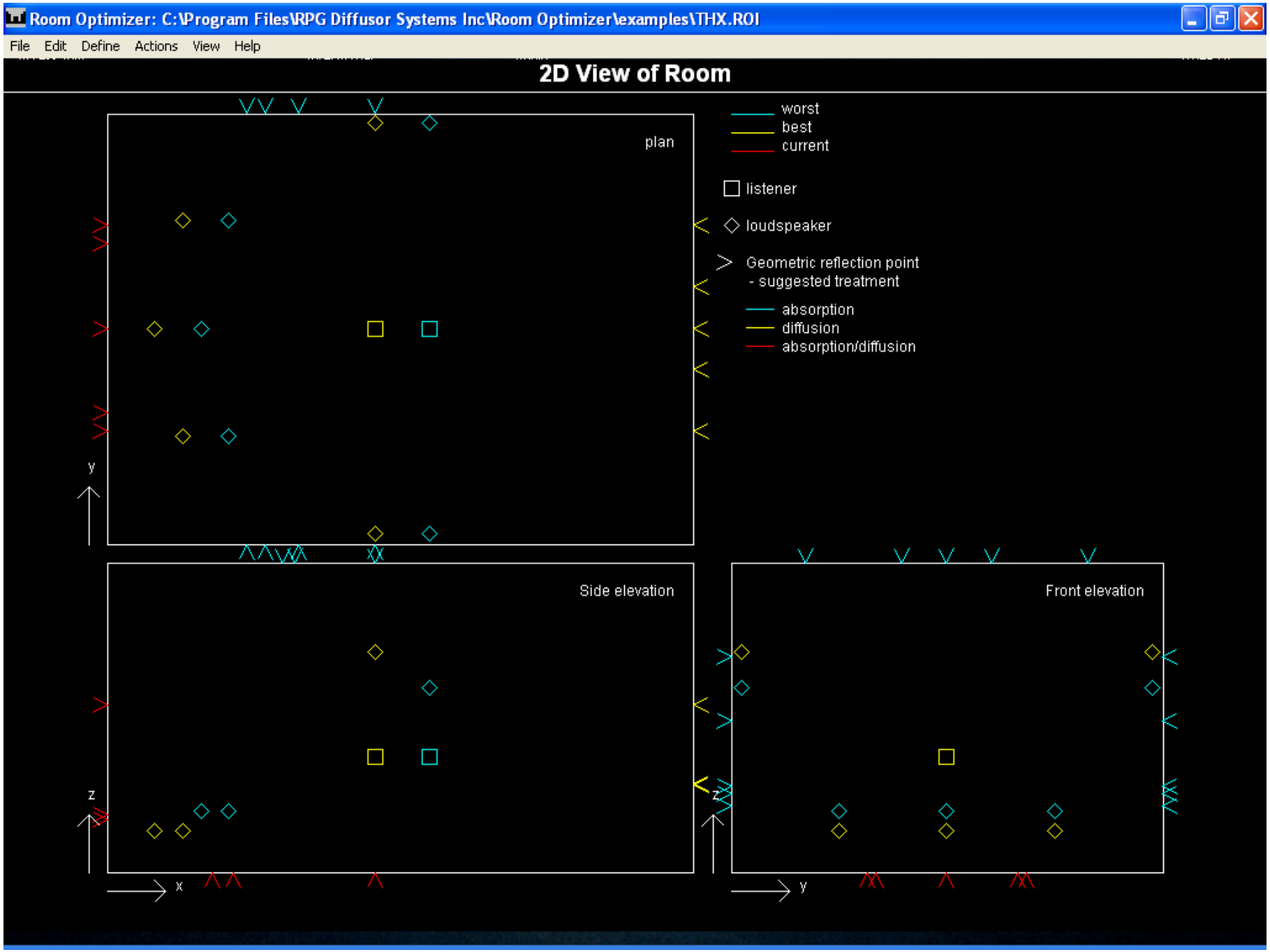
- Sound waves in rooms will resonate like a tuning fork because of sound bouncing between the walls.
- Two subwoofers are a great way to reduce room mode problems with low frequencies.



Speaker Boundary Interference

- Early reflections from surrounding surfaces cause frequency anomalies from comb filtering effects.




