ROOM MODES, RESONANCE, RATIOS, and RINGING

The resonances in a room are called the **modes**. Every rectangular room has three main modes, one for each of the length, width, and height. Rooms with irregular shapes have more than three modes and are more difficult to calculate. The worst shape is a cube where all three dimensions are the same, because all three dimensions **resonate** at the same frequencies.

The mode is the fundamental resonant frequency of a dimension. That frequency is related to the wavelength that the dimension represents. If the dimension (let's say it's length) is 10 feet, the frequency that has a wavelength of 10 feet is 113 Hz. (1130, the speed of sound, divided by 10 = 113). The fundamental resonant frequency is half of this. So for the 10-foot length of the room, the fundamental resonant frequency would be 113/2 = 56.5 Hz.

Large rooms vs small rooms

Large rooms have a flatter response than small rooms. Figure 2 shows the modes for one dimension - let's say length - of two rooms. The large room has a lower resonant frequency, so it also has more room modes, just like harmonics on a musical instrument. The modes (peaks) are close together on the graph. This equals a fairly flat frequency response.

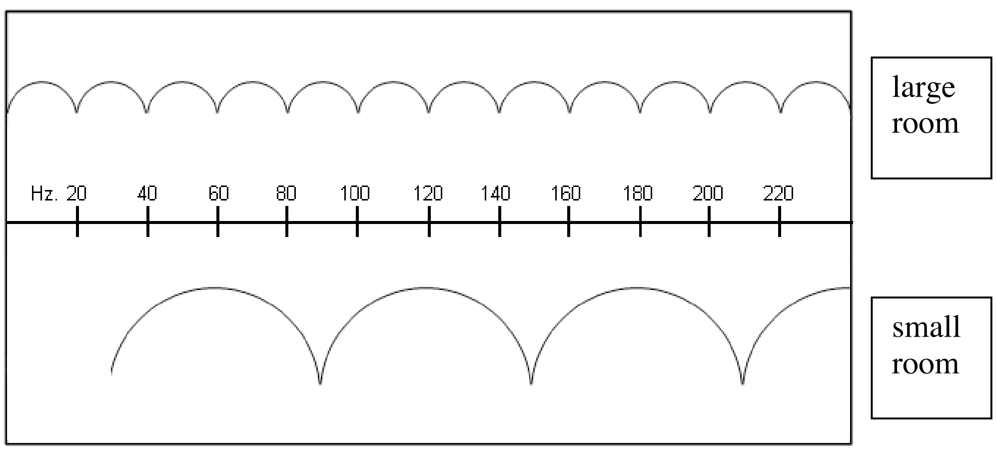


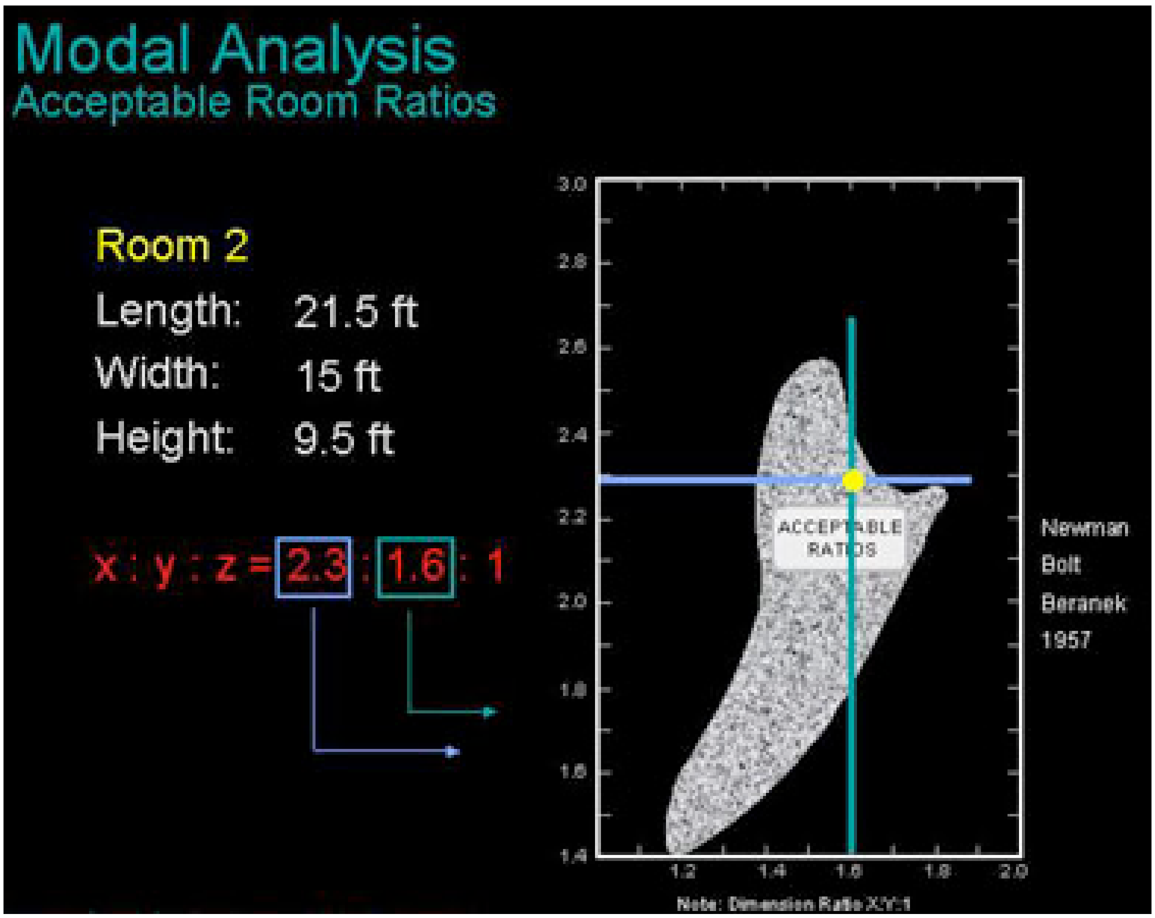
Figure 2

The smaller room has a higher resonant frequency, so it has fewer modes, spaced farther apart on the graph. The result is fewer peaks, but stronger. This equals an uneven frequency response.

