Approach To Space Design: Acoustical Considerations

Goals are clear in architectural and engineering design: requirements of the functionality and performance of space and equipment must be met. Acoustical design is no different but the end results are often subjective, and must balance the design goals with how sound will behave in each individual room.

When sound bounces back and forth between the surfaces of a room, it affects both the quality and level of sound. Acoustical room design requires unique tailoring of individual spaces to achieve the desired quality and level which varies depending on types and use of each space. Design expectations can be met if these needs are clearly identified at the start of a project.

In order to adequately design any space for acoustics, it is important to quantify the acoustical properties and adjust them appropriately by changing various aspects of the space. Acoustic modeling software creates a three-dimensional model from the input of data defining which material properties are assigned to each surface. Once a basic room model has been created, additional data can be input for more detailed analysis. Audience areas as well as specific listening seats are useful in mapping a space’s sound distribution and overall sound levels. The addition of specific loudspeaker models can be input for determining coverage areas and correct aiming angles. After the model is complete it is easy to calculate the necessary parameters used in the acoustical analysis.

The analysis process includes examination of the following parameters:

- **Reverberation Time (RT):** useful when selecting the appropriate materials and treatment for a space
- **Direct Sound Pressure Level (SPL) and Total Sound Pressure Level (SPL):** calculations used to examine the noise in a space
- **Articulation Loss and Speech Transmission Index (STI):** used to measure intelligibility
- **Center Time:** a reference spatial impression; the higher the value, the larger the space feels
- **Arrival Time:** a measure of the length of time it takes for the sound to reach a specific listener seat; useful when examining direct sound
- **Early Decay Time (EDT):** a measure of reverberation. Not as general as RT formulas because it accounts for the shape and distribution of the materials in a space. Reflects what the actual listener will hear in a room
- **Clarity and Definition:** energy measurements of a space; measure how certain sounds are differentiated between one another, i.e. how the discrete notes in a piece of music stand apart from one another
- **Lateral Fraction:** a measure that reflects the perception of the lateral sound reflected from the sources
- **Echo Speech:** projections of how much delayed energy will degrade the quality of speech
- **Echo Music:** projections of how much delayed energy will degrade the quality of music
- **Sound Strength:** a characterization of the volume level
These are examples of the calculation capabilities of acoustics modeling software but not all will be used on every project. Some calculations are more pertinent to specific uses and types of spaces and may not apply to other types of spaces. For example, *Echo Music* would not be a required measurement in a conference room but it would be relevant in an auditorium or vocal music room.

In addition to the calculation capabilities, modeling software may be utilized to create auralizations of the spaces being analyzed which allow the ability to actually listen to the designed space at various listener seats. When seated in a completed space, occupants will not know specifically what it means to have an RT of 1.20 seconds versus 0.80 seconds but they will be able to hear the difference between the two.

Acoustical design deliverables may include drawings and specifications, as well as narratives. Because the end product is subjective to human perception which varies from person to person, it is important that the deliverables convey an explanation of the findings and design recommendations. As with other engineering disciplines, drawings show correct locations and amounts of treatment required to meet the design goals. The specifications indicate the necessary types of treatment required to achieve the desired acoustical performance. The narrative is necessary to deliver the calculated results, as well as the recommended treatment option(s) and the resulting outcomes. Auralizations, if requested, will be delivered as .wav files.

Acoustical design is unique to each individual space but the overall process is almost always the same. It is important to examine all aspects of the space and analyze all acoustical parameters to ensure that the outcome is desirable both scientifically and subjectively.

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Jessica has over six years of experience as an acoustical engineer, specializing in room acoustics analysis and design. Her diverse design experience ranges from auditoriums, music rooms, athletic facilities and general classrooms, to courtrooms and city council chambers. Jessica’s specialized training in the field of acoustics includes architectural room acoustics, CATT Acoustics and EASE computer modeling and auralization, and noise and vibration control. Jessica earned bachelor and master degrees in architectural engineering from the University of Nebraska’s Peter Kiewit Institute.