Acoustics 101

Practical Guidelines For Building A Sound Studio

Including Advice On The Proper Materials To Use

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Auralex acoustics

Acoustics 101

Welcome to our newly expanded **Acoustics 101**, the world's best source for bottom line, no BS, just-the-facts-m'am advice on how to build a good sounding recording studio or listening room. The tips contained in this small booklet have worked for me & have worked for others, including many of our most famous customers. They will work for you and, if well implemented, should exceed your sonic requirements and expectations without breaking your bank. We know these tips can save you a lot of time and grief.

What follows in **Acoustics 101** is knowledge we've gained over our decades of experience in broadcasting, music & acoustics– all condensed into one handy little reference guide & put into language virtually anyone interested in controlling sound can understand. It doesn't contain any hard-to-decipher charts or graphs. There's no smoke & mirrors, no dog & pony shows. Just good, solid, cut-to-the-chase advice that you'd be hard pressed to find anywhere else, & certainly not for free. We used to sell **Acoustics 101**, but are happy to be in a position now to provide it here for you at no charge. As acoustical consultants, we often charge quite healthy sums to impart this sort of knowledge, but feel free to read **Acoustics 101** at your leisure.... there's certainly no "per diem" charge like there'd be if we came out to consult you in person!

How confused you must be when you read so many conflicting opinions in the audio press about the "right" way to control sound–or even how to form a "correct" opinion of your own about what constitutes "desirable" sound. *I feel your pain*. All I can say is this: we at Auralex have decades of experience in broadcast, studio design, live performance & recording and have never had a single complaint about advice we've given. As the president of Auralex, I feel confident in saying that we know what it takes to make good sound and to make a room sound good. Our famous clients attest to our level of knowledge and the quality of our acoustical products. Collectively, we've built, worked in & consulted enough facilities that I feel we've got something valuable to offer you; something my personal search long ago taught me simply isn't available anywhere else: acoustical advice that doesn't cost an arm and a leg and that us plain folks can understand & put into practice all by ourselves.

One thing you'll probably notice right away–**Acoustics 101** is brief and to the point. No lab values, no intense charts, no graphs. No 500 pages of tiny print for you to weed through just to find the answer to some basic question.....just real-world advice. So, if you're a technohead who's obsessed with formulas, dBs, STCs, STLs, etc., you may not find in **Acoustics 101** what you're looking for. There are plenty of books at your local library written in that style; I should know, I've read most of them. If you have, too, and they got your head spinning and eyes rolling around like BBs like they did *mine*, you've come to the right place. **Acoustics 101** will give you just the sort of real world advice you were hoping you'd find in all those other books, but without all the additional fluff & tough-to-follow equations.

If you've not read all the other books out there, great! **Acoustics 101** could save you hours and hours of time and trouble because we've taken everything we've learned, thought up, observed and heard about in all our years in broadcasting, recording & pro sound and condensed the best parts down into **Acoustics 101**.

Are these tips the same ones you could get if you hired the "million dollar room" guys? In some cases, yes they are. Are these tips guaranteed to give you the world's best recording studio, one that'll test better than Oceanway and cost only $100 and 2 hours time to build? No.

What these tips *will do* is give you a solid basis of knowledge with which you can build a very functional recording studio, listening room or production facility without breaking your piggy bank. If you can follow directions, can think logically, have a little bit of money to spend and know how to do basic carpentry while paying careful attention to detail, you're well on your way to building yourself a solid, quiet room! Then, once it's built, if you treat your room with the appropriate Auralex acoustical products, you'll also have a great *sounding* room, one that'll be a pleasure to work in...be in...create in.

I'm no longer a commercial radio personality, but I'm still active in freelance voice work for commercials, messaging-on-hold and more, & we just built our production companies, Captive Audience™ Inc. & Alien Multimedia, a new 6-studio digital audio & video suite at our new headquarters. Everything you'll read in **Acoustics 101** has been put to use at our new facilities, so you know I personally place a lot of trust in these solutions.

I'm fully aware that there are loads of degreed acousticians out there who have written books and probably would be glad to spec out your new studio for you if you were willing to pay them $250 an hour. I'm also aware that many of them know no more than we do and that many of them know even less than we do. While the million dollar room guys can make acoustics seem like rocket science when it's appropriate and the budget allows, often you and I don't need that level of tedium and expense. We need somebody to give us good, easily-implemented advice. **Acoustics 101** does just that.

Another thing you'll notice: this booklet recommends that you use some of the products sold by Auralex. Now, are you free to substitute other companies' barrier materials, acoustic foams, adhesives, etc. if you choose? Sure you are; nobody's twisting your arm. But I honestly don't think you'll be able to find similar products that exhibit all our products' benefits & advantages–especially at our prices. This booklet is intended to provide you with sufficient knowledge so you can make the choice for yourself that our products are simply the best ones available to you. Even if you do ultimately decide to use other firms' products, though, we know you'll have a better understanding of acoustics and reap more enjoyment from sound in general having read **Acoustics 101**. If we can help facilitate that for you, we'll be happy.

So, enjoy Acoustics 101. We hope it answers the questions you've had floating around in your head & that you find the information it contains to be both easy-to-understand and useful. Now, get out there and build a great room, make great sound, make great money and most importantly ENJOY YOURSELF. You can do it!

