Education Stakeholders and the ANSI Standard for School Acoustics

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The new standard for classroom acoustics (ANSI S12.60-2002) has generated much interest – and some anxiety in the school planning and design community. The standard is not mandatory but can be adopted voluntarily by schools or school districts. The standard specifies maximum noise levels and reverberation times in unoccupied classrooms, and minimum values of sound isolation between classrooms and adjacent spaces. ANSI-compliant classrooms are inclusive: the vast majority of teachers and students will find such spaces comfortable and effective for teaching and learning. This article addresses some questions asked by stakeholders in the education and school building process, and looks at the historical role of acoustics in school planning.

Some stakeholders in the school building planning process were surprised by what they perceived as tough noise criteria in the first U.S. national standard for school acoustics.[1] Why is a school acoustical standard needed, and why were some surprised by its noise level criteria? ANSI S12.60-2002 and its criteria are intended to ensure classroom acoustics that are adequate for classroom learning for most people. If the ANSI criteria came as a surprise to some educators and school planners, it is because the acoustical literature was ignored or disregarded. More than a half-century earlier, eminent acoustical scholars Knudsen and Harris made essentially identical noise recommendations!

Knudsen and Harris stated in 1950 that unoccupied noise levels should not exceed 35 dB(A) " . . . in classrooms in which a quiet environment is especially desirable" (now termed core learning spaces) and 40 dB(A) in "ordinary classrooms" (now termed ancillary learning spaces).[2] In 1968 Kingsbury and Taylor provided recommended guidelines for the acoustical design of classrooms.[3] These recommendations were not disputed, but widely ignored by educators and school planners. As a result, American schools were usually built with acoustics that fell short of meeting educational needs. This practice has had serious consequences for our knowledge-based society. The 56-member ANSI S12 Working Group that prepared the standard hoped it would change the way schools are planned and built. Stakeholders in the school building process have questions about the need for these changes. They also want to know their costs and benefits.

Objectives

Key noise and reverberation time requirements of ANSI S12.60-2002 are shown in abbreviated form in Table 1. For the complete requirements, including sound isolation (STC and IIC) see the standard. Its 35 dB(A) background noise limit for unoccupied core classrooms was determined independently of the recommendations of Knudsen and Harris. The ANSI noise limit is intended to assure a minimum 15 dB speech-to-noise ratio near the back of a typical lecture classroom with an average talker speaking with a raised voice effort typical of teachers in lecture settings.

How Many American Schools Meet the ANSI Criteria? No large-scale study has been made to learn how many American schools meet the ANSI criteria. A 1995 survey by the US General Accounting Office found that 28% of schools surveyed listed "acoustics for noise control" as the most serious environmental problem in their school. It seems very likely that education is degraded at noise levels well below the level where most people recognize an educational impact.

We estimate from very limited data that about two-thirds of American classrooms fail to meet the 35 dB(A) noise criterion. About half the classrooms examined had noise levels exceeding 45 dB(A). No reliable data for the distribution of reverberation time are available, but it seems certain that a significant fraction of classrooms will fail to meet the ANSI reverberation time criteria.

Many are surprised to learn that even a 'small' excess of noise or reverberation can seriously degrade learning. This is most likely under marginal listening conditions. Degradation may be due to increased stress levels, reduced attention span, misunderstood words, lost class time for repetition of material, and vocal strain. The adverse impact of marginal acoustics is far worse for English language learners, those with even modest temporary or permanent hearing loss, those with Attention Deficit Disorder or other learning disabilities, poor or unmotivated learners, and young children just learning to read.

Different Appearances? Attention to appearance instead of functionality lies somewhere near the root of the persistence of poor acoustical design of classrooms. Schools that meet the ANSI criteria may, but need not, look different from schools that are otherwise well designed. However, there are some features that are *not* seen in schools that meet the ANSI classroom acoustic standard.

Do not expect to see open plan classrooms. There is no known way to prevent the sounds from one learning group from intruding on adjacent learning groups in open plan settings. For the same reason, do not expect to see adjacent classrooms separated by partial-height partitions in ANSI-qualified schools. Partial-height partitions are mere visual barriers and are not acoustical barriers. Despite the magical beliefs of some educators, an increasing number of their colleagues recognize that what is heard but not seen from an adjacent classroom can have a negative effect on childrens' educations!

Further, do not expect to see unfinished ceilings that display building utilities such as ventilation ducts, water, electrical and gas pipes. Acoustical ceilings are almost always needed to reduce reverberation and acoustical cross-talk between classrooms. Money-strapped designers have sometimes eliminated acoustical ceilings and then proclaimed their poor design an innovative educational feature. Why build classrooms that inhibit learning?

Education Stakeholders

Table 2 is a short alphabetical list of education stakeholders, intended to suggest broad categories of people who may be impacted by changes in the acoustical design of school buildings. To the extent feasible, all stakeholder interests were represented on the unusually large ANSI Working Group that developed the standard. The list is divided rather arbitrarily with user stakeholders listed in the left column and provider stakeholders on the right. Not all stakeholders appreciate how the standard may affect them. The initial reactions of a few stakeholders are summarized below.

