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Abbreviations

ADA	American with Disabilities Act
ADAAG	Americans With Disabilities Act Accessibility Guidelines
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASA	Acoustical Society of America
CCA	Coalition for Classroom Acoustics
dB	decibel
dB(A)	decibel (A-weighted)
HVAC	heating, ventilating, and air-conditioning
IBC	International Building Code
ICC	International Code Council
IDEA	Individuals with Disabilities Act
IEP	Individual Education Program
RT ₆₀	reverberation time
SNR	signal-to-noise ratio
STC	Sound Transmission Class

Executive Summary

The Americans With Disabilities Act is a civil rights law prohibiting discrimination against persons with disabilities, ensuring equal opportunity for usage and accessibility to public and governmental buildings and facilities. In 1997, a petition was sent to the Architectural and Transportation Barriers Compliance Board, a federal agency responsible for issuing Americans With Disabilities Act guidelines, alleging that poor classroom acoustics constituted an architectural barrier to students receiving an education. Several organizations mainly in the acoustics industry supported this petition.

In 1998, the Architectural and Transportation Barriers Compliance Board issued a Request for Information with intent to receive public input on the matter. A working group made of mostly members of the Acoustical Society of America was formed in 2000, and, under the auspices of the American National Standards Institute, produced *Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools*, a set of norms for good acoustics in classrooms. The standards are voluntary, but many states, municipalities, and education boards have adopted them, either fully or in part, with the result that the design team is now responsible for good classroom acoustics in new and renovated school construction.

(187 words)

Chapter One: Background

The United States is generally proactive in ensuring equal rights for all its citizens. Progress was made in the area of women's rights in the 1920s, and on the rights of Blacks and other minorities in the 1950s and 60s. Toward the end of the century, however, another movement began to emerge, the movement to ensure the rights of disabled Americans. In 1990, the United States Congress passed the Americans With Disabilities Act (ADA) in an effort to guarantee equal access to public buildings for all citizens. The ADA stipulates that a building must not only be designed and constructed to code, but that all architectural barriers prohibiting easy access must be avoided.

The question, then, is how to define an architectural barrier. Some barriers are more obvious than others. Stairs, for example, pose an obvious problem for persons in wheelchairs; therefore, an alternate means of access, such as a ramp, must be provided. Doors used for human passage inside and outside public buildings now typically include power-operated mechanisms that open and close at the push of a button, making them accessible to the disabled as well as the elderly. Equal access to and usage of public buildings has been deemed by the federal government to be a civil rights issue, touching on basic human freedoms and Constitutionally-guaranteed rights.

Barriers also exist, though, for people with less conspicuous disabilities. Safety is compromised for the hearing impaired when fire alarms are not equipped with strobe lights. Improved lighting in offices and classrooms aids the visually disabled. The broad standards of the ADA are meant to benefit society as a whole; practically then, the

implications of the law have far-reaching consequences, impinging areas that may not have been considered by the law's framers. One such area is acoustical design.

Petition to the Access Board

In 1997, a petition was sent to the Architectural and Transportation Barriers Compliance Board (hereafter, the Access Board) from a parent whose child was hearing impaired, alleging that poor classroom acoustics constituted an architectural barrier to their child receiving an education (Thibault). The child, who possessed otherwise normal learning capabilities, had progressively fallen behind in school because the classrooms allegedly possessed an acoustical environment that prevented the child from being able to hear the teachers. The petition also claimed that students with learning, developmental, auditory processing, speech, and language disabilities were at a high risk. Several organizations supported the petition, including the National Cued Speech Association, Self Help for Hard of Hearing People, the Alexander Graham Bell Association for the Deaf, and the American-Language-Hearing Association (Architectural).