Room Optimizer: C:\Program Files\RPG Diffusor Systems Inc\Room Optimizer\examples\THX.ROI
File Edit Define Actions View Help
2D View of Room
plan
worst
best
current
listener
loudspeaker
Geometric reflection point
- suggested treatment
absorption
diffusion
absorption/diffusion
y
Side elevation
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Front elevation
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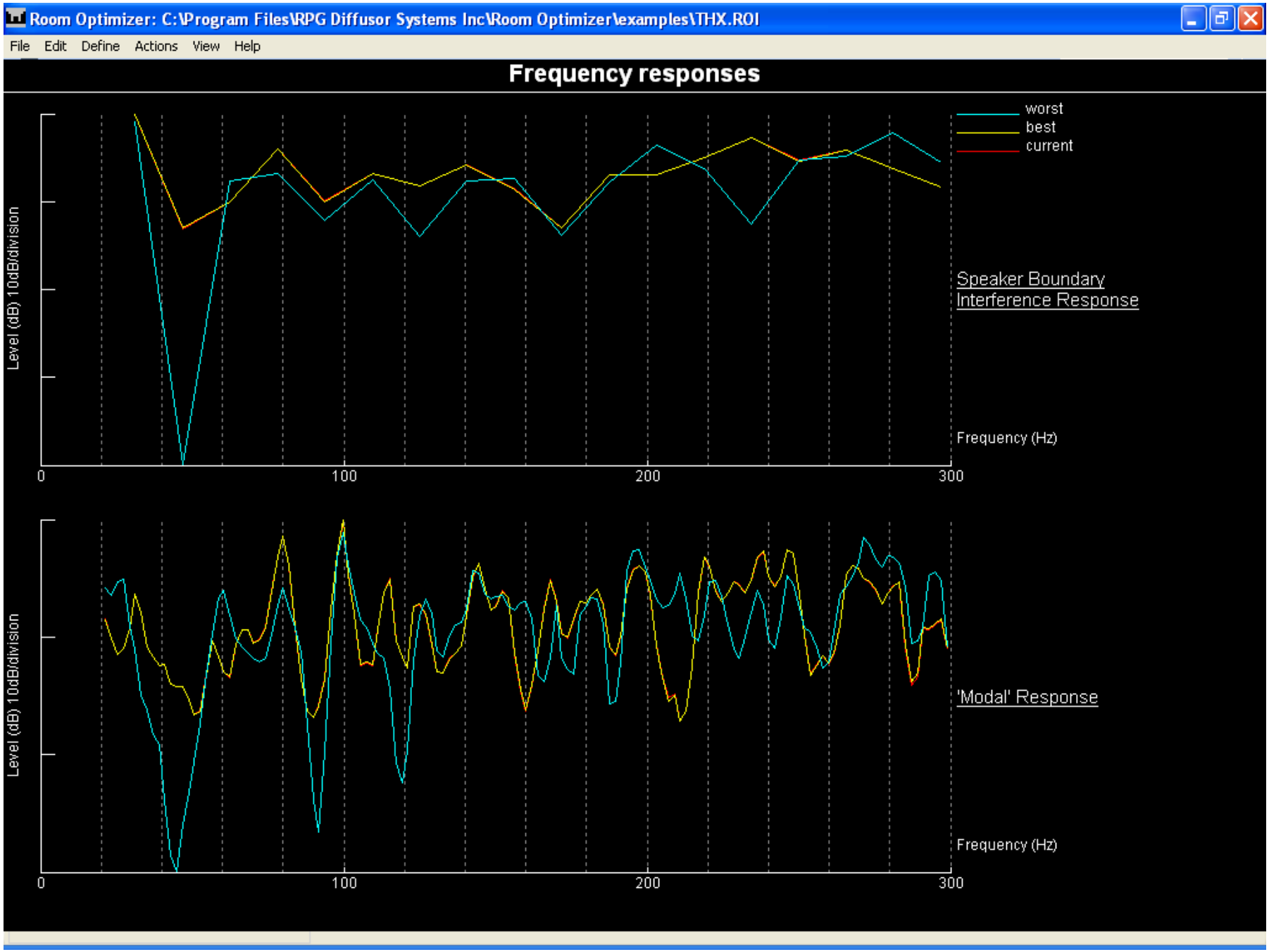
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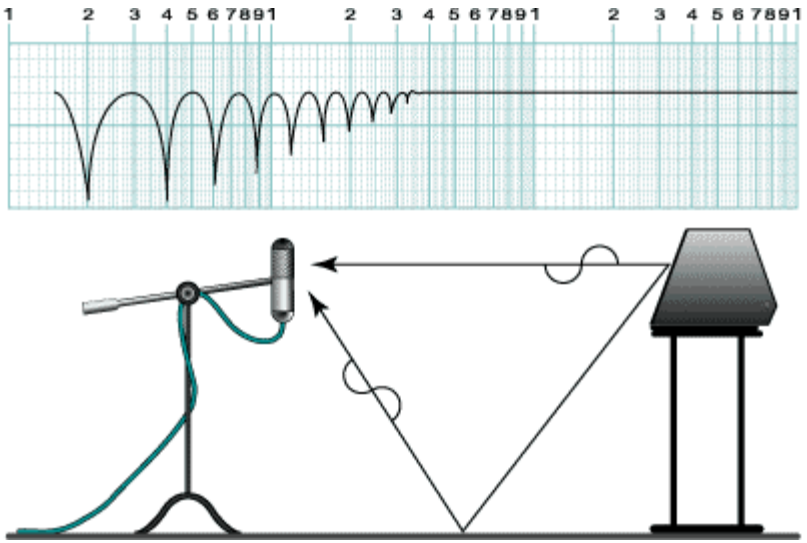
File Edit Define Actions View Help
Frequency responses
worst
best
current
Level (dB) 10dB/division
Speaker Boundary
Interference Response
Frequency (Hz)
0
100
200
300
Level (dB) 10dB/division
'Modal' Response
Frequency (Hz)
0
100
200
300

