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Architectural Acoustics

When faced with the question: What is the Technical Committee on Architectural Acoustics? (TCAA), I begin my reply with emphasis on the people involved. To me it is clearly the professionalism, passion, and friendship of the people of the TCAA that make the other functional side of the Committee …well…function.

The TCAA was among the first of the committees established by the Society in 1960. We are one of the largest TC's, with nearly 200 members on our official roster. Committee meetings are lively and enjoyable, have a significant student presence, and an average attendance of over 70 for the past 5 years. We typically sponsor 7 to 10 special sessions per meeting and often include local tours--usually considered "too many" as opposed to "not enough."

Having the honor to serve as the chair of TCAA, I attribute the health and success to a long tradition of strong and visionary leadership that has embraced the diversity of our field's application. We are well balanced between research, application, academia, and commercial business. This diversity results in a relevant and meaningful appeal to a broad variety of participants and is beneficial in many ways by providing a large pool of resources, talents, and expertise. We are also a very socially active group, hosting student design competitions, Newman Fund, Concert Hall Research group, and the ASA Jam--now under the College of Fellows--was started by TCAA.

So What is TCAA?

Each of the thirteen Technical Committees within the Acoustical Society of America serves a unique and important role, each focusing on a specific discipline with the general science of the acoustic community. So what is TCAA? Let's begin with the definitions to put in context the idea of just what Architecture Acoustics is:

- Architecture is defined as 1: *"the art or science of building; specifically: the art or practice of designing and building structures and especially habitable ones*[1]*."* (Webster dictionary);
- Acoustics: *"a science that deals with the production, control, transmission, reception, and effects of sound."*[1]

So by definition, the TCAA is the Technical Committee within ASA whose focus is on the science and practice of the production, control, transmission, reception, and effects of sound within inhabitable buildings and structures or simply; sound in the built environment.

The TCAA works with the intersection of the built environment and the human element inhabiting them. Early in my career I was told a simple and yet fundamentally important perspective on architectural spaces. "Buildings are a tool." The simple genius in this wisdom runs deep. Why do we build, what is the purpose of a building, what do we want the "tool" to do? If the answer to that question involves people, then the acoustics of the environment become a critical part of the building function.

[1]http://www.meriam-webster.com/dictionary

Architectural acoustics involves the following four basic fundamentals to achieve the function needed in the built environment:

1. Sound isolation, both airborne and structure borne - between interior spaces, between outdoors and indoors, and between outdoor locations.
2. Noise and vibration control of building systems – including (but not limited to) HVAC, plumbing, electrical, and elevators.
3. Finish treatments and surface shaping – sound absorption, reflection, and diffusion to create the appropriate sound qualities for the application.
4. Electro-acoustics – AV and media systems, indoors and outdoors.

These fundamentals are applied uniquely across "first, second and third spaces" architectural application, as described below.

First, Second and Third Spaces...

In the architectural community, the function of spaces can be referred to as first, second, and third spaces. The first space is the home or primary dwelling. Dwellings, as well as the occupants, may differ, but a series of common themes and expectations can be categorized in first spaces.

Second spaces are defined as places of business or work. This is where people spend a significant portion of their day. Obviously, these spaces have a wide variety of expectations, many of which are dependent on one's vocation. But, overall, the common question is: Does the space function as a tool to efficiently help the work (whatever the "work" is) get done?

The third space comprises all the other spaces in which people spend their time. Aside from home (first space) and work (second space), what other buildings do people inhabit?

Let's explore a few architectural spaces in each category, the function expected, and how acoustics play a significant part.

First Spaces

Homes and dwelling places: Think about the home, what kind of tool is it, what function is desired from it, and what do users expect their home to provide? Rest, recharge, engage, entertain, and retreat. Isolation is probably the most critical common acoustical aspect of first spaces. Sound isolation is required from neighbors, traffic, and other intruding sounds.

Not that people retreat to their homes and sit in sensory-deprivation boxes; instead, for most people, interaction is a critical part of the home, but it is the ability to control that interaction that is important. Everyone unwinds and relaxes differently, and everyone has different needs from their homes at different times.

The architectural acoustic community serves these spaces by starting with the location of the building. Homes located near a freeway will require more acoustic isolation than homes in a more rural and quiet setting. Materials and assemblies are chosen for an appropriate Outdoor Indoor Transmission Class (OITC). For multi-dwellings, high Sound Transmission Class (STC) & Impact Isolation Class (IIC) materials and assemblies are required to isolate airborne (STC) and structure borne (IIC) sounds from dwelling unit to dwelling unit. As the typical living space becomes more compact, complaints from intruding voice, TV, and footfall noise from adjacent apartments or condominiums are an increasing issue.

Second Spaces

Where we work and do business: What tasks are done during the normal workday? What are the acoustic needs for these tasks? Does one need sensitive privacy, focus, or collaboration? Most likely all of the above at some point in time would be the appropriate answer to each question. Here are a few examples of types of second spaces and the acoustic consideration they need.

Schools: Clear intelligible speech is critical to the learning process. TCAA works closely with TC Noise, and also joined with TC Noise to develop the ANSI S12.60 Classroom Acoustic Standard. I will leave deeper explanation on speech communication and auditory processing details to other fellow TC's, but we simply do not "catch" all the words spoken during a conversation, we are able to fill in the "blanks" contextually. This works fine for most adults with experience listening to language, but not so well for children: Add new concepts like fractions; and second language students or teacher accents; temporary hearing loss from a head cold; and then rooms that work fine for adults are putting children's education at risk.

