Investigation of Acoustical Properties for a Studio Designed by Békésy

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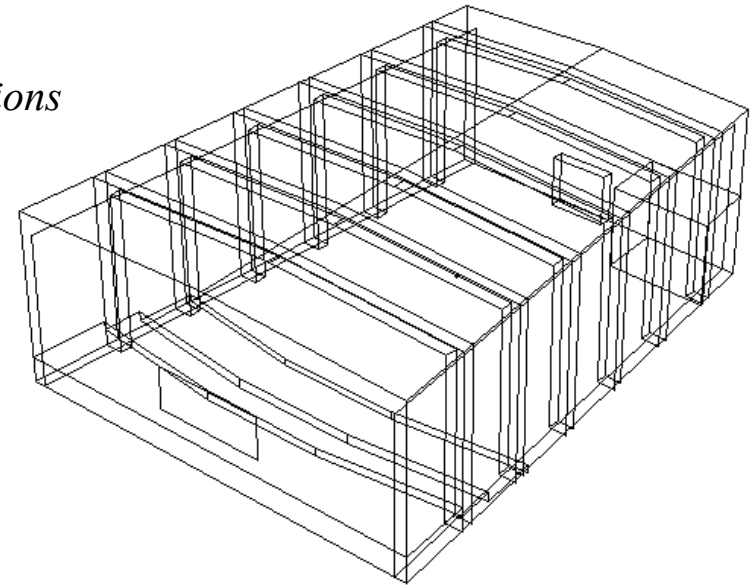

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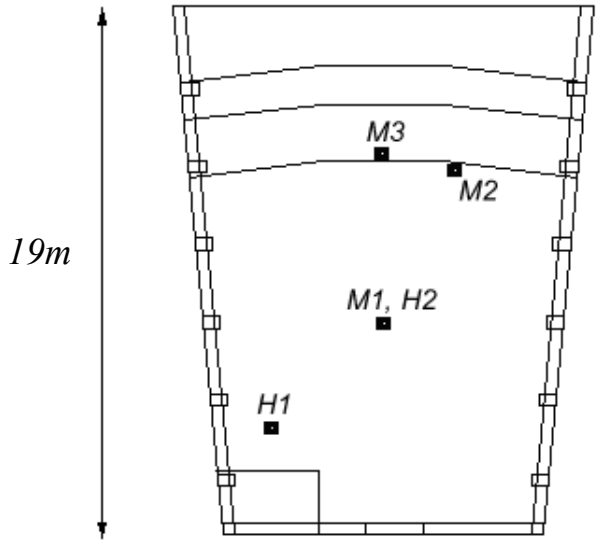
Introduction

- The investigation of an existing studio
  … assist to obtain an evaluation of
  the room acoustic properties of the studio
- The relationship between the objective and subjective side… new objective parameters
- Parameters for concert halls … studio acoustics

The Studio

- The studio was designed by Békésy,
  - inaugurated in 1935,
  - Classical music studio and rehearsal room for the Symphony Orchestra of the Hungarian Radio