Room Treatments

- Improve room resonance.
- Minimize comb filtering problems.
- Reduce room mode problems.

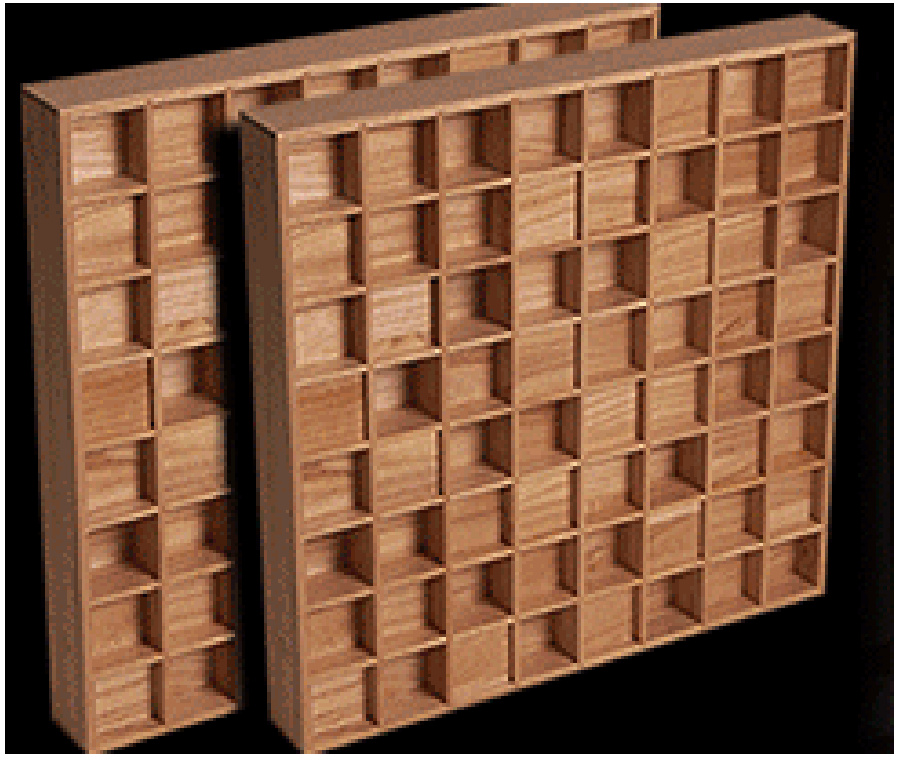


Room Treatments

- Sound Absorption
  - These products attenuate reflected sound energy, reducing noise, echoes, loudness, excessive reverberation and muddied sound.
  - The thickness of the product will determines the minimum frequency it will absorb
  - Curtains, soft furniture, rugs and carpet will also fill this role.

Room Treatments

- Sound Diffuser
  - These products distribute and balance sound energy uniformly and predictably, improving speech intelligibility as well as clarity, imaging and tonal separation for music and performances, while reducing strong interfering reflections in any one direction.



