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Dealing with room acoustics

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Very few people are lucky enough to have a purpose designed listening room with optimised dimensions and acoustic treatment. Most of us have to deal with the acoustics of the room as best we can. Typical problems are:

- Resonances – These are most noticeable at low frequencies, where you can hear certain frequencies being amplified and hanging on or booming, whereas others seem depressed.
- Flutter echoes – These are rapid reflections, usually across parallel walls. Clapping your hands readily shows them up.
- Tonal problems – Tied in with the comments above on getting the right balance from the speakers, here we consider the effects of soft furnishings or lack of them.

Now, room acoustics is a science unto itself and it is beyond the scope of this article to get in too deeply. This discussion is on a very light level.

Resonances, standing waves, eigentones – call them what you will – occur in any enclosed space at specific frequencies defined by the ratio of the wavelength to the room dimensions. Probably the simplest resonant enclosure to imagine is an organ pipe, where the fundamental tone and harmonic structure are related mainly to the length, because the other dimensions are so much smaller. In a room, however, all dimensions are comparable. You can get simple resonances from reflections across parallel surfaces and more complex ones involving reflections off two or more surfaces. At low frequencies, these resonances will add unevenness to the response of the speaker. They're easy to detect if you have an oscillator, but if not, play some music containing a bass scale. You will hear some of the notes exaggerated and others depressed. Furthermore, the exaggerated tones will also hang on or boom, ruining the transients of the bass.

Resonances tend to be more troublesome if the dimensions of the room are the same or simple multiples of one another. You get fewer of them, but they are more severe. You may have heard of the expression "Golden Ratio", which at 1 to 1.4 to 1.9 is supposed to be the optimum ratio between dimensions of a rectangular room to spread out or diffuse the effects of resonances. However, others think slightly differently and Olsen recommended the following ratios for different size rooms:

Room size	Height	Width	Length
Small	1	1.25	1.6
Medium	1	1.6	2.5
Large	1	1.25	3.2

The IEC recommends some specific room dimensions for domestic listening based on three different heights:

Height (m)	Width (m)	Length (m)	Area (m^2)	Volume (m^3)
2.5	4.0	6.0	24.0	60.0
2.8	4.2	6.7	28.1	78.8
3.0	4.8	7.2	34.6	103.7

For those who prefer imperial units:

Height (ft)	Width (ft)	Length (ft)	Area (sq ft)	Volume (cu ft)
8	12.8	19.2	245.8	1966
9	13.5	21.5	290.8	2617
10	16	24	384	3840

If you have the luxury of designing a room from scratch, you would be well advised to consider these recommendations.

You can also place both the speakers and listeners to minimise the effects of resonances. Their effect is worst if either or both are positioned in a node or antinode of the resonance. It is surprising how little movement can transform the sound of the speakers – even 20cm (6 in) can make a difference. Don't forget the height dimension. Sometimes a speaker sounds better for having air underneath it, but be careful that the optimum listening axis is still directed at the listeners' ears.

Sometimes, resonances are so bad that you will have to resort to some kind of acoustic treatment. This can be applied to the walls or there are tube traps – tall cylinders that can be tuned to the resonance frequency and positioned in the room for maximum effect. This approach is better undertaken with help from an expert. However, you can do a lot with large pieces of furniture that will alter the resonance modes and, if soft like a sofa, absorb some of the energy and damp the resonances.

Flutter echoes are best prevented by using furniture to break up the evenness of the walls. Bookshelves and pictures are particularly good for this. Using curtains along one of the offending surfaces can damp them. You can change the acoustics considerably simply by drawing curtains across windows.

The level of soft furnishing also affects the general tonal balance of the sound. We've all sung in the bathroom and know the effect of hard reflective surfaces. However, although we might think we sound better singing in the bathroom, the same does not necessarily apply to speakers in a barely furnished room. They can sound very harsh. Conversely, too much soft furnishing can make the sound dull and lifeless. It's all a question of compromise. Be careful where you place the furnishing. You need a certain amount of reflection round the speakers to help create a good image. Often it is better to have absorbent at the listening end. There is also a compromise regarding left-right symmetry. Although assymmetry can diffuse resonances, it can also skew the image.

There are several computer programs on the market designed to help you place the speakers in the room. However, many are either very complex to use or too simple in their analysis to be accurate enough. A good dealer should be able to offer constructive advice, but there is no substitute for experimentation – providing you have the freedom to do it!

If you want to look into room acoustics in more detail, the recommended background reading list in the article **Can you suggest background reading on audio topics and speakers in particular?** contains details of some literature on the topic.