In 1998, the Access Board issued a Request for Information (RFI) with intent to receive public input on the matter. It was pointed out to the Board that a study had already been conducted on noisy restaurants, where patrons had difficulty communicating with wait staff. That study had concluded that the main factors associated with communication difficulties in restaurants had to do with background ambient noise levels and reverberation characteristics of the space, factors which could be addressed in the architectural design phase (Architectural). If design provisions existed for restaurants, the

argument went, then surely they should also exist for public schools, especially since studies show that as many as 1 out of 8 U.S. school children experience some form of hearing loss (Hearing). In the end, the Access Board determined that the aural environment has much to do with a student's ability to learn, and that aural barriers should be addressed in the design phase of constructing a classroom.

It was not until 2000, though—three years after the initial petition was sent to the Access Board—that the issue of classroom acoustics saw its day in court.

Case Study – Classroom Acoustics in the Courtroom

In 2000, Cread and Tamela Clifton of Wilson County, Tennessee, sued the local school system on behalf of their son, Kyle, alleging noncompliance with the Individuals with Disabilities Act (IDEA). IDEA is a 1997 law meant to help “strengthen academic expectations and accountability” for the nation’s children with disabilities, and “bridge the gap” that too often existed between disabled children’s learning curriculum and that of non-disabled students (US Dept. of Ed.). Specifically, the Clifton’s suit stated that the school system did not comply with the passage in the law that ensures “that all children with disabilities have available to them a free appropriate public education that emphasizes special education and related services designed to meet their unique needs and prepare them for employment and independent living”(Wilson).

IDEA mandates that a public school district must prepare an individualized education program (IEP) for all disabled students. The school district is encouraged to integrate the IEP within a “normal classroom” with non-disabled students, but may

separate the disabled student from non-disabled students when appropriate. Parents have input to the IEP and can accept or deny the district's proposal. If the parents deny the district's proposal, they may request a hearing with the local education agency, and, if still not satisfied, appeal to the state education agency. The law goes on to say that, if an IEP is not agreed upon, the child may be placed in a private school specializing in the child's disability, and the parents may seek reimbursement from the public school, provided they can show that the public school's proposed IEP was indeed inadequate (U.S. Dept of Ed.).

With regard to the Clifton's lawsuit, the IEP proposed by the Wilson County School District contained six items, one of which was special education in a classroom that the Cliftons alleged impeded Kyle's ability to learn. The classroom, they said, was "too noisy," and not conducive to quality learning for a child with hearing and auditory disabilities (Wilson). Several people, including school officials and Kyle Clifton's special-education teacher, testified to the classroom's poor acoustical characteristics.

The court awarded the Cliftons full tuition reimbursement for the cost of the private school, and ordered the school district to provide necessary related services, "including, but not limited to, modification of the facilities to create an acoustically-treated environment" (Wilson).

The school district appealed the ruling, but the appellate court upheld the lower court's decision.

Others Impacted by Classroom Acoustics

The case for better classroom acoustics is usually presented with regard to hearing disabled children. Though this was certainly the catalyst for the campaign, students with normal hearing are also at a disadvantage in acoustically-poor classrooms (Lubman, “America’s”). In particular, students with learning disabilities such as Attention Deficit can be adversely affected. Students who speak English as a second language are also at a disadvantage, as are those with shorter attention spans or who have begun to experience hearing loss.

Children are more at risk than adults. Adults have better ability to overcome noise nuisances and understand speech, which is extremely vital in the learning environment. Studies as far back as 1975 show that all children, not simply the hearing impaired, suffer academically in poor acoustically-treated classrooms (Weaver-Dunn). Bronzaft & McCarthy conducted a seminal study in which they compared two sets of reading scores from two sixth grade classrooms at the same elementary school. One classroom was located across the street from elevated train tracks; the other classroom was located on the other side of the same building but away from the train tracks (Stansfield, 131). Bronzaft & McCarthy found that, at the end of the study, the children on the “noisy side” of the building tested approximately one-half year behind the children on the quiet side. After noise abatement provisions were implemented in the noisy classroom, however, the two sets of students started testing equally.

