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DOPE FROM HOPE

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Room Proportions and Distribution of Eigentons

For some years I have suspected that the "Golden Mean room"* would display a more smoothly distributed system of low frequency modes (Eigentons) than a room more nearly cubical. Obviously in a cubic room the first 3 Eigentons would be identical, would superpose, and would therefore reenforce each other strongly, whereas distribution of them would be desirable. Computing the first 50 Eigentons for the Golden Mean room showed no "doubling", that is no 2 Eigentons occured at the same frequency.

Attention was called to a paper by Bolt** who indicates a liking for room ratios ranging from 1 : 1.5 : 2.5 (nearly Golden Mean) to 1 : 1.26 : 1.59.

Using room dimensions of 1 : X : Y Bolt plotted a contour of X vs Y showing "smoothest frequency response", and all the values above fall within the contour.

From the standpoint of stereo reproduction, my own experience suggests a floor plan of X : Y of 1.6 or less, 1.4 appearing to be a good number and 1.26 entirely tolerable.

While the "Golden Mean" may suggest some esoteric magic in numerology there doesn't seem to be any evidence that there is any real magic in the number as applied to room acoustics. The computed Eigenton spacing was well distributed but this may be true for other ratios. Our Studio (10 x 16 x 25 feet) at the factory offers excellence of both frequency response and stereo geometry and this (in part) led to the Golden Mean preference, but other rooms more nearly 1 : 1.3 : 1.6 have also sounded good.

It is interesting but probably not significant that Bolt's $2^{1/3} = 1.26 = 1.618^{1/2}$

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*Golden Mean Ration r = 1.618 so a "Golden Mean" room would have dimensions of (for example) 10 x 16 x 25 feet.

** R. H. Bolt, "Note on Normal Frequency Statistics for Rectangular Rooms", JASA Vol. 18, No. 1, July 1946, pp 130-133.

Probably some lengthy computations for various room proportions would indicate presence or absence of doubling of Eigentons but the suspicion is that there is nothing critical if one is in good range of values.

It is suggested that these values offer attractive proportions for most uses as well as for reproduction and original rendition of Sound.

It is hoped the above will prove useful to people who are planning new homes and want a good music room, and also to architects.

Reference is made to 2 previous "Dope From Hope" on the subject of room acoustics:

DOPE FROM HOPE Vol. 5, No. 1 — 24 February 1964 "ROOM ACOUSTICS"

DOPE FROM HOPE Vol. 1, No. 4 — 16 December 1960

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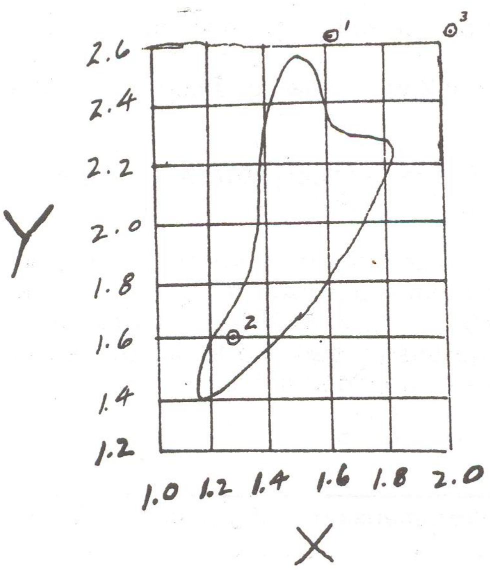
The sketch is traced from Bolt's paper** and shows a contour within which a room should have good Eigenton distribution and provide good sound if absorption co-efficients are satisfactory.

In the figure, X represents the ratio of room width to room height; Y is the ratio of room length to height. For example, X=1.4 andY=1.8 would mean that, in a room with a 10 foot ceiling, the room width is 14 feet (10x1.4) and the length is 18 feet. Point marked "1" represents the dimensions of our studio facility 116, which is 10x16x25 feet. This falls outside the contour but is still regarded as a good room.



Another room, this one in a home, is 8x17x21 feet and this also falls outside the contour (point 3). This room is judged by many listeners to be a good one. Thus one can assume the contour encloses "near perfect" rooms in Professor Bolt's estimation.

My personal thought is that the length and width may exceed the height by more than shown by Bolt, but that the length to width ratio should lie between 1.26 and 1.62. The lower limit of Bolt's preference, 1:1.26:1.59 is shown by point 2. This happens to be approximately the square root of the "golden mean." As stated earlier, there doesn't seem to be any magic about the golden mean numbers as applied to rooms for music listening. There seems to be a wide range of ratios that are suitable. Obviously the worst condition would be cubical (all 3 major Eigentons superpose). Next worst would be square. Apparently the range from 1:1.26:1.6 to 1:1.6:2.5 can be considered good, and we know of at least two good sound rooms that fall slightly outside Bolt's contour.

My personal feeling is that if a person is building a home and expects music to be a part of his joy of living, he could do well to get his architect to study Bolt's paper.**

Paul W. Klipsch
18 April 1969

**R. H. Bolt "Note on Normal Frequency Statistics for Rectangular Rooms", J.A.S.A. Vol. 18, No. 1, July 1946 pp130-133. Figure reproduced with permission.