Room Treatments

- Helmholtz Resonator
  - These products resonate at a narrow bandwidth to target specific single frequency anomalies

Electronics

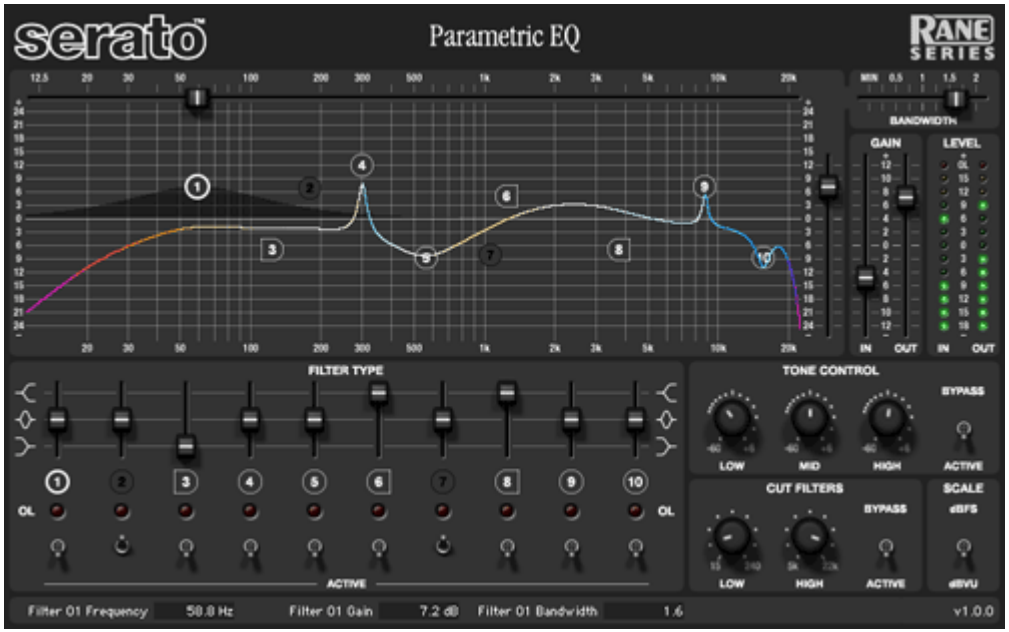
- Amplifiers
  - Need to deliver sufficient current with low distortion and flat frequency response.
  - Many products today meet this requirement as long as the speaker's needs are moderate.
  - Low impedance speakers can be a major challenge.
  - Low efficiency speakers can be a major challenge.

Electronics

- Processors/Preamplifiers
  - Need to deliver low distortion and flat frequency response.
  - The ability to compensate for sound performance problems is desired.
    - Parametric Equalization
    - Variable crossover frequency
    - Subwoofer limiter
  - Many products today meet the first requirement.

Electronics

- External Equalizers
  - Many quality products are available.
  - External equalization of subwoofers can be very useful.
  - Equalization of all speakers is frequently useful.
  - External equalizers are generally less desirable than those built into current processors that operate in the digital domain.



Speakers

- Efficiency
  - Efficient speakers reduce the amplification requirement
- Dynamic Range
  - Realistic sound reproduction requires loud sound levels
- Distortion
  - Low distortion is very important
- Dispersion
  - Speakers that beam sound in a narrow field are not very useful for a group of people
- Frequency Response
  - Flat frequency response is useful, but can be compensated for with equalization to a limited extent and/or a subwoofer.
- Designs That Radiate Sound To The Rear
  - May create some serious problems with sound reflected from the rear.

How I would get great sound reproduction

- Minimize frequency anomalies
  - EQ major frequency problems with relatively low Q and low gain adjustments (Do not try to EQ out the very narrow peaks and valleys in the frequency response curve)
  - Purchase speakers that have good frequency response
  - Nominal levels of room treatment
  - Position speakers well
  - Use two subwoofers
- Minimize distortion
  - 6 Ohm or greater speaker impedance
  - Purchase drivers that match room size
  - Don’t under estimate the improvement from a great subwoofer
  - Use two subwoofers
- Great dynamic range
  - Sufficient power and efficient speakers with good dynamic range

How I would get great sound reproduction (continued)

- Speaker manufacturers I prefer…
  - Acoustech
  - Infinity
  - Onyx
  - Salk Signature Sound
  - Sonus Faber
  - Revel
- Subwoofer manufacturers I prefer…
  - Cambridge Soundworks
  - Bowers & Wilkins
  - Salk Signature Sound
  - REL
- Electronics manufacturers I prefer…
  - Yamaha (receivers)
  - Outlaw Audio (amplifiers)
  - Anthem (amplifiers)
  - Meridian (processors)

Questions?

Useful Sources For Information

- Room Treatment Products
  - Auralex http://www.auralex.com/
  - AVL Systems http://www.avlonline.com/index.html
  - Sonex http://www.sonex-online.com/
- The Master Handbook Of Acoustics by F. Alton Everest