Teachers in noisy classrooms are also at a disadvantage. In a study conducted at a preschool in Vancouver, Canada, where background noise levels and reverberation times

did not meet relevant criteria in any of the classrooms, results showed that while non-aural conditions, such as air-conditioning, lighting, and room layouts, were considered to be of average quality, the listening environment in the classrooms was considered by teachers to be of the worst-quality (Yang, 47). To compensate for poor acoustics, teachers often have to increase their voice volume, which then causes vocal fatigue. Studies show that, on average, teachers are absent from class two days a year as an indirect result of poor classroom acoustics. This is estimated to cost the U.S. education system approximately \$567 million annually (Weaver-Dunn).

A study presented to the World Health Organization (WHO) on the cognitive effects of noise on children, found that outdoor noise was to blame for students' poor reading comprehension in Europe. Data from eighty-nine schools located near airports in London, Madrid, and Amsterdam found that aircraft noise transmitted through school buildings adversely affected students' reading comprehension skills. The results suggested that, while students tuned out the aircrafts flying overhead, they also tuned out the teachers at the front of the class (Bakalar, 6).

Chapter Two: Addressing Poor Classroom Acoustics with ANSI S12.60-2002

The Access Board soon came under pressure to amend ADA guidelines because of the overwhelming evidence that a student's ability to learn is greatly enhanced in an acoustically-treated classroom. In the 'Other Issues' section of the ADA's 1998 *Accessibility Guidelines for Building Elements Designed for Children's Use* is found the following:

Organizations representing people who are hard of hearing, as well as audiological and acoustical trade associations and consultants, recommended that the final rule provide acoustical performance standards for classrooms. These commenters recommended specifications for background noise-levels, reverberation time, and the signal-to-noise ratio. Acoustical standards have not been included in the final rule because none have been proposed and made available for public comment. While acoustics is an important consideration, not only in classrooms but other spaces as well, it has not been addressed at this time (ADA Accessibility Guidelines).

The Access Board issued its formal RFI to the general public soon after this statement. Dozens of responses were received from across the country, mostly from parents and acoustics industry professionals.

In 2000, the American National Standards Institute (ANSI) Committee on Noise, under the secretariat of the Acoustical Society of America (ASA), was given two years to

draft a standard for classroom acoustics. A working group was formed, and the standard was completed in 2002, later approved as ANSI S12.60-2002 (U.S. Access Board, ADA Accessibility).

The most important elements of the standard concern reverberation control, background noise-levels, and signal-to-noise ratio (SNR) (American).

Reverberation Control

The standard sets criteria for reverberation control in classrooms. Reverberation time (RT_{60}) is the most widely used term when discussing how a room responds acoustically, and is the duration for interrupted sound to decay 60 decibels (dB). It is a function of room volume, surface area, and sound absorbing properties of room materials.

The longer the RT_{60} , the longer sound “exists” in the room before dissipating. Long RT_{60} diminishes speech intelligibility, which is the ability to hear and understand the spoken word (Long, 25). Since speech intelligibility is vital in a learning environment, it is important for a classroom to have a very short RT_{60} . Appropriately located sound absorptive materials, such as acoustical ceiling tiles and sound absorbing wall panels, help to lower reverberation and keep speech intelligible, as well as alleviate echoes. ANSI S12.60-2002 stipulates an RT_{60} of 0.6-0.7 seconds in the mid-frequencies for “normal sized” classrooms.

Background Noise-Levels

Background noise is noise generated by heating, venting, and air-conditioning systems (HVAC), as well as noise from an outside source. Noise can transmit through walls, ceilings, and floors, and interferes with effective listening since it competes with the spoken word.

HVAC systems noise can be controlled through proper system design, as well as implementing noise control items such as acoustical duct liner, duct silencers, and quieter air diffusers. Systems equipment selection is a major factor, since some systems components are quieter than others.

Sound Transmission Class (STC) ratings are assigned in the standard to walls and floor-ceiling assemblies to better ensure background levels in classroom are minimally impacted by activities occurring in adjacent spaces and outdoors. Higher STC ratings result with increased construction material mass in floor/ceiling and wall assemblies (masonry, multiple layers of drywall, etc). Requirements for impact insulation are also presented. A background noise level of no more than 35 A-weighted decibels [dB(A)] for normal-sized, mainstream classrooms is suggested.