By the way, USE YOUR HEAD WHEN YOU USE YOUR EARS™–LISTEN RESPONSIBLY!

Sincerely,

Eric Smith
Founder & President, Auralex Acoustics Inc.

The Basics

In writing this booklet, I make a few assumptions. I know the old saying about what happens when you assume, but I do so anyway.

I assume you're interested enough in improving your sound that you can put your brain into action to try to grasp **the concepts** put forth in these pages. While you can build a great room just by following these guidelines, there's nothing stopping you from putting on your thinking cap, putting these theories through your mental blender and coming up with even better ideas than I've written here. If you do, that's great! Fax me your ideas so all of us dedicated sound people & future A-101 readers can benefit from what you've come up with. When making changes, though, make sure you've really thought through the ramifications of what you're doing. Random substitutions could put you in a world o' hurt & degrade everything you've accomplished.

I assume you understand the basic methods involved in how sound behaves. That it gets through **any** small opening. That it bounces back and forth between hard, parallel surfaces. That the only two ways to stop sound from being transmitted from one space to another are **dead air** and **mass**. That **limp mass** is better than **rigid mass**. That every item, every construction material has a **resonant frequency** at which it's virtually an open window to sound–kind of like a tuning fork that goes nuts at its particular resonant frequency. That different materials have **different resonant frequencies**. That **trapped air** is a very good insulator to sound. That the best way to stop sound transmission through a building structure is to **isolate the sound source from the structure before the structure has a chance to vibrate**. That **walls** need to be isolated from **ceilings and floors**, usually by means of **dense, yet pliable rubber**. That **airtight construction** is what we're after. That **sound**, like air & water, **will get through any small gap**.

I assume you understand that acoustic foam, Auralex's core product, is not meant to fully "soundproof" your room. That it is an **extremely effective absorber of ambient, reflected sound** & helps make any room "sound better." That it does contribute *some* sound isolating properties, but isn't sufficient by itself to keep sound in or out of a room. That thicker acoustical foam is better at absorbing low frequency sounds. That controlling reflected sound within a room is **extremely important** in producing good sounding recordings. That when you hear Mike Wallace's voiceovers on 60 Minutes you're smart enough not to sit and say "Boy their studio sounds good. They must've spent a million bucks on it." That you're smart enough to say, instead, "It's amazing what some good 2" acoustic foam can do for a glorified, yet well-constructed closet."

I assume you have a few bucks to spend to make your studio the best it can be. That you're smart enough to realize that empty egg cartons, cork squares and carpet scraps aren't going to a) keep sound from leaving or invading your studio and b) aren't going to yield that pleasing, neutral, "Mike Wallace" sound within your studio. That you've made a reasonable **mental** commitment to improving your room, not just a **monetary** one.

I assume you realize that these guidelines, if improperly implemented by you, may not yield the desired results. That we can't be held liable for the advice given because we're not going to be there watching you do the work or helping you. That these tips are being provided free of charge and we're not charging you $250 an hour for our thoughts on how to build a good room. Caveat Emptor ("Buyer Beware"). Enter At Your Own Risk. Void Where Prohibited. Your Mileage May Vary.

I assume you know the differences between brittle and pliable caulk, and can sense the benefits of & are ready to get messy with silicone caulk, the pliable kind.

I assume you either know how to handle a circular saw & other common power tools or have the money to hire someone who does. That you can apply drywall tape and mud or can hire someone who can. That you've got at least a basic understanding of the importance of solid, level construction techniques. That you know the meaning of the phrase "Measure twice, cut once." That you're not going to settle for less than perfect (i.e. tight, well-joined) construction.

I assume that you see the benefits of constructing your studio, if at all possible, to be symmetrical geometrically and to be built out of the best materials you can afford. That you realize money well spent now will benefit you for a **long time** into the future.

I assume that you're more concerned with **real world results** than what a computer printout says. That you believe that one of the keys to getting good, clean sound on tape or hard disk is **removing the sound of the room from the equation**, to one degree or another. For a great example of this objective successfully implemented, listen to the Eagles' *Hotel California* or Pink Floyd's *Dark Side Of The Moon.*

If these assumptions I've made are correct, you're gonna do just fine. If not, you might have a bit more work ahead of you than the next guy, but you'll still be able to grasp the concepts and get excellent results, it just may take you a bit longer. Rest assured, though, that any extra effort you expend implementing the tips contained in **Acoustics 101** will pay you back sonically for a long time to come. **Make no mistake: they're worth whatever work it takes to put 'em into practice.**

Good Luck and Happy Reading!

Materials & Products Specified

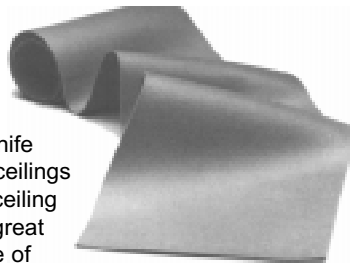
In **Acoustics 101** a few materials and products are specified which you might not be familiar with, so I'll cover them here in no particular order. Your local lumberyard or hardware store can probably guide you if you don't know exactly where to pick up the items discussed, just be careful not to let them steer you wrong with substitutions or deletions. You don't want to fall victim to the old "Ya know, my brother-in-law used to date a girl whose cousin knew a guy who got fired as a janitor at a radio station once, & you know what they used...." The reason I wrote Acoustics 101 in the first place was to combat bad or misguided advice being given by other so-called "experts" in the field!

