Acoustic design

Improving the academic performance of students depends, in part, on our ability to create “learning friendly” environments. Unfortunately, schools are seriously challenged by overcrowding and disrepair, substandard plumbing and HVAC systems, inadequate technology, and health- and safety-related concerns.
The architectural acoustics of educational buildings are often not taken into account until late in the design phase.

Noise and Silence

Noise usually masks important acoustic signals. Insulation against outside noise results in a great relief to the users of the classrooms. Building technology has made enormous progress by sealing windows and doors against penetrating airborne sound. The most serious acoustic problems are due to noise transfer between rooms and excessive reverberation in rooms.

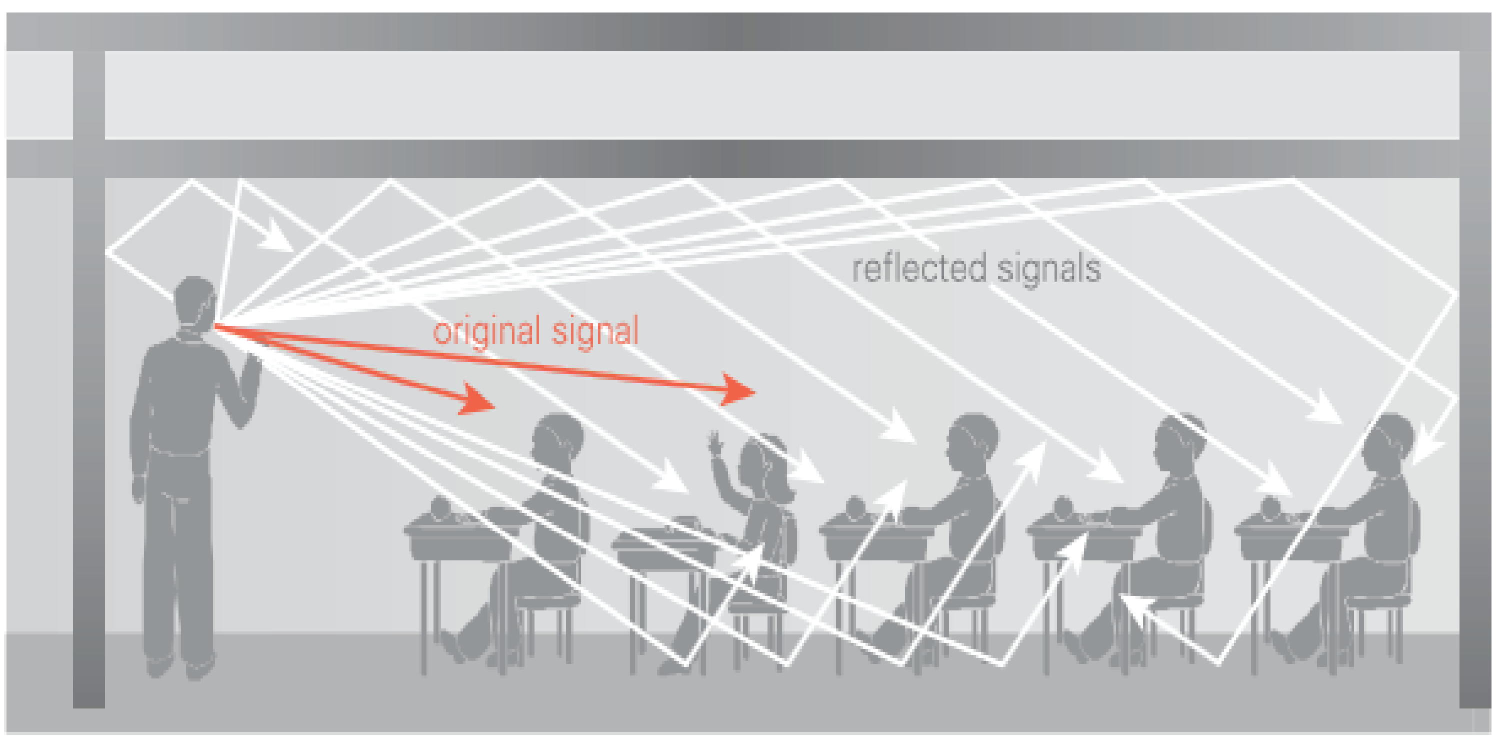
Reverberation

Reverberation time is the time required for a steady -state sound to reach one millionth or -60dB of its original intensity.
There are several models used in calculating the reverberation time but the first and most commonly used is that of Wallace Sabine (1868-1919).

$$T_r = 0.161\frac{V}{A}$$

states that the reverberation time (Tr, in seconds) is directly proportional to the volume of the room (V, [m3]) and inversely proportional to the room's effective surface area (A, [m2]). The effective surface area is the sum of the product of an area covered by a particular material and the material's absorption coefficient.

$$A = \sum_{i=1}^{n} \alpha_i A_i = \alpha_1 A_1 + \alpha_2 A_2 + \alpha_3 A_3 + \ldots$$



Sources of background noise in unoccupied classrooms, source from Trane Engineers Newsletter — Vol. 32, No. 1

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Surface Treatment	Absorptivity at Frequency 125	250	500	1000	2000	4000
Acoustic tile, rigidly mounted	.2	.4	.7	.8	.6	.4
Acoustic tile, suspended in frames	.5	.7	.6	.7	.7	.5
Acoustical plaster	.1	.2	.5	.6	.7	.7
Ordinary plaster, on lath	.2	.15	.1	.05	.04	.05
Gypsum wallboard, $\frac{1}{2}$″ on studs	.3	.1	.05	.04	.07	.1
Plywood sheet, $\frac{1}{4}$″ on studs	.6	.3	.1	.1	.1	.1
Concrete block, unpainted	.4	.4	.3	.3	.4	.3
Concrete block, painted	.1	.05	.06	.07	.1	.1
Concrete, poured	.01	.01	.02	.02	.02	.03
Brick	.03	.03	.03	.04	.05	.07
Vinyl tile, on concrete	.02	.03	.03	.03	.03	.02
Heavy carpet, on concrete	.02	.06	.15	.4	.6	.6
Heavy carpet, on felt backing	.1	.3	.4	.5	.6	.7
Platform floor, wooden	.4	.3	.2	.2	.15	.1
Ordinary window glass	.3	.2	.2	.1	.07	.04
Heavy plate glass	.2	.06	.04	.03	.02	.02
Draperies, medium velour	.07	.3	.5	.7	.7	.6
Upholstered seating, unoccupied	.2	.4	.6	.7	.6	.6
Upholstered seating, occupied	.4	.6	.8	.9	.9	.9
Wood/metal seating, unoccupied	.02	.03	.03	.06	.06	.05
Wooden pews, occupied	.4	.4	.7	.7	.8	.7

Absorptivity, source from Trane Engineers Newsletter — Vol. 32, No. 1