Signal-to-Noise Ratio

The SNR in this instance is the relationship between the sound level of the source (such as the teacher) and the background noise level of the room. The higher the background noise level, the louder the teacher has to speak to overcome it and be heard by the students. Background noise has direct effect on a proper SNR. Distance from the

source also has a significant effect on the SNR, since the level of a direct sound falls off in linear proportion to the distance between the speaker and the listener.

Speaking at the same volume as the background noise level is barely discernable to a lot of listeners. While many adults may be able understand speech at this level, most children cannot (Nelson, 29). Therefore, ANSI S12.60 suggests +15 dB SNR, which is clearly detectable to most people, particularly children.

Apart from the SNR, speech intelligibility can be enhanced by delivery and performance styles, and with the use of electronic sound amplification systems in the space (Bradley).

Additional Considerations

It is important to note that the standard only applies to unoccupied classrooms, and does not account for sound levels created by students, teachers, or activities in the classroom space. Permanent noise from building services or instructional equipment is already addressed, since these items impact the overall background noise-level. Less restrictive guidelines for cafeterias, gymnasiums, and ancillary spaces are also included (American).

Furthermore, subsequent literature has been issued by various members of the working group, and others in the acoustical consulting profession, that caution against the use of electronic sound amplification systems in classrooms (Lubman, "Classroom," 33). These systems work well only in acoustically-addressed, ANSI-compliant classrooms, and even then their use may not necessarily be appropriate. Large lecture-type classrooms

may necessitate, or benefit from, electronic sound amplification systems; however, implementation does not necessarily correlate with good classroom acoustics. At best, electronic sound amplification systems should be viewed as a possible compliment to classroom acoustics standards, but not as a substitute for ANSI S12.60-2002.

Chapter Three: Enforcing ANSI S12.60-2002

The original intent of the ANSI Committee on Noise was to draft classroom acoustics standards for subsequent inclusion in the Americans With Disabilities Act Access Guidelines (ADAAG), and to reference classroom acoustics in the International Building Code (IBC). However, opposition from the modular classroom and HVAC industries, led by the Air-Conditioning and Refrigeration Institute (ARI), successfully prevented the International Code Council (ICC) from mandating the standard as part of the IBC (Air Conditioning, ANSI). The attempt at an ADAAG revision also failed.

Opposition

Groups opposed to ANSI S12.60-2002 contend that the 35 dB(A) background noise-level limit is too strict (Air Conditioning, ANSI). “Simple” air-conditioning systems, such as standard wall-mounted fan coil unit ventilators and A/C window units, cannot attain this sound level, and many school districts do not have enough money in their budgets for quieter, central plant systems or split HVAC systems, which are better able to achieve the suggested noise-levels. Requiring ANSI S12.60-2002 in building codes would essentially prohibit the installation of a large number of HVAC systems, and would have a tremendously negative impact on the air-conditioning industry. Likewise, modular classrooms, though offering poor sound isolation and noisy air-conditioning units, are said to be a logical choice for school districts needing to accommodate high-growth before expansion (North Carolina).

In 2005, an ARI-funded study of 48 classrooms indicated that the average overall decibel reading was 47 dB(A): 12 decibels over the 35 dB(A) guideline (Air Conditioning, School Construction). Background noise came from mechanical systems and sound transmission from adjacent interior spaces; none of the interior partitions attained the recommended STC standard requirements. ARI contends that retrofitting these classrooms to meet the standard requirement will cost school districts an additional 4% to 19% of their budget.

Addressing classroom acoustics in the design phase still increases the construction budget, but by much less. Various sources have indicated a rise in overall construction cost of 1% to 3% (Nelson, 31).

Though lobbyists for these industries oppose this portion of the standard, the 35 dB(A) guideline is not out of the ordinary. As far back as 1950, Knudsen and Harris recommended 35 dB(A) in their pioneering architectural acoustics textbook, *Acoustical Designing in Architecture*, for “classrooms in which a quiet environment is especially desirable” (Knudsen). The World Health Organization, as well as nations such as England and Sweden, set their guidelines for 35 dB(A) as well, with little opposition (World Health).