Regarding substitutions, the second reason I wrote Acoustics 101 was to keep our staff and phone system from being tied up so often arguing....uh, I mean, uh, *gently reasoning*....with some weenie who can't understand why he can't just rip down his drywall, slap up some $8.99 paneling and call hisself a recording studio. I'm not suggesting that a good-looking, intelligent and well-dressed individual like you could possibly think and act like that, but I'm sure you see my point and can realize how these sorts of conversations can really gobble up 800 line time and monopolize business days. **Think about it: what worked once to construct a tight, good-sounding recording studio will work umpteen thousand more times because sound never changes.** Auralex isn't equipped to, nor is there any legitimate reason to, reinvent the wheel 60 dozen times each week, which is exactly what we were doing before **Acoustics 101**. So please, have a heart and don't call to ask us why you can't substitute 1/8" masonite for 5/8" drywall..... The methods and materials outlined here have proven themselves to **work** many times over and should prove more than sufficient for your needs. Also, with few exceptions, don't add multiple layers of the materials specified; in this case more isn't necessarily better due to the resonance issue noted previously.

Lumber & Construction Materials

You can construct a perfectly good-sounding, airtight recording studio with common, easily-located materials. There is simply no "magic" material that you absolutely must use if you're to have a good room. The materials discussed herein are available at any decent lumberyard and won't set you back two years' salary. They're common items like 2x6s, 1/2" & 5/8" drywall, 3/4" tongue & groove chipboard or plywood, 3/4" particle or MDF board (compressed sawdust mixed with glue; MDF is more dense than regular particle board), drywall screws, construction adhesive, silicone caulk and more. For those of you who aren't used to building things, bear in mind when figuring your dimensions that lumber isn't really the actual dimensions it's called by. For instance, a 2x4 isn't; it's actually 1½"x3½". A 2x6 is 1½"x5½", etc.

SheetBlok™ Professional Sound Barrier



Auralex's proprietary limp mass, dense vinyl sound barrier material available in 10'x4' sections or 30'x4' rolls. It is 1# per square foot, 1/8" thick, highly flame retardant, easy to install with plastic-cap nails, staples or trowel-applied PL PRO construction adhesive or multi-purpose floor adhesive and yields a great **Sound Transmission Class (STC)** of **27**. Compared with a sheet of solid lead which only yields an STC of about 21, SheetBlok is safer, cheaper, easier to work with, more effective, easy to cut with scissors or an ordinary utility knife and UPS shippable (when necessary) right to your door. It is used to "float" walls, floors & ceilings (isolate them from the rest of the structure), or as one or more of the layers in a wall or ceiling intended to block the transmission of sound to neighboring spaces. It has been used with great success by our most famous clients & is simply **unbeatable**. SheetBlok is quite simply one of the best investments in good sound control that you'll ever make.

Tubetak™ Permanent Liquid Adhesive

The world's best acoustic foam adhesive, guaranteed to keep your foam up for as long as you want it there and not to "eat" your foam. Also works great to attach various materials to each other during construction of your studio. Tubetak applies easily with a standard caulking gun and gives a solid, permanent bond that actually improves the sound isolation of your construction. You don't want to use Liquid Nails brand because its very manufacturer published a memo some time back advising that it not be used with foam due to possible chemical interactions that can cause the foam to disintegrate prematurely.

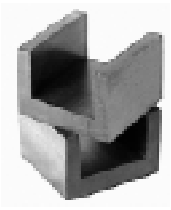
Foamtak™ Spray Foam Adhesive

Auralex's own proprietary brand of spray adhesive that has to be the easiest foam mounting solution on the planet. Using Foamtak can save you **tons** of time & effort! Foamtak features a unique "web-like" spray pattern that gives it a real competitive advantage–it doesn't soak into the foam like other brands do, which is why they so often **fail**. **Foamtak absolutely rules!**

Studiofoam™ Sound Absorbent Wedges & Pyramids

Simply the world's best and most complete line of acoustic foams at prices that make our competitors cry, modify their product lines to try to be more competitive with us or even leave the business entirely. Acoustic foam is such an important component of *any* studio's sound control that some mention of our various foam products and their functions is warranted in **Acoustics 101** and may be found in the following pages. Overall, there is no better or simpler way to make **any** room sound better.

U-Boats™ Rubber Floor Decouplers



Recently we developed what we think is the world's best solution to an age old acoustical problem: how to physically decouple ("float") a floor without having to use rigid mechanical fasteners like screws or without having to take out a second mortgage. Described in full detail in our brochure, U-Boats make quick work of floating a floor at a price virtually anyone can afford. They are much smarter than the expensive rubber "pucks" that have been used by acousticians in the past. Not only don't you need a PhD to use 'em, U-Boats yield better sway resistance than pucks, are not rigidly attached to your existing structure and are **much more affordable** to boot. What else is there? Famous studios and recording artists are using 'em.

