Archival Audio Services
ABN50813640401

PO Box 36, BUNDARRA, NSW, 2359
Phone 02 6723 7040
http://www.archivalaudio.com.au

Classroom Acoustics

We have prepared this document in an effort to shed some light on the sad truth about the acoustics in a typical classroom, and to offer some (small) solutions.

Unfortunately, most classrooms are an acoustic nightmare, which is a real problem for kids. *But don't kids have better hearing than adults?* Yes, *some* do...but plenty don't. There are many types of hearing loss suffered by children. One of the most common is *Chronic Otitis Media (*in some areas, up to 85% of Aboriginal children are affected). And then we have various *Auditory Processing Disorders*, as well as *Attention Deficits* and general learning difficulties. And then we have kids who have come from a non-English-speaking background.

All of these scenarios make it hard for kids to attend to lesson content. And even kids with 'perfect' hearing need better acoustics than do adults to reliably perceive speech. *Why is this?* Because adults have been listening to (and making sense of) speech for a long time...we've had lots of practice...but kids are still learning to perceive speech. Maybe (before we get into our noisy classroom) it's time to discuss *Phoneme Restoration.* This is a perceptual skill that enables us to 'reconstruct' speech that is obscured by noise. We do it all the time, and we're so good at it that we don't even realise we're doing it. In our day-to-day life, speech is frequently masked by noises: doors slamming, knives and forks clanking, dogs barking...and yet we usually manage quite well. Our perceptual mechanisms 'convert' portions of the noise into the sounds that we expect to hear (this is all done in the brain, of course, not in the ear). This is because we are very adept at building up a picture in our minds of 'what we expect to hear', based on context, familiarity, and general knowledge. But we're adults. Kids can't do this, because they're still at the stage of life where 'everything is new'...expectations aren't as robust for kids.

There's a philosophy book somewhere that describes a situation where Mum and Dad and Toddler (in a high chair) are sharing a meal...all of a sudden, Dad 'levitates'...he starts hovering around the room, and he waves as he sails past the light-shade...Toddler laughs, and waves back...Mum has a heart-attack and dies...this is because Mum has pretty much decided what's real (and what's *not* real) in the world...but Toddler is open to new and unfamiliar things, and happily accepts the fact that Dad can fly. This is why Mum (if she were still alive) would probably have no trouble making sense of speech in a noisy environment...she has a very good idea of what to expect. But Toddler really doesn't have these entrenched expectations...after all, she is still learning about the world. And she is still coming to grips with her native language, and will be for many years to come.

But let's get back to the classroom. Now that we know why acoustics are so important for kids (especially considering that they're trying to learn schoolwork as well as to perceive speech), and even more so for kids with hearing impairments or learning difficulties, we can discuss how classrooms fall short, as well as what we can do about it. The main acoustic problems faced by classrooms are *Ambient Noise Level* and *Reverberation*. These will be discussed separately.

Ambient noise level is a measure of 'background' sound. In an ideal classroom, this should be about 35 dBA, or less. Unfortunately, in many classrooms, these figures can be in the 60s or 70s. As normal speech sits somewhere between 50 and 70 dBA, we often have the scenario where the teacher's voice is swamped, and s/he has to shout. The difference between voice level and background level is known as 'signal-to-noise ratio', and should be (even for listeners with no hearing loss) *at least* +15 (meaning that if the speaker's voice level is 65 dBA, the noise level should be below 50 dBA) to allow for reliable speech perception. And of course, signal to noise ratio decreases with distance between talker and listener…it's always worse when the teacher is at the other end of the room, or facing the other way.

Reverberation is the other serious problem that affects classrooms: it is measured as the time taken (in seconds) for a sound to decay by 60 dB, and is called RT (60): a 60 dB decay is where we perceive a sound to have disappeared. Back in our ideal world, RT (60) for reliable speech perception is around 0.4 seconds. In our classrooms, however, figures of between 1 and 2 seconds are not uncommon, and in this situation the significant bits-and-pieces of speech sounds begin to overlap each other: this is, of course, a very serious problem when the listeners are children, who are still learning to make sense of their own language; the effort required to disambiguate 'messy' speech sounds seriously detracts from attention to lesson content.

What can be done? Quite a bit, actually. Although some ambient noise is beyond our control (we can't move the main road, or the airport), if we have a really hard listen we can identify lots of small things that really do add up: things that clank and squeak and bang, such as drawers, chairs, tables and things stored in tin-cans, can be modified. Rubber chair-tips work wonders; felt pads can silence doors and drawers; if there's a noisy fridge, move it or replace it. Lawnmowers are one of the worst sources of external classroom noise: have a word to the school principal, and see if the mowing can be done out of teaching hours. And even seemingly innocuous things like wind-chimes (or 'mobiles' made from knives and forks) can make word recognition hard, especially for the younger students who aren't yet adept at phoneme-restoration. So just have a listen, and take note of the things that make noises…then attack them.

The other thing we can do, which is equally important, is reduce reverberation time and 'soak up' some sound. This can be done by adding soft surfaces, and by breaking up the acoustic space. Carpet is a wonderful absorber of sound, as are fabric wall-hangings (great art projects) and soft-surfaced display boards (especially if they're placed at angles: this reduces parallel surfaces, and makes it harder for sounds to bounce back and forth). Hang things from the ceiling, especially soft things. Open-fronted bookshelves break up and absorb sound (libraries aren't quiet just because of the rules). View any flat, hard surface (including glass) with suspicion, and if you can hide it or soften it or make it more complex, you will make a difference. And if the budget allows it, have acoustic ceiling tiles installed: these make a huge difference to RT (60).

Once you've reduced the ambient noise, and reduced the reverberation time, you will notice that not only will the students 'hear better', they will also be quieter themselves. This is due to the Lombard Effect (or 'café effect')…when things become a bit hard to hear, we make more noise ourselves. Not convinced? Have a listen in a café sometime: as people become louder, everyone else becomes louder too…it's really a snowball effect. Ever been shouted at by somebody who's wearing headphones? That's because they can't hear you very well, and they assume that you can't hear them.

It's all perfectly human, and natural. But it works in reverse too, which is great for education: if the classroom is quieter, the students will be quieter too.