Voluntary Standard

Though opposition has prevented ANSI S12.60-2002 from being required in schools, design professionals do become liable for good classroom acoustics if the school system or municipality require the implementation of the ANSI guidelines (Inside

Acoustics). ANSI S12.60-2002 also becomes a requirement if it is referenced in regulation, ordinance, or code.

In April 2004, the Minnesota Senate Education Committee approved a bill mandating all school districts in the state incorporate the standard in their construction documents. This set a precedent for other states to follow (Inside Acoustics). As of July 2005, ANSI S12.60-2002 has been adopted by the State of Minnesota, the State of Connecticut, the Ohio School Facility Commission, the New Hampshire State Board of Education, and the New Jersey School Construction Board, effectively making design teams responsible for good acoustics in schools (US Access Board, Implementing a New Standard).

Other bodies that have adopted parts of the ANSI S12.60-2002 guidelines, or have opted for other classroom acoustics standards altogether, include the New York State Department of Education, the Los Angeles Unified School District, Minneapolis Public Schools, the Washington State Board of Health, Washington D.C. Public Schools, and the California Collaborative for High-Performance Schools.

School District Opposition

The reason usually given by school districts for not mandating better acoustics in the classroom is a lack of money. Though school districts undoubtedly want quality resources and learning environments to maximize student potential, many districts feel that good acoustics come with a high price tag (Weaver-Dunn). To lower reverberation time, sound absorbing materials must be installed; to minimize background noise, noise

control procedures have to be introduced into the mechanical systems; to provide quality sound isolation, suitably heavy construction materials must be used. School districts cannot always afford such expensive improvements. Fixing acoustics after construction, either by modifying existing classrooms for noise control or integrating acoustics into already existing facilities, can be even more expensive than addressing the issue during the design phase (Weaver-Dunn).

Though a school district may not be able afford items necessary to comply with ANSI S12.60-2002, simple matters can still be addressed in the design phase. Mechanical equipment can be selected for lower sound level emission; classrooms can be located away from the perimeter of the building when noisy items exist outside; customary acoustical materials, such as carpet on padding and suspended sound absorbing ceiling tile systems, can be utilized in classroom interiors. These will cost the school district little, if anything, and still offer acoustical advantage.

As pointed out by the Coalition for Classroom Acoustics (CCA), however, school officials are often the greatest barrier against good classroom acoustics (Weaver-Dunn). School officials who state publicly that school budgets cannot incorporate necessary acoustical improvements are often able to find room in the budget for elaborate landscaping and the latest equipment for their sports teams. This is where the CCA and ASA are most needed: to impress upon those who control the purse strings the need for better classroom acoustics. The ASA, for instance, published a booklet in 2000 titled *Classroom Acoustics: A Resource for Creating Learning Environments with Desirable Learning Conditions*. The aim of the booklet was to educate architects and others about

the items necessary to improve acoustics, and the important role good acoustics plays in education (Classroom Acoustics).

Chapter Four: Conclusion

As far back as the late 1800s, research on classroom acoustics showed that noisy classrooms are detrimental to a child's education (Weaver-Dunn). The need for better classroom acoustics has been a long time coming; it took even the Access Board seven years after the passage of the ADA to act on this vital but often overlooked issue of equal access for the hearing impaired.

Slowly, education boards are themselves becoming educated. The adoption of ANSI S12.60-2002 by various bodies should be interpreted as recognition by some states and school districts that good classroom acoustics is not just a civil rights issue, but an important attempt to help children in every classroom realize their full potential.

Appendix A: Suggestions for Additional Work

The completion of this field project comes at a pivotal time for the issue of classroom acoustics and civil rights law. In 2003, the Access Board submitted portions of ANSI S12.60-2002 to the ICC in hopes of being included in the newest revision of the IBC. Acceptance of the provisions would have implemented classroom acoustics guidelines as building code requirements. The attempt failed, but enough interest was generated that another submittal is anticipated for 2006. Also in 2006, the Access Board will again address the possibility of amending the ADAAG to include classroom acoustics standards and guidelines. If passed, the impact would be greatly felt in the architectural and construction industries, as well as all associated fields.

