Room Acoustical Design

Misc notes from the internet

Sound intensity is measured in decibels [dBA] exponentially [10dBA is 10 times more powerful than 0dBA & 20dBA is 100 times more]. Silence is 0dBA; a whisper is 15dBA; conversation is 60dBA; car horn is 110dBA & a firecracker is 140 dBA. Sound travels through air at 768mph [1126fps] & diminishes with distance. You can measure the dBA at a given distance by using the inverse square law [dBA at distance/ dBA at source = (distance at source/distance away) squared. x/90 = (10/100) squared. So if a 20 dBA difference is 100 times more, then x=70 dBA. See GSU website for calculator.

Sound reflects off of surfaces & is known as reverberation [typically measured in seconds (T or RT) to drop 60dBA]. Loudness of reflected sound depends on absorption, while direct sound depends only on distance. Concave surfaces can focus sound & create an annoying echo. A good RT for speech is 0.5-1.0 & music is 1.5-2.0. Notre Dame is at 8.5 & Carnegie Hall is at 1.7. Aim for 2.0 in a multi-use room & 0.75 in a classroom.

Hard surfaces may reflect 95% of the sound & absorb 5% [thus an absorption coefficient of .05]. Coefficients may vary with different frequencies [measured in Hertz (waves per second) after Heinrich Hertz]. Use 500 Hz or an average of the middle 4 frequencies known as NRC [noise reduction coefficient] for simple calcs. Other materials NRC are brick, wood, gyp bd = .02-.05; carpet = .25; acoust clg tile = .7; tectum = .85 [may vary].

A Sabin is a unit to measure sound absorbed [1 Sabin = 1sf @ 100% coefficient] or [# of Sabins = surface area x NRC]. You can find the total Sabins in a room by adding (clg area x it's NRC)+(wall area x it's NRC)+(flr area x it's NRC) [some calcs may add people & upholstery]. The Sabine formula [named after Wallace Sabine] is T = (0.05)V/S or V/20S (if measured in feet) or T = (0.16)V/S (for meters). This will measure the RT of a room. T=seconds; V=rm vol; S=Sabins. You can use S=V/20T to find the Sabins required at the desired RT. The difference in S is the amount needed to add. Divide that by the NRC of the material proposed to find the area of the acoustic material to add. See GSU or Tectum website for calculator.

Sound Transmission Class [STC] is used to rate how well a wall or flr/clg assembly blocks sounds. And Impact Insulation Class [IIC] tells us how much we hear footsteps from the floor above. A standard rating of each would be 50. A typical wall of studs & gyp bd would be 35 STC. Add R11 insul & resilient channel to get 50. Carpet, pad, plwd, flr frmg, resilient channel, gyp bd flr/clg is 50 STC.

Sources: www.tectum.com www.MBIproducts.com www.usg.com
www.hyperphysics.phy-astr.gsu.edu www.science.howstuffworks.com