Perhaps an over simplification, but good classroom acoustic design comes down to a high signal to noise ratio (S/N). Low background noise from HVAC and other building systems, and blocked intruding noise from outside and other interior spaces are required to not exceed 35 dB to control the noise part of the ratio. Direct sound and early reflections that enhance the teacher's voice provide a strong signal. However, later reflections effectively add as noise that convolute and confuse the signal. As a consequence, T60 Reverberation Time (RT) not exceeding 0.60 seconds is required for typical classrooms.

Healthcare: There are many types of healthcare spaces, each requiring different acoustic concerns. The need for private, personal, and potentially embarrassing conversation in examination, treatment, and consultation rooms provides a specific challenge for medical office buildings. The Privacy Rule within HIPAA requires that personal information and communication in paper, electronic, and oral (acoustic) form is kept confidential. Information orally shared in the room must be contained within the room. This requires a high level of sound isolation from room to room and often electronic sound masking to increase the background noise and preventing any speech escaping to adjacent spaces. The specific ratio of speech content to background noise is calculated into a Privacy Index (PI). PI of 95% or better is defined as confidential.

Patient rooms in hospitals are second spaces for staff, but temporarily first spaces for patients. Sound isolation is even more important because the ability to rest is critical to the recovery process. Building systems must operate quietly, but noise from medical equipment such as monitors, and noise from staff and visitors must be accounted for as well.

The TCAA currently has two specific Healthcare related initiatives. The Subcommittee on Healthcare Acoustics and the Speech Privacy in Healthcare - Working Group 44, jointly with TC Noise.

Offices: The variety of office styles and needs are nearly as diverse as there are professions. However, we can categorize offices into three types of work/task needs. These include private spaces, focus spaces, and collaborative spaces.

- Private spaces are those where the confidentiality of a conversation is important. Conference rooms or closed offices as example and again can be measured in PI.
- Similar to classrooms, conference rooms, and especially teleconferencing rooms, require low RT for clear intelligible speech.
- Focused spaces do not require speech privacy from the talker perspective but they do require sufficient sound isolation to minimize distraction to enhance productivity and accuracy of work. Sound reduction from one open space to another is called Inter-Zone Attenuation (IZA) and self-defining as the attenuation of sound from one "zone" (open work area) to another and is mainly driven by cubical/partition height and ceiling Articulation Class (AC). Privacy in the focused environment is also qualified as PI with a PI of 80% or better being considered "non-intrusive."
- Finally, collaborative spaces have a much lower sound isolation needs than other work spaces. Workers typically will need to communicate and collaborate with nearby coworkers. These spaces are often arranged in groups or clusters designed for easy communication within the cluster, but with isolation between clusters.

Third Spaces

When not in the home or business, people still use a wide range of other spaces, each having various "needs" in terms of the acoustic environment.

Restaurants: The "correct" acoustic environment for restaurants, pubs, and cafes depends on the desired atmosphere. A festive and loud pub can give a sense of liveliness and fun. This is a "happening" place. But the space can also be too loud if people must yell across the table. Inversely a quiet dining experience may be a great way to celebrate an anniversary, but others may consider the atmosphere "dead and stuffy." Interestingly, a recent survey conducted by Third Place Consulting[2] asked questions related to what determines the places people frequent. Why do people go where they go? The people there… "that's where my friends gather" and the acoustic environment… "the ability to talk and have a conversation" ranked among the most important factors. In fact acoustics ranked higher than the food quality.

Houses of Worship: These are important spaces where those who worship seek a spiritual connection and this may vary in meaning depending on whom you ask. Maybe this type of space more than any other is where the acoustician needs to fully understand the needs, desire, and culture of the client. What are the acoustics needed to promote this connection for the users? Is worship quiet and reverent or loud and celebratory? Do participants need individual solitude or a rock band? Is the designer making a mosque, a temple, a chapel, cathedral, or mega church, and what are their different needs? Most importantly, the spoken message is the core

[2]http://www.thirdplaceconsulting.com/

point so clear intelligible speech is needed. These are all vital consideration to create successful acoustical environments. High sound isolation is required to prevent exterior distractions, low building system noise, early and late reflection control and, in most cases, amplification systems promote clarity of music and speech.

Performance Spaces: As with worship spaces, the acoustical design is extremely dependent on the performance type: symphonies, operas, theaters, and cinemas all have very different expectations and very different acoustical needs. A life study can be made from the understanding and practice of performance spaces, from ruins in Ancient Greece to the Disney Concert Hall. Also like worship spaces, high sound isolation, low building system noise, early and late reflection control and often the amplification system are part of the design.

It is impossible to cover each and every built environment and all of the special conditions, nor was it my intent to do so. My hope is that I have given a "flavor" of just what colleagues in TCAA work with and a hint of our success factors.

TCAA Chair Kenneth W. Good, Jr. along with former TCAA chairs K. Anthony Hoover, Bennett Brooks, Jiri Tichy, William J. Cavanaugh, Leo Beranek, Brigitte Schulte-Fortkamp, and Wolfgang Ahnert.

Biosketch

Kenneth W. Good, Jr. currently serves as the Chairman of Technical Committee for Architectural Acoustics and Philadelphia Regional Chapter Representative. Ken spent 11 of his 17 years with Armstrong World Industries in research and development before accepting his current role as Acoustic Specialist for Armstrong's TechLine team, where he works with the architecture and specifying community assisting with acoustical material selections and design considerations for building renovations and new construction.