Resilient Channel (or RC for short, aka "Z" Channel)

This is a piece of metal shaped like a Z to which drywall or other building materials can be mounted to isolate them from the framing members (studs) of a wall or ceiling. One leg of the Z (turned sideways) attaches to the stud, the other leg to the layer of building material being hung. This isolation helps improve the structure's ability to achieve greater sound transmission loss (see definition below). Special screws must be used so they don't penetrate through the Z and get into the studs, which would defeat the whole purpose of the channel. Z channel can be expensive in some markets, but if well implemented is definitely worth its price.

Soundboard

The term soundboard is often misunderstood, so I'll try to set the record straight here. Many people mistakenly use the term to describe materials like regular drywall or even particle board. This isn't accurate. Soundboard is actually a description for a brown, compressed paper board that is usually 1/2" or 5/8" thick & is manufactured by the Celotex company. The best way to describe it for you here is to say that it's alot like a sheet of masonite or pegboard, only thicker & a bit softer. It may go by other names like "Homosote" in your neck of the woods, but if you describe it to your building materials supplier, he can probably direct you to it. It is pretty dense, so it makes a good layer in a multi-layered wall configuration. In conjunction with layers of 5/8" drywall, 3/4" particle board or MDF & SheetBlok, it's really effective at blocking the transmission of sound.

Some Brief Definitions & Statistics

The two ratings of how sound control is measured are listed here with their respective definitions so you'll know what the heck Acoustics 101 is talking about.

The first is **NRC (Noise Reduction Coefficient)**, a numerical rating given a material which tells us how much airborne sound the material absorbs. This rating generally applies to soft materials like acoustic foam, fiberglass, fabric, carpeting, etc. but also applies to much lesser degrees to harder materials like brick and drywall. A material's NRC is an average of its absorption at various center frequencies between 125Hz & 4000Hz. The higher the number, the better an absorber the material is.

The second is **STC (Sound Transmission Class)**, a numerical rating of how effective a material is at blocking the transmission of sound through itself. This rating generally applies to hard materials like rubberized sound barriers, concrete, brick and drywall but also applies to a much lesser degree to softer materials. Virtually every material filters out some of the sound that travels through it, but dense materials are much better at this than are spongy materials.

Another Important Definition

If you've read any books or articles on acoustics, you've probably run across the term "**room modes**." A room mode is a bump in a room's frequency response that is facilitated by the room's dimensions and the way those dimensions cause soundwaves to interact with each other. There are three types of room modes: axial, tangential and oblique. While there's no such thing as a "good" room mode, tangential and oblique ones are much less detrimental to good sound than are those dastardly **axial** modes. There are intricate formulas in books at your library that can help you determine your room's modes; there is also software on the market that can do the same. Auralex has such software and would be glad to work with you or your salesperson in figuring your room's modes to help steer you in the direction of the proper acoustical treatments. (This offer only goes for those of you who are in square or rectangular rooms; no weird-shaped ones please. That gets really tricky & can take days of computations.)

Common Wall Configurations & Their Sound Transmission Coefficients

As mentioned before, trapped air and mass are the two components that are most effective at stopping the transmission of sound from one space to a neighboring space. This fact is plain to see when you examine the STCs generated by various types of walls.

- Single wood stud wall, 16" o.c., with 3½" R11 insulation and a single layer of ½" drywall on each side: **STC 38**
- Same wall, but with a double layer of ½" drywall on both sides: **STC 41**
- Same wall, but with the double layer of drywall on one side mounted to resilient channel: **STC 53**
- Staggered stud 2x4 wall, double layer of ½" drywall both sides, with 3½" R11 insulation: **STC 53**
- Two identical 2x4 walls, each with 3½" R11, built ½" apart, outside face of each with double layer ½" drywall: **STC 60**
- Single metal stud wall, 24" o.c., with 3½" R11 insulation and a single layer of ½" drywall on each side: **STC 49**
- Same wall, but with a double layer of ½" drywall on both sides: **STC 54**

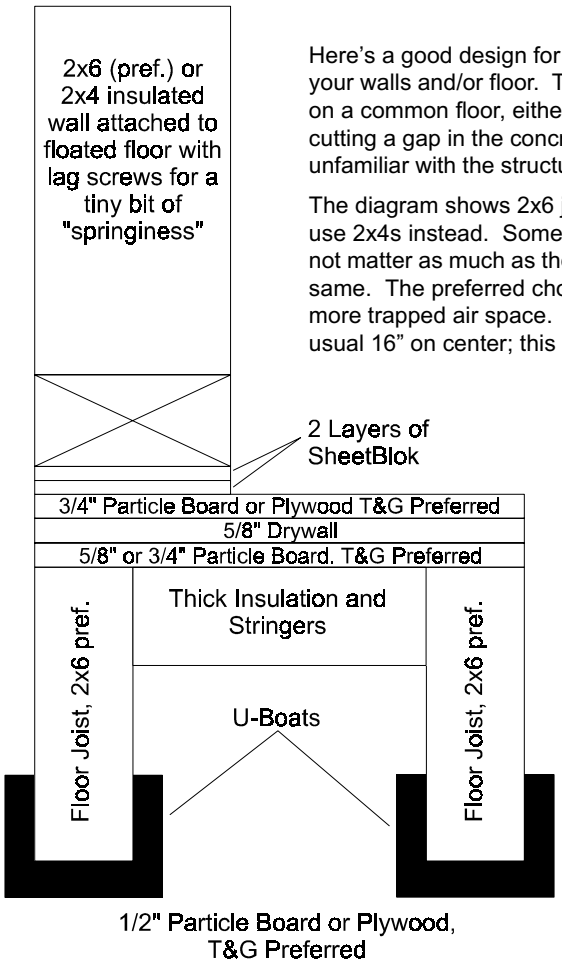
Clearly, while some of these designs yield STCs that approach those necessary for studio construction, none of them hits a home run. The addition of a layer of SheetBlok, with its **STC of 27**, can yield the extra control necessary–saving you time, money and floorspace in the process.