Representatives of hearing-impaired students and their parents, and representatives of hard-of-hearing persons are very enthusiastic supporters of this standard. Young hearing-im-

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paired students have a great stake in immediate implementation. They cannot wait for compliant schools to be built. They often ask how schools can meet ANSI objectives through renovation. Some are seeking accommodation in school IEP (Individual Educational Plan) reviews. One parent has developed a relocatable sound-absorbing panel that can be moved to new classrooms as a hearing-impaired student progresses through school grades.

Audiologists, especially educational audiologists, are very enthusiastic supporters of the standard, and have promoted it within their professional societies. However, they have had little influence to date on its adoption or implementation by schools.

Representatives of HVAC system vendors and relocatable classrooms have actively opposed the standard. A major reason for their opposition is that wall mounted HVAC units currently used in many classrooms, especially in relocatable classrooms, are too noisy to comply with the ANSI standard. A recent and welcome exception may reflect a new supportive trend by HVAC system vendors.[4]

Representatives of HVAC system design firms have generally supported the standard. ASHRAE TC2.6 Subcommittee on Sound & Vibration Control has been a particularly strong supporter. They recommend a background noise criterion for school classrooms that is consistent with the background noise requirements specified in the ANSI standard.

Representatives of acoustical insulation vendors, including manufacturers of acoustical ceilings and panel absorbers, are supporters. Some vendors are promoting new products for the school market.

Representatives of school districts have had mixed responses. Some are very enthusiastic to support anything that promises to improve the school environment and student achievement. However, many administrators and planners are far more concerned with the potential cost impact for new construction and renovation than with their educational benefits. Advocates of the standard are collecting realistic cost information to counter misleading information conveyed to school administrators by adversaries.

There has been little response so far from representatives of other affected groups, including teachers, students with normal hearing, and parent-teacher groups. Advocates of the standard, including acoustical consultants, are being encouraged to use film and slide presentations in outreach programs.

Good classroom acoustics will not happen without support. It must be demand-driven by school owners and users. Mandating the standard in school design documents is a sensible way to ensure good acoustics.

Figure 1. Maximum A-weighted steady background noise levels and maximum reverberation times in unoccupied, furnished learning spaces.

Learning Space	Maximum one hour average A-weighted steady background noise level (dB)	Maximum reverberation times for sound pressure levels in octave bands with midband frequencies of 500, 1000 and 2000 Hz (sec)
Core learning space with enclosed volume < 10,000 ft^3 (< 283 m^3)	35	0.6
Core learning space with enclosed volume > 10,000 ft3 and ≤ 20,000 ft^3 (> 283 m^3 and ≤ 566 m^3)	35	0.7
Core learning spaces with enclosed volumes > 20,000 ft^3 (> 566 m^3) and all ancillary learning spaces	40[a]	b

a) When corridors are used solely for conveyance of occupants within the school building and structured learning activities do not occur, the A-weighted steady background noise level limit for such corridors may be increased to 45 dB. The use of corridors for formal learning purposes should be avoided.
b) Guidance for the control of reverberation is contained in Annex C of the ANSI standard.

Figure 1. Kindergarten students listen intently to their teacher's instructions in a typical elementary school classroom. Acoustics are an important, but often overlooked, ingredient in the learning environment. Photo by Heather Pierce.

Acoustics – A Stepchild of School Planning

How can the historic acoustical neglect of schools be explained? What lesson(s) can be learned from it?

The Missing Leg of the Stool – Neglect of Acoustics in School Environmental Requirements. Prior to the ANSI standard, environmental design requirements for schools could be likened to a three-legged stool with one leg missing. The two intact legs were lighting and air quality. Criteria for these needs were usually provided in local codes or in school construction bidding documents. The missing third leg was acoustics. With few exceptions, environmental acoustic criteria for school design were either absent or too lenient to satisfy appropriate speech communication guidelines for learning.[5] With the new ANSI standard, some education stakeholders are awakening to the need for change. Still, meeting new and challenging demands for better acoustical performance will require changes in school planning and design. These changes present challenges and opportunities for education's diverse stakeholders.

School Planners Have Plenty To Do without Acoustics. Consider that school planners have their hands full to fill the demand for affordable schools that meet tough new environmental standards. There are recent state and national requirements for physical accessibility, safety, energy efficiency, air quality, lighting, sustainability, etc. But there is no national requirement for good acoustics. Except for the states of Washington, Minnesota and New Jersey, state and local acoustical requirements for schools are usually absent or excessively lenient. And until now, there has been no serious acoustical standard for school planners to meet.

School Acoustics Looses in Value-Engineering Challenges. Money for school building is limited and must be balanced against competing needs. Value engineering is the field of battle

Table 2. Short list of stakeholders in education

User Stakeholders	Provider Stakeholders
Children and child advocacy groups	Acoustic and noise control engineers
English language learners and their parents	Architects
Hard-of hearing advocacy groups	Audiologits
Hearing-impaired students and their parents	Building code groups
Normally hearing students and their parents	Government officials
PTA and other parent groups	HVAC manufacturers
School boards and school districts	HVAC system designers
School planning and building officials	Acoustical material vendors
Special education students	School administrators
Teachers and educators	Taxpayers

for this competition. The monetary value of, for example, energy savings is fairly easy to estimate and justify. The monetary value of better acoustics has been difficult to quantify. It is even more difficult when participants in the value engineering process have little knowledge of acoustics and the consequence of acoustical changes. The result is that important and valuable acoustical features often lose out to less important but measurably valuable features in value-engineering challenges.