- Geometry
  - sizes: 19m x 16.2m x 7.2m
  - area: 300m^2
  - volume: 2160 m^3



The History

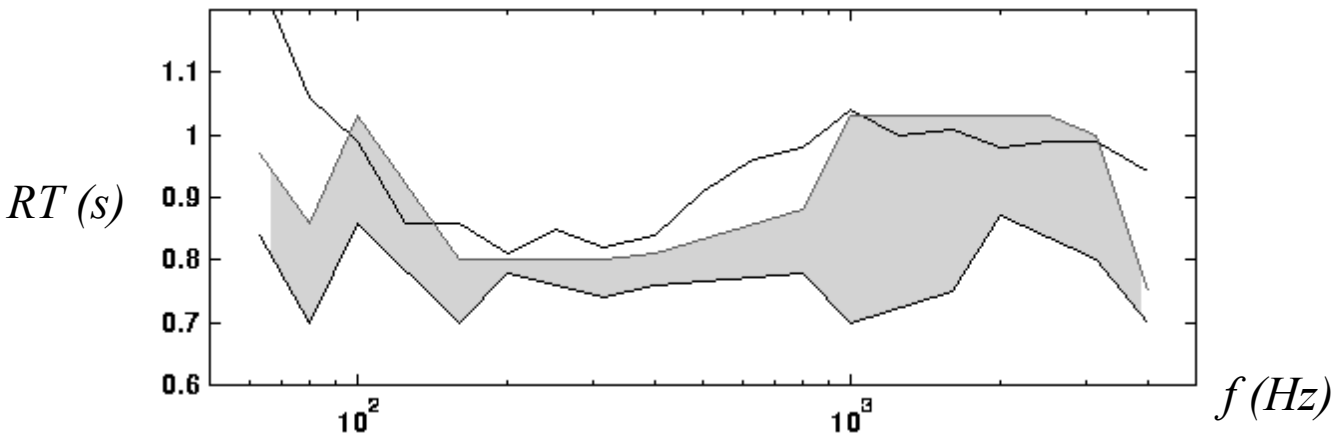
- In general
  The aim is to design a room with required subjective quality.

- At that time there was only one objective parameter: reverberation time, defined by Sabine
  (the time for the -60 dB attenuation of the received energy)

- Békésy began the design with thoroughness.
  Finding the optimal value of the reverberation time:
  - Subjective investigations changing the reverberation time of the studio step by step.
  - Subjects musicians, teschers of music, experts of Radio, music fans.

The History (2)

- Illustration of the phenomenon:
  - reverberant condition <> very damped condition
  - changing the absorbing cover to find the most favourable reverberation time
- Comparison of measured and proposed RT



measured values with given tolerance

Measured Objective Parameters

- Using only RT is insufficient, more parameters are needed based on the impulse response:
  - reverberation time (RT)
  - early decay time (EDT)
  - centre time (t_s)
  - clarity (C)
  - support (ST)

- Reverberation Time (RT)
  - from measured time between -5…-35dB attenuation
  - mean value: RT_M=0.93s

Measured Objective Parameters (2)

- EDT - a novel measure of reverberation time
  - emphasizes the subjective importance of the early part of the reverberation process (10 dB interval of the decay)
  - measured value: EDT=0.82s
  - high value indicates much reverberance and low clarity or vice versa.
- Centre Time (t_s) - the centre of gravity of the energy distribution

$$t_S = \frac{\int_0^\infty t \cdot p^2(t)dt}{\int_0^\infty p^2(t)dt} [\text{sec}]$$

Measured Objective Parameters (3)

- Clarity - ratio of received energy before and after a specified time point, given in dB

$$C(t) = 10 \cdot \lg \frac{E(0,t)}{E(t,\infty)} [dB] \qquad where \quad E(t_1,t_2) = \int_{t_2}^{t_1} p^2(t)dt$$

  - usually C(*40msec*) or C(*80msec*) is evaluated

- Support (ST1, ST2)

  In concert halls this gives the ratio between the early reflection energy sent back to the platform and the energy of the direct sound in dB.

$$ST_1 = 10 \cdot \lg \frac{E(20,100ms)}{E(0,10ms)} [dB] \qquad ST_2 = 10 \cdot \lg \frac{E(20,200ms)}{E(0,10ms)} [dB]$$

Evaluation of the Measured Results

- The measured values

	t_s (ms)	C_{40} (dB)	C_{80} (dB)	ST1 (dB)	ST2 (dB)
h1,m1	33,8	5.7	8.88	-2.54	-1.31
h1,m2	42.1	7.6	10.52	2.01	3.1
h1,m3	64.6	3.46	6.57	3.6	5.06
h2,m3	34.9	7.5	10.4	2.29	3.34
h2,m2	48.4	5.6	8.83	3.54	4.75

- To find the optimal values of the new objective parameters for different type of studios, ...more subjective tests have to be carried out.

Conclusions

- New objective parameters to qualify the acoustical parameters of a room
- More possibilities to predict the acoustical behaviour of the studios using computer modelling
- To find the optimal values of the objective parameters, extensive research work is needed