Useful Absorption Coefficients

Here are absorption figures for some common building materials. They plainly illustrate the need for specialized acoustic materials in studios that require well-controlled sound.

- Heavy carpet on concrete: 125Hz NRC=0.02, 4KHz NRC=0.65
- Wood floor: 125Hz NRC=0.15, 4KHz NRC=0.07
- Plate glass: 125Hz NRC=0.18, 4KHz=0.02
- Painted concrete: 125Hz NRC=0.01, 4KHz NRC= 0.08

Floor & Ceiling Construction



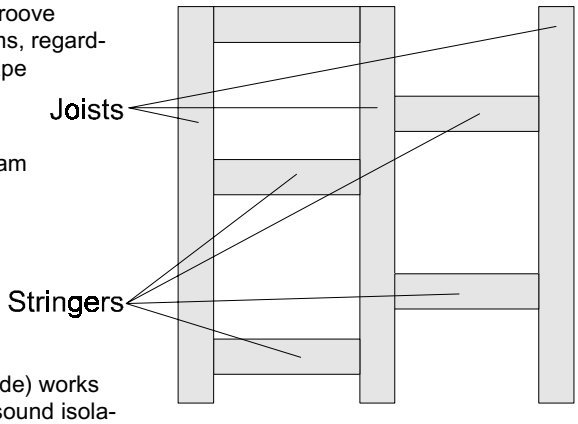
Here's a good design for those of you who have the vertical space to spare and need to float your walls and/or floor. This is perfect for when a studio and control room are both going to rest on a common floor, either wooden or a concrete slab. If yours is concrete, consider (carefully) cutting a gap in the concrete between the two rooms first, then proceeding as follows. If you're unfamiliar with the structural ramifications of doing this, please consult a local expert.

The diagram shows 2x6 joists and walls, but if you don't have the space or the money, you can use 2x4s instead. Some may even have to go to 2x2s or 2x3s; the specific material used may not matter as much as the proper implementation of the materials; the general method stays the same. The preferred choice if you have the space, though, is 2x6s because they allow for more trapped air space. Consider installing your studs and joists 12" on center instead of the usual 16" on center; this makes your construction much more solid for improved isolation. It is also advisable to caulk all the joints where studs meet drywall (if physically reachable from the back). Use a strong construction adhesive or Tubetak to glue your layers of wall in addition to screwing them.

If you can't build your floor or ceiling exactly as pictured, for whatever reason, be it a space limitation, lack of funds, etc., first try to grasp the concepts used in the construction pictured. If you're serious about wanting to stop sound transmission, you've **gotta** isolate the sources of sound from the structure. Air and mass are your friends. Put 'em to work for you!

The wall actually rests on two layers of SheetBlok to de-couple it from the floated floor below. In a perfect world it would be preferable to glue the SheetBlok to the bottoms of the wall plates and joists instead of nailing it; in fact, wherever possible, glue any materials you can together rather than nailing or screwing them. But you've got better things to do than glue SheetBlok to your walls' bottom plates, so just tack nail or staple it into place. The reason gluing is recommended is that the adhesive itself will have its own resonant frequency, so it will actually contribute some degree of sound isolation via filtering, too. Nails and screws serve as bridges acoustically and transmit sound from one layer to the other too well, so you want to avoid them whenever possible. Pick screws over nails (preferably used in conjunction with glue) because they form a tighter bond that yields less resonances. Example: I suggest gluing the particle board down, caulking the seams & boundaries, then gluing down the drywall, taping & mudding the seams & caulking the outside boundaries. Lastly, I'd glue down the final layer, whatever you use, finally screwing through all three layers into the joists & caulking all seams & boundaries. This makes less penetrations than if you screwed down each layer.

Adjacent layers of materials should be rotated 90 degrees so no seams line up (see diagram on the next page) and, if used, the preferred tongue & groove (T&G) materials should be glued together at each T&G joint. All seams, regardless of material used, must be sealed up tight with caulk (or drywall tape & mud if you're using a layer of drywall in your floor "sandwich").



Where applying baseboard or other moulding & desiring it to help hold your new floor steady, you can line the bottom of the moulding with foam weather-strip tape to help de-couple it from the floor if you're installing flat flooring like vinyl or parquet instead of carpeting. Naturally, if you are installing carpet, your carpet pad should be the thickest & densest you can afford and accommodate from a space standpoint; 8#, 1/2" re-bond carpet pad has worked well for us under certain types of carpet like plush or berber, while ¼" ComfortWear-200 (made by GFI & sold under a variety of tradenames; it's usually purple or blue and has a honeycomb pattern embossed on one side) works well under short-pile commercial-type carpet & contributes a few dB sound isolation.