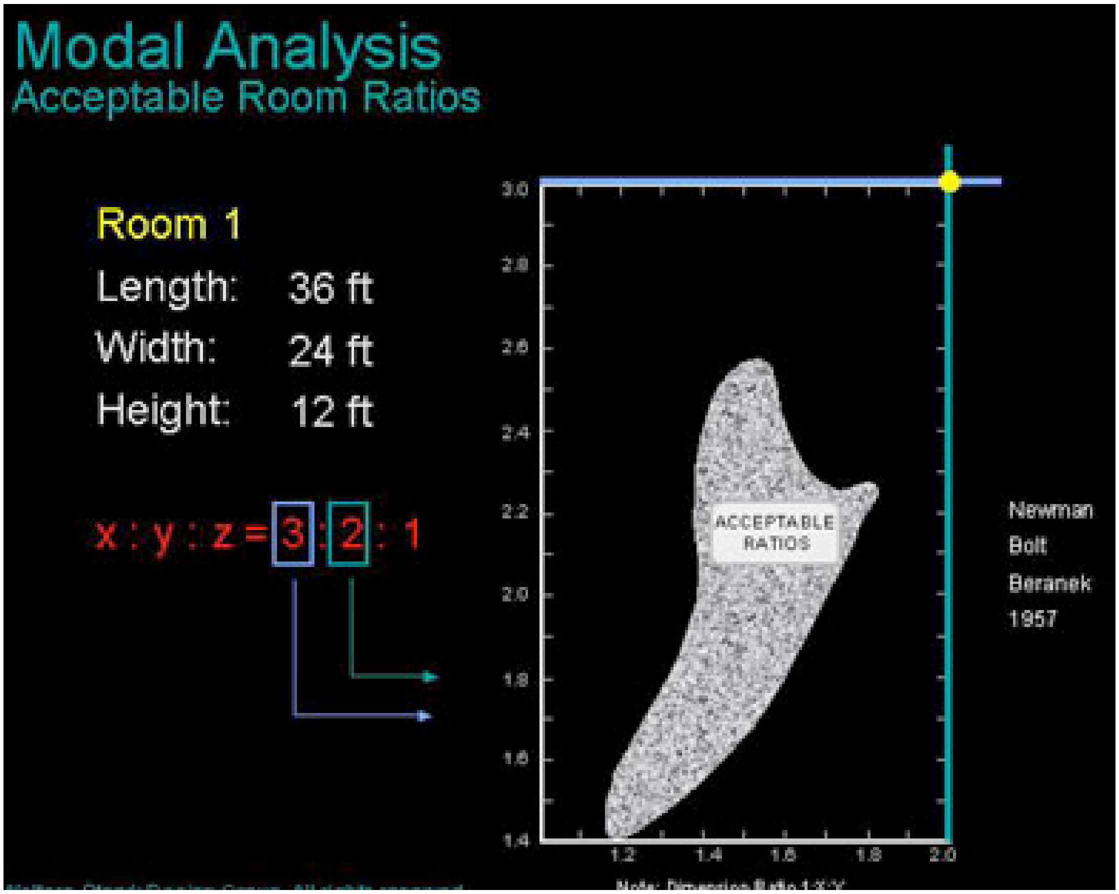
Acceptable Room Ratios

The ratio of the three main modes of a room can tell you if the room will be fairly flat, or fairly colored. If the room were a perfect cube, the ratio would be 1:1:1, which would be awful. The resonant frequencies of the cubic room would be the same in all dimensions, and reinforce each other.

There are some ratios that are better than others. These ratios can be checked on a chart like the one below. The first image shows an acceptable ratio. The second image shows a very undesirable ratio.



21.5' x 15' x 9.5' room - good low frequency room mode acceptability



12' x 24' x 36' room - poor low frequency room mode acceptability

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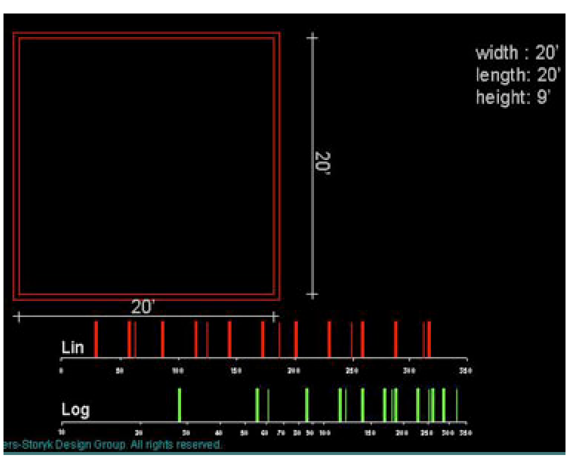
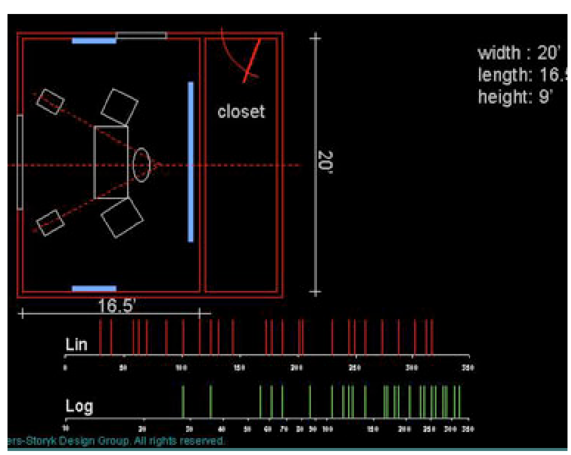
“Before” and “after” low frequency modal distributions for a 20' x 20' room. On the left, the room has two identical modes, width & height. So the frequency response shows an emphasis of the fundamental (about 28Hz) and its harmonics. The modes of the treated room on the right are less numerically related, so the frequency response is more spread out.





Acoustic Ringing

A room can ring just like a bell. The diagram below shows a room resonating, or ringing, at certain frequencies. The diagram represents 3 dimensions.

1. Bottom to top = amplitude, min to max.
2. Left to right = frequency, low to high.
3. Back to front = moving forward in time.

In this example, the sampled time is 400 ms. The upper image shows an untreated room. It rings very strongly at about 132 Hz, and also at about 40Hz, 64Hz, 94Hz, etc. The lower image is the same room after treatment. It emphasizes the same frequencies, but there is more sound energy spread into the gaps between the peaks. The room response is flatter.