The campaign for good classroom acoustics has made impressive strides since the matter first really came to issue in 1997. Since the release of ANSI S12.60 in 2002, 11 different states, local jurisdictions, and boards of education have adopted the standard or parts of the standard into their school design. The Access Board seems to be making sincere attempts in getting acoustical guidelines widely accepted on a national basis through rulemaking under the ADA and submittals for IBC revisions. If their endeavor falls short of nationwide acceptance, look for more and more states and boards of education to adopt their own acoustical standards much like those mentioned.

The biggest opponents remain industry (mainly, HVAC and modular classroom) and the school boards themselves. In terms of engineering, the air-conditioning and refrigeration industry stands to be the most impacted as classroom acoustics become increasingly accepted on a national level. It will be interesting to see how these industries

react if laws and building codes force them to adapt to the background noise-level guideline. These industries have to be convinced to re-engineer their products to integrate with proposed acoustical guidelines if classroom acoustics standards remain widely voluntary.

Lastly, states and local jurisdictions need to continue to be educated on the importance of classroom acoustics. It is a widely accepted notion that U.S. public schools lag behind other nations' public schools in terms of academic performance. One could deduce that classroom acoustics could be a major reason why—as mentioned earlier, many nations have mandatory acoustical standards for classrooms, so perhaps it would be worthwhile to conduct additional research to see how those countries with mandatory classroom acoustics standards compare to the U.S. and other countries without such standards.

Appendix B: Members of ANSI Working Group S12.42

According to Peggy Nelson in her 2005 *Acoustics Today* article titled, “The ASA Classroom Acoustics Effort,” the following people were members of ANSI Working Group S12.42:

ASA members: Robert Apfel, John Bradley, Bennett Brooks, Daniel Bruck, Angelo Campanella, Robert Coffeen, T. James DuBois, Stanley Ehrlich, John Erdreich, Richard Godfrey, William Hannon, Robert Hellweg, Murray Hodgson, K. Anthony Hoover, Daniel Johnson, Howard Kingsbury, Jerry Lilly, Harold Merck, Peggy Nelson, Michael Nixon, Stephen Payne, Jr., Karl Pearsons, Richard Peppin, Joseph Pope, Daniel Queen, Stephen Roth, Kenneth Roy, Mark Schaffer, Neil Thompson Shade, Gary Siebein, Joseph Smaldino, Sigrid Soli, Noral Stewart, Brandon Tinianov, Ewart Wetherill, and William Yost.

Non-ASA members: Karen Anderson, Daniel Collings, Carl Crandell, Gary Ehrlich, David Fagen, Jay Gould, Steve Inglis, Cheryl Johnson, John Lyons, Ronald Moulder, Julie Olson, Richard Randall, Linn Redden, Anne Seltz, Linda Semesky, Donna Sorkin, and Sarah Woodhead.

Glossary

Access Board: See *Architectural and Transportation Barriers Compliance Board*.

air diffusers: A distribution outlet for air-conditioning, heating, and ventilation, typically located in the ceiling at the end of the air duct.

air handler units: Air-conditioning components (fan, filters, coils, etc.) in a packaged assembly, used for distributing conditioned air to building spaces.

ambient sound level: See *background noise*.

Americans With Disabilities Act (ADA): Civil rights law passed in 1990, meant to ensure equal access to and usage of public and governmental buildings and facilities to individuals with disabilities.

Americans With Disabilities Act Accessibility Guidelines (ADAAG): Document developed under the Americans With Disabilities Act (ADA); Titles II and III stipulate that new building construction and alterations to existing buildings shall be in compliance with the ADAAG.

ANSI S12.60-2002 (“Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools”): Standard for classroom acoustics, to be included in public school design; voluntary unless enforced by regulatory power such as city code or state law.

architectural acoustics: The study of sound and acoustical behavior within a building or architectural design.

