Modern Room Acoustics

Practical Sound Improvement in Large and Small Rooms

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First Edition

High-end stereo system, Los Angeles, CA.

Cover photo courtesy RiverRock Studios, Minneapolis, MN.
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Introduction

Unless your profession is acoustics, you probably don’t often think about the effects of rooms on sound. We live our lives immersed in a sea of sound but we’re not usually aware of how our rooms affect what and how well we hear. Most of us only notice “acoustics” when there are obvious problems. Outside noises intruding on an office conversation or hard-to-understand voices in a lecture hall are the types of problems you may have blamed on “bad acoustics” and you would have been correct.

There can be many acoustical problems in rooms, whether they were designed “acoustically” or not. The work of acoustical professionals is to mitigate the problems as much as possible given the constraints of time, money and practicality. For our purposes, practical room acoustics can be divided into two categories: less noise and better sound. Or in acoustical terms, soundproofing and room treatments.

We’ll explore these two categories separately because they have different sets of problems and solutions. First we need to examine the reasons these problems exist and we’ll do that at two levels: “what time is it?” (Overview); and “how does the clock work?” (Details). If you like to move through explanations quickly and arrive at possible solutions sooner you’ll want just the Overview. If you’d like to know cause and effect you’ll prefer a deeper dive into the Details. Or you might mix and match, depending on your goals. Your choice – both are presented here.

Humans have lived in various “rooms” from caves to skyscrapers over the span of millennia but the science of acoustics is a little over a hundred years old. While some comprehension of the effects of enclosed spaces on sound are intuitive because we’ve had millennia of living and working in rooms, our understanding of improving the acoustics of rooms both large and small is continuously evolving. As you read, please keep in mind that acoustical science is ongoing.

The Science of Acoustics has many related disciplines we won’t examine here – ocean, insect, infrasound and ultrasound are a few examples – we’ll focus on Architectural Acoustics, which is essentially human-audible sound in and around rooms of different sizes and shapes. Our intention is to simplify practical room acoustics for non-acousticians.
Creating Better Sounding Rooms Is Easier Than You Might Think

Acoustics is a term most people associate with complex concepts and deep science. And while there IS a lot of science in acoustics, understanding the basics – enough to help you make good decisions about improving the sound of your room – is easier than you might think.

For simplicity here, acoustics means improving sound in rooms. There are two categories that professionals use to help improve room sound - soundproofing and room treatments, and they are distinctly different. Soundproofing means less noise and treatment means better sound.

You may want less noise. The sound of traffic, neighbors and construction can be annoying and a quiet space can be very healthy. Or you may want your sound system or musical instrument to sound better in a room. You may want both to varying degrees.

Let’s look at soundproofing. The products used to lessen noise work by increasing structural mass and isolation. A room’s walls, ceiling and floor must be dense and isolated from the rest of the structure and all air gaps – such as doors and windows, heating and cooling vents and electrical sockets – must be sealed.

Think of soundproofing like weatherproofing. You want the structure to be as solid as possible and you want all the holes sealed so the weather stays outside and comfort stays inside. For soundproofing, the amount of mass and isolation needed depends on how much noise there is outside and inside your room and how much you want it reduced. A recording studio in a large city needs much more soundproofing than a stereo listening room in a house in the countryside. It all depends on your situation and your goals (and possibly your budget).

One common noise control tactic is to add more and isolated layers to sheetrock walls and ceilings by using resilient channels, wall-layer elastomeric compounds and acoustical caulking. Also, door openings can be effectively sealed with aftermarket door seal kits which place gaskets around the side and top edges with an automatic bottom seal which lowers when the door is closed. Floors can be isolated with elastic flexible underlayment barriers and windows can be sealed with clear removable magnetic covers. There are many products to improve soundproofing in a room (or a
Once a room is more soundproof you may want the room itself to sound better. Acoustical in-room treatments are used to reduce the destructive interference effects of strong flat-surface reflections from walls and ceilings. There are two types of treatment tools – sound absorption and sound diffusion. Absorption is somewhat like a hole in the wall. Some of the sound energy that would have been reflected into the room leaves the room and that reduces strong interferences. Diffusion smoothly spreads out the reflected sound energy in a room, also reducing the harmful effects of strong interferences. The best treatment plans utilize a combination of absorption and diffusion to improve sound in rooms.

Absorbers are usually made of fibrous materials like fiberglass, recycled cotton or mineral wool with a fabric wrap or cover and they are often in flat-panel form which can be easily installed on walls and ceilings (there are also micro-perforated panel absorbers – see Fig. 3). Determining how much absorption a room needs depends on the geometry of the space. Small cubic shapes usually need more treatment and large irregular non-parallel shapes usually need less. However, too much absorption treatment in a room will make the space sound and feel unnatural or overly muffled.

Diffusors can be smooth curved-surface panels or mathematically derived irregular-surface panels, either of which can also be easily installed on walls and ceilings. These types of panels have the advantage of spreading out flat-wall reflections that would otherwise combine destructively with original sound waves. A mix of diffusors and absorbers greatly improves sound in rooms by reducing harmful flat-surface reflections while retaining the room’s natural ambience.

Each room is different and your situation and goals may vary from reducing a few echoes in a hallway to building an amazing entertainment space for your family. The common elements in improving the sound in any space are to define the problems, clearly state the goals and choose a balance of solutions to accomplish the goals effectively. There is a wide range of acoustical products available to audio professionals, businesses, designers, homeowners, and everyone seeking less noise and better sound. There will always be a need for good sounding acoustical spaces. Our hearing system wants to make sense of the world and to make sure we’re safe so our ears are always attuned to our environment. Humans prefer rooms in which it’s easy to hear music, understand speech and feel safe from potential danger.

Also, there will always be a need for physical acoustical treatments. Regardless of digital-audio room-correction advances, the laws of physics have not changed and the effects of rooms on sound will always remain. First, fix the room acoustics. Then, if you still feel (hear) the need, use a digital system to alter the signal fed to the speakers. Just know that the room is always there, fixed or not, and fixed always sounds better. It’s easier to fix your room and be happy with it than you might think.