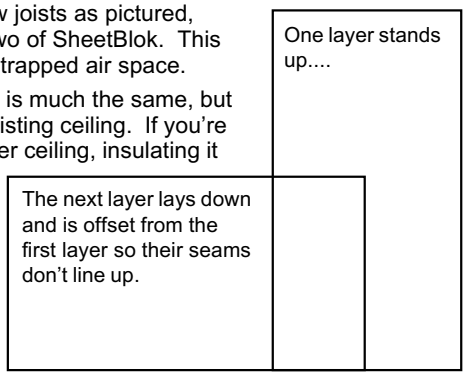
Where your raised floor meets the existing walls (if you're not going to build a new wall as pictured, just a new floor), it is better to build it in such a way that the two have a slight physical separation, but if you must attach them, run a piece of SheetBlok at the juncture first before attaching the band (perimeter) board to the wall with screws. Caulk the gap with silicone.

It is of great benefit to run stringers at uneven intervals between your floor and ceiling joists before insulating them. This helps tie the whole ceiling or floor together so it is less likely to move and transmit sound. Stringers are short (14½" normally

if your joists are 16" on center) pieces of the same material as your joists that run perpendicular to the joists and are nailed between them in a **staggered** fashion. It might seem like a pain putting them in, but it's time well spent. I know. I let someone talk me out of them once and lived to regret it. In serious studios, they install stringers between their wall studs, too, & caulk 'em tight.

Got pretty good control except for when, say, someone plays piano or acoustic drums? Instead of constructing an entire new floor, you might be able to fashion an effective spot barrier to put on the floor under the offending instrument by using SheetBlok, U-Boats, drywall and other materials mentioned in this booklet. This also applies to those of you in basements who don't want to frame new floors as earlier described. Put your thinkin' cap on.....

In situations where you simply have no vertical room to spare or can't install new joists as pictured, you should consider floating a couple new layers of T&G flooring on a layer or two of SheetBlok. This yields increased STL & physical decoupling, but obviously doesn't give you any trapped air space.



The method for controlling structure-borne sound that's passing through ceilings is much the same, but generally will include adding additional layers of SheetBlok & drywall over the existing ceiling. If you're lucky enough to have vertical height to spare, drop down 3 1/2" and frame another ceiling, insulating it and covering it with 2 layers of drywall (5/8" & 1/2") with a layer of SheetBlok in between 'em. If you have an unfinished existing ceiling, insulate it with the thickest insulation you can, cover the joists with a layer of 5/8" drywall (+ a layer of 1/2" drywall if space, time, funds & motivation permit) and then drop down 3 1/2" and frame your new ceiling. Some people have asked about insulating their existing unfinished ceiling then layering it with drywall. One of the million dollar room guys says this is not the wise thing to do because the layers of drywall segment the dead air space between the floor above and the new lowered ceiling. Another of the million dollar guys says the opposite. I must admit that at our old studios we followed the first guy's advice and now regret it. *You do the smart thing: go ahead & put layers over your existing ceiling joists before you drop down and frame a new ceiling.* Most of us, however, aren't so lucky and won't have the height to spare anyway. (By the way, if you desire to angle your ceiling, the front end of your room [normally the end with your monitors] should be the lower end so as to direct reflected sounds toward the back of the room, away from the engineer.)

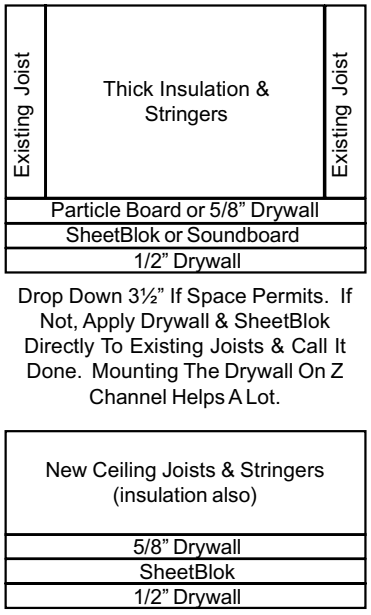


Diagram showing the correct way to layer your ceiling material, whether you're framing a lowered false ceiling or just applying more layers to your existing.

If you fall into the "don't have the height to spare" category, to your existing ceiling you should add a layer of drywall, a layer of SheetBlok,then another layer of drywall. If your problem is not too severe, perhaps a layer of SheetBlok, then an additional layer of 5/8" or 1/2" drywall will do the trick for you, especially if you mount the drywall to Resilient Channel (RC). The choice is yours depending on your budget and how severe the problem seems to your ears. At our studios we insulated the existing joists after adding stringers, then dropped down as far as possible, framed a new ceiling and layered 5/8" drywall, SheetBlok and 1/2" drywall.