Architectural and Transportation Barriers Compliance Board (“Access Board”):

Independent federal agency responsible for developing guidelines for standards released under the Americans With Disabilities Act; the Access Board developed the Department of Justice’s original Americans With Disabilities Act Accessibility Guidelines in 1990, entitled *ADA Standards for Accessibility Design*, and all subsequent revisions.

architectural barrier: Building design that prevents individuals from equal opportunity to the usage or access of any interior or exterior public space.

A-weighted Scale [dB(A)]: A common and convenient one-number reference to sound level; derived by adjusting levels in octave frequency bands according to human ear sensitivity, then combining levels.

background noise: The combined noise of all sound sources in a particular space. HVAC systems noise, sound transmission from adjacent interior and exterior spaces, and other “fixed” sounds contribute to the background noise in a classroom.

building code: Rules and regulations mandated in buildings for safety and public welfare considerations.

Code: See *building code*

construction documents: Building design drawings and specifications manuals.

decibels (dB): Logarithmic measurement ratio describing the power and pressure level of sound.

duct silencers: A device usually constructed of sheet metal and sound absorbing material, used to attenuate sound within a relatively short length of duct.

duct liner: A fiberglass lining, usually 1-2 inches thick, applied to the inside of the sheet-metal duct of an air-conditioning system; used to reduce noise transmitted along the duct.

frequency: The number of oscillations per second of a sound wave; the lower the frequency, the more “bass” or “rumble;” the higher the frequency, the more “hiss” or “squeal;” expressed in hertz (Hz).

impact insulation: The application and implementation of materials used to reduce the transmission of impact noise.

Impact Insulation Class (IIC): A single-number rating used to determine the degree of impact noise in a floor-ceiling construction; the higher the number, the better the impact insulation.

impact noise: Sound transmitted through the structure as a result of impact; typically, footsteps, door slamming, etc.

Individualized Education Program (IEP): Program developed under the Individuals With Disabilities Act (IDEA), requiring a school to form an individualized curriculum based on a child’s disability, at the request of a parent or guardian.

International Building Code (IBC): Comprehensive building code developed for reference and incorporation into regional building codes.

International Code Council (ICC): Federal organization responsible for drafting and issuing the IBC and subsequent revisions.

mechanical equipment: General term for refrigeration, air-conditioning, and plumbing systems equipment and components.

noise control: The technology of controlling and abating noise for obtaining an acceptable noise environment.

reverberation: The existence of sound in an enclosed space persisting from diffusion, scattering, and other reflections.

reverberation time (RT_{60}): The time duration for interrupted sound to decay to 60 decibels; sometimes abbreviated as T_{60} ; measured in seconds.

signal-to-noise ratio (SNR): Sound level of messenger, minus the background noise level.

sound amplification systems: A system of microphones, power amplifiers, loudspeakers, and associated controls; used to increase the level of a sound source within an interior or exterior space.

sound transmission: The passage of sound from one space to another (typically room-to-room, floor-to-floor, etc.).

Sound Transmission Class (STC): A single-number rating used to determine the degree of sound insulation of a building element, such as a wall assembly, floor assembly, window assembly, etc; the higher the number, the better the sound isolation.

speech intelligibility: The comprehension and auditory understanding of the words within a spoken sentence; in general, the longer the reverberation time, the poorer the speech intelligibility.

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Author's Note

This field project began as a term paper for a graduate level class taught in the Engineering Management department at the University of Kansas, *Law and the Design Professional*. The impact of civil rights legislation on classroom acoustics so interested me that, even after the class was over and the paper turned in, I continued to collect journals, books, and industry group emails on the subject.

Of course, sieving through all of this information was an arduous task. At the time of this writing, only a handful of states, local jurisdictions, and school boards have adopted a classroom acoustics standard. It seems obvious, though, that the issue is gaining support, and there will be much to keep on top of over the next several years. The changes will be fascinating to watch, and the challenges interesting to take on. I look forward to my continued work in this area.