This problem could be eliminated by adoption of minimum criteria for school acoustics such as those given by ANSI S12.60-2002. In practice, however, participants in the value engineering process need skills to anticipate the acoustical consequences of architectural changes. Persons with these skills must be brought into the review process. Acoustical consultants can supplement value-engineering exercises when the designer team lacks those skills. The acoustical education that architects and designers receive will need to be strengthened *by the educators* through in-service courses and curriculum changes. It would also help if credible estimates of the monetary benefit to better learning by good acoustics were available to inform design tradeoffs.

School Acoustics Has No Strong Advocate in the School Planning Process. Everyone understands that the squeaky wheel gets attention. There are many squeaky wheels in the school planning process. There can also be indirect pressure on school planners from industry lobbyists and special interests. For example, well-organized industry groups are more likely to advocate noise levels that serve the needs of their industries rather than the needs of students and teachers. Until very recently, one influential industry group has advised schools that unoccupied classroom noise levels of 50 dB(A) are adequate for learning.[6] Public education officials, lacking the motivation and resources to verify industry claims, may pass them on to planners and to the public as revealed wisdom.[7] Historically, there has been no strong acoustical advocacy group to counter industry claims. Until recently, hardly any collective voice was raised to complain about inadequate school acoustics. With such a tiny constituency for school acoustics, it is not surprising that little research has been funded on the impact of poor acoustics on learning outcome.

There is also a problem identifying existing classrooms in need of acoustical improvement, as few schools can afford professional acoustical surveys. Classrooms that are in need of acoustical improvements must be identified by teachers, staff, students or parents. Experience has shown that classrooms with acoustical problems that are serious enough to degrade education often go unreported or unrecognized. A teacher may not report a suspect classroom to avoid being perceived by the school administration as a complainer. Teachers and students may not be conscious of a problem. In some cases hearing impaired students, their parents or school audiologists may be the first to notice and report acoustical problems. Teachers, school administrators and maintenance staff can learn to recognize, report and sometimes even repair acoustical problems. Acoustical awareness should be a part of teacher training.

Reasons for Recent Interest in School Acoustical Reform. Three factors promise to end the stepchild status of acoustics in school planning.

- First was the tireless personal advocacy of the late acoustician and visionary Robin (Buzz) Towne and his associates[8] and the active support of the late 1995-96 ASA president, Robert Apfel and late ASA Standards Director Dan Johnson.
- Second, the U.S. acoustical community (but not yet educators) rediscovered the guidelines for classroom acoustics, and recognized the critical link between classroom acoustics and learning that had already been established. It was clear that a national school acoustical standard was needed. Soon after this realization, the Acoustical Society of America organized enthusiastic volunteers to create the needed standard through its ANSI S12 Committee.
- Third was the embrace of universal design and design inclusiveness ideas by public officials and architects. From that, a need was recognized to accommodate children with hearing disabilities in mainstream classrooms. The U. S. Access Board, enforcer of the Americans with Disabilities Act, lent its support to the ANSI standard then under development, when they recognized that this standard could serve the needs of persons with hearing, language and learning disabilities.

Summing Up – Four Reasons for the Stepchild Status of Acoustics in School Planning. We suggest four main reasons for the past failure to press the legitimate need for school acoustics:

- Unawareness of the educational impact of poor school acoustics.
- No strong advocacy group for school acoustics.
- No strong national standard, until now, for school classroom acoustics.
- Acoustical criteria for schools are rarely put into building codes.

With so little awareness of the educational importance of acoustics, the absence of a strong advocacy group is not surprising. Without strong advocacy for school acoustics, there was little to motivate the development of an acoustical standard. Absent a recognized standard for school acoustics, and with no code requirement, there was little to motivate school designers to exceed the generally lax requirements.

Unawareness of the impact of poor school acoustics can eventually be overcome by education, albeit a slow process for the public. A long-term solution is mandating good school acoustics by incorporating acoustical criteria into state or national school building codes. Until that happens, each school board or local jurisdiction can adopt the ANSI standard voluntarily. The Acoustical Society of America encourages each school district in the nation to do so. INCE-USA has also taken a strong position endorsing the standard.

ANSI standard S12.60-2002 is a vital step toward ensuring that acoustics will no longer be a neglected stepchild in school planning and design. Public education is vital for the next step, which is for the standard to be adopted by school boards, implemented in building codes, or otherwise incorporated into design and renovation contracts.

What's Next?

Noise control engineers can play a vital role in this process. Much practical 'how-to' information intended to help school designers meet the current ANSI criteria cost-effectively is available, including online resources such as:
www.access-board.gov/publications/acoustics-factsheet.htm

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