Should you be in a situation where you need more sound barrier effect but absolutely can't add any more drywall, you'll be pleased to know that SheetBlok is now also available in a pleasing khaki color and features a slight pebble embossing on its surface that looks quite elegant, thus negating the absolute need to cover it. A piece of wood trim is recommended at each vertical seam and across the top & bottom of each piece of SheetBlok. If khaki doesn't match your decor, your SheetBlok may be painted with high-quality latex paint. In order to use it as a finish layer, you've gotta be very careful during installation so as to not nick up the SheetBlok. By the way, our Tubetak adhesive is great for mounting acoustic foam, but doesn't work worth a poop for mounting SheetBlok. Your local hardware can provide you cove base or multi-purpose flooring adhesive, better SheetBlok mounting solutions, because they're made for use with vinyl. A contractor who buys SheetBlok by the truckload has found PL PRO adhesive to work well on SheetBlok, but we haven't tried it for ourselves.

No matter which method you use, the less light fixture boxes set in the ceiling, the better because they serve as open windows to sound. Track lighting is preferred to recessed lighting and you should caulk any wire holes as outlined elsewhere in Acoustics 101 because holes really sonically weaken a wall or ceiling–so much so in some instances that people have virtually wasted their time. Bummer.

Mr. T (Bar)

Many times a customer with an existing T-bar (suspended or "drop") ceiling will ask if he should remove it to expose the bare drywall ceiling above, then treat the drywall ceiling with foam. If the existing ceiling tiles are the really cheap, not-very-absorbent type (the NRCs of which you might be able to verify with the help of your local hardware store or lumber yard), probably yes. If the existing ceiling tiles' NRCs are able to be verified and are .75 or above, leave 'em, but over the top of them & the T-bar roll out at least one layer of 6" unfaced insulation. Doing so not only helps alleviate the reflected sound that can bounce around between the top of the suspended ceiling & the drywall above, it improves the NRC of the ceiling as a whole, especially with regard to its low frequency absorption, and is likely to improve sound isolation from whatever's above the room, be it a neighbor or the great outdoors.

If you're in a space that has an existing drop ceiling that has decent NRCs, but you desire absolutely the maximum amount of sound transmission loss from above and are absolutely unable to frame a new false ceiling, we have a couple solutions for you. The first involves rolling out unfaced insulation as noted above then rolling out SheetBlok over the top of the insulation. SheetBlok weighs 1# per square foot, so some reinforcement of the T-bar suspension straps may be necessary. Overlap the SheetBlok 1", then tape the seams with foil duct tape or at the least regular cloth duct tape. An alternative is to cut SheetBlok to the size of each of your ceiling tiles, then glue it to the back of each tile. Or, you can buy T'Fusors and lay a piece of rigid material like particle board or soundboard (preferably with SheetBlok cut to fit & glued to it) in the cavity molded into the back of each T'Fusor. This yields improved diffusion, a bit of low frequency trapping & improved isolation.

Some suspended ceilings aren't the sturdiest things, so be sure to check yours out and make sure it will support the weight of the composite panels before you go ordering the materials. Nothing ruins a session like a heavy ceiling crashing down on top of you. Severe bummer.

If you feel the need to install a suspended ceiling in a room where there isn't one already, the tile manufacturers recommend that it be dropped down from the existing ceiling 16" to 18" for the best acoustic performance.

For those of you sharing space with neighbors, especially in industrial settings, a commonly overlooked route of sound transmission is the space above the drop ceiling and straight up from the wall separating you from your neighbor. Many times this area will be totally open, so the only things stopping sound from your neighbor getting to you (& vice versa) are your & your neighbor's drop ceilings! SheetBlok hung vertically above the wall & sealed as tightly as possible to the structure can be an effective, affordable solution. The "air tighter" the better, so grab your caulking gun and go wild.

The types of settings in which this route of transmission is often a problem also tend to have cinder block walls, metal studs, poured concrete slabs shared among tenants, etc. Remember earlier in the booklet where I talked about isolating the sources of the sound from the existing structure? This means you, soldier. Be prepared to float floors, build false, floated walls, float a ceiling, etc. *or at least apply SheetBlok to all existing surfaces* if you're serious about containing sound within your space or keeping others' sound out. If you've already leased such a place or are contemplating doing so, hit up, uh bargain with, your landlord to ask him to share the expense of making the space habitable for your needs. A landlord who's worth his salt will kick in; a landlord who's in it for a quick buck and will likely be tough to deal with down the road if the space needs repairs will not. Caveat emptor.

We have one customer who actually talked their neighbor tenant into chipping in more than half of the expenses! This is a man who should be selling used cars, right???? Have you already been locked into a lease and the space has proven that it just isn't soundproof enough, but the landlord won't kick in or let you out of the lease (this has happened to more than one of our customers)? See the Yellow Pages under "Attorneys." Small claims court is another cheap option and the judges are usually pretty darned fair if you're armed with plenty of evidence (bloody gloves not recommended).

Cathedral Ceilings

Ever seen pictures of world-class studios? Sure you have. Ever seen one with a flat ceiling? Rarely, if ever. The reason for this is that it's widely acknowledged that rooms with more cubic volume (space inside them) sound better than small rooms. Why is this?

