DEVELOPMENT OF ROOM ACOUSTICAL CALCULATION AND MEASUREMENT METHODS FROM SABINE TO TODAY

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In 1895, Wallace Clement Sabine was asked to improve the speech intelligibility in the lecture room of the Fogg Art Museum in Boston. Five years later, he was appointed acoustic consultant for Boston Symphony Hall – probably as the first person in such function. In order to find a relation between reverberation and absorption, he measured the *reverberation time* as a function of the number of 'meters absorbing pillows' in several rooms – probably the first systematic room acoustical measurement. Figure 1 shows his measurement setup with an organ pipe as the sound source and a chronograph as the 'receiver'. In order to explain the results of his measurements, he developed his diffuse field theory – probably the first well-defined room acoustical model – leading to his famous reverberation time formula – probably the most frequently used and misused formula in acoustics.

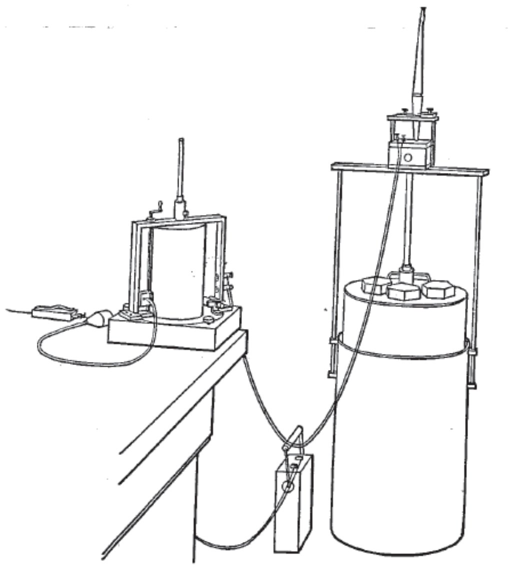

Figure 1. *Sabine's reverberation time measurement setup.*

Since the diffuse model is not valid in most sound fields and, hence, Sabine's formula is not a very accurate predictor, many new room acoustical theories and models have been proposed since then.

In the 1960s, the importance of *impulse responses* to analyze the acoustics of a room was recognized. Pioneers like Marshall and Barron showed that early and late reflections have specific contributions to the auditory perception of musicians as well as listeners. Beside new methods to accurately measure impulses responses, new calculation models were developed based on concepts such as mirror image sources and ray tracing.

Individual impulse responses do not reveal the wave character of sound and its inherent spatial properties. The introduction by TU Delft of *array technology*, i.e., measuring or calculating impulse responses along an array of positions, has solved this restriction. Figure 2 shows impulse responses measured along a linear array of microphone positions over the full width of a lecture hall, enabling the identification of direct and reflected sound waves.

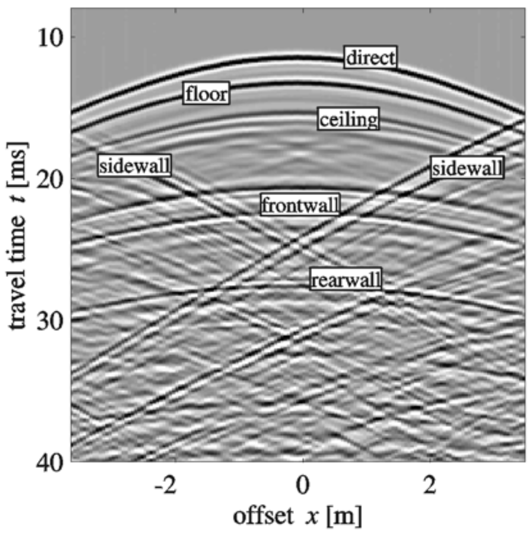

Figure 2. *Multi-trace impulse response measured along a linear array in a lecture hall.*

The above developments will be discussed and illustrated during the presentation.