Small rooms tend to sound, well, *small*. This is because small rooms have less space for sound waves to develop and breathe. Think about it. In a 10'x10' room, a sound wave that's traveling 1182 feet per second can get from wall to wall to wall to wall in no time at all. This effectively means the room doesn't allow time-delayed reflections to develop; reflections that would give the room a sonic "acoustical space" signature. Implementation of good diffusors (Auralex T'Fusors™ are best) can definitely help a small room sound larger by properly reflecting the sonic energy in the room, giving the sound more room and time to breathe. Further, digital delays & reverbs have improved enormously over the last decade and we can now add our own "acoustical space" signatures to sounds–and best of all, *only when we desire to have them*. I personally would rather have a drier room and add ambience digitally *when I want ambience* rather than rely on my room to interject ambience *all the time*. My reason for this is that there are quite a few times when I don't want ambience, and other times when I want a different ambience than the room may have. Still, I recognize there are plenty of others out there–perhaps yourself included–who do like their room to have its own ambient sonic signature. It is for this reason I started this talk about cathedral ceilings.

Few of us have unlimited budgets–budgets big enough to allow us to buy real estate with as much square footage as we'd really love to have. Does this necessarily and always mean that we're forever resigned to suffer with tiny little flat ceiling'd rooms? No way.

Square footage is expensive, but cubic footage isn't. Look at Japan–what've they done? Because Japanese real estate is at such a premium (i.e. they're out of it), they've chosen to grow *up* instead of *out*. For example, one of the best sounding isolation booths you could ever build would be 5'x6' and have a ceiling 9' high (this booth exhibits exemplary axial mode response). The point is: think *up*, not *out*. We can put the Japanese principle to work for us in order to gain cubic volumes for our rooms. Maybe to a relatively small degree, but we can gain some amount of useful cubic space to be sure. Cathedral ceilings are the easiest way to do so.

If You Can't Beat 'Em.....

As noted before, room boundaries cause low frequency pressure zones that increase the apparent amount of bass we perceive in our rooms. Specifically, I would normally be speaking of trihedral corners where two walls come together and meet the ceiling. Today's discussion, though, centers on the cathedral ceiling, which is after all just a variation on this trihedral theme.

It's kind of a Catch 22 though. We need a cathedral ceiling to help us gain sonically-valuable cubic space, but we don't want the low frequency problems inherent in such a design. Hmmmmmmmm.

Since it's impossible to build a room without boundaries, we're forced to develop ways to make boundaries work *for us* rather than *against us*. Luckily, proper implementation of boundary treatments can turn virtually any space into one with neutral enough sound for our purposes.

The Meat Of The Story

We know that corners are the places where low frequencies congregate. We know that we don't want extra low frequency energy muddying the sound of our rooms. We have the technology. We can beat this problem–cheaply, easily and in a way that still yields the extra cubic space we want without the sonic problems.

As discussed elsewhere in Acoustics 101 and other Auralex literature, there are a couple ways to gain low frequency absorption. One way is to install a massive hunk of absorbent material right where the lows tend to develop & congregate. A *really* massive hunk would be too expensive and take up too much of our space, so that's out. (Ok, an Auralex LENRD Bass Trap or Venus Bass Trap is pretty much the optimum solution as far as an absorbent, affordable, cool-looking hunk o' foam is concerned, but these don't work for most cathedral ceilings because they don't involve a 90° angle.)

Another, more workable way is to line a large air cavity with absorbent material & install a wooden facing over it, making the facing either solid (by using ½" plywood or ¼" masonite & SheetBlok™, forming what's technically known as a panel absorber) or perforated (by using pegboard or wooden slats, forming what's technically known as a Helmholtz resonator). This is the best way to deal with a cathedral ceiling's peak–both physically and acoustically.

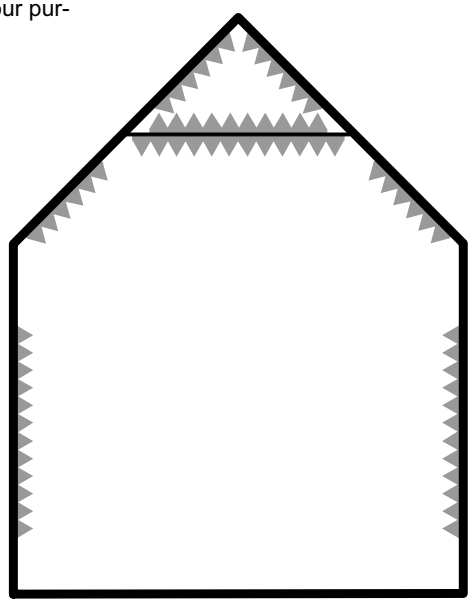


Figure 1

Submitted for your approval, Figure 1. In it, I've installed 4" Studiofoam on the two ceiling surfaces that come together to form the peak of the cathedral ceiling. Below that (the farther down, the more effective it is), I've installed a horizontal piece of material to form the face of my trap. In my example, the face material is 1/4" pegboard and I've covered both sides of it with 4" Studiofoam. Instead of using 2 separate pieces of 4" Studiofoam leading up to the peak, a viable and perhaps even more effective alternative is to "span" the peak with a piece of Studiofoam, forming a small triangular-shaped airspace behind the Studiofoam. The best way to control sound in general and low frequency sound in particular is to force the sound waves to fight their way through multiple layers of different materials and dead air before they can strike the room boundary. This forces the waves to lose intensity. They get so tired of fighting their way to the boundary that they finally throw up their tiny little hands and say, "Screw this. I'm going home." If you listen real, real closely you can literally hear them say this. (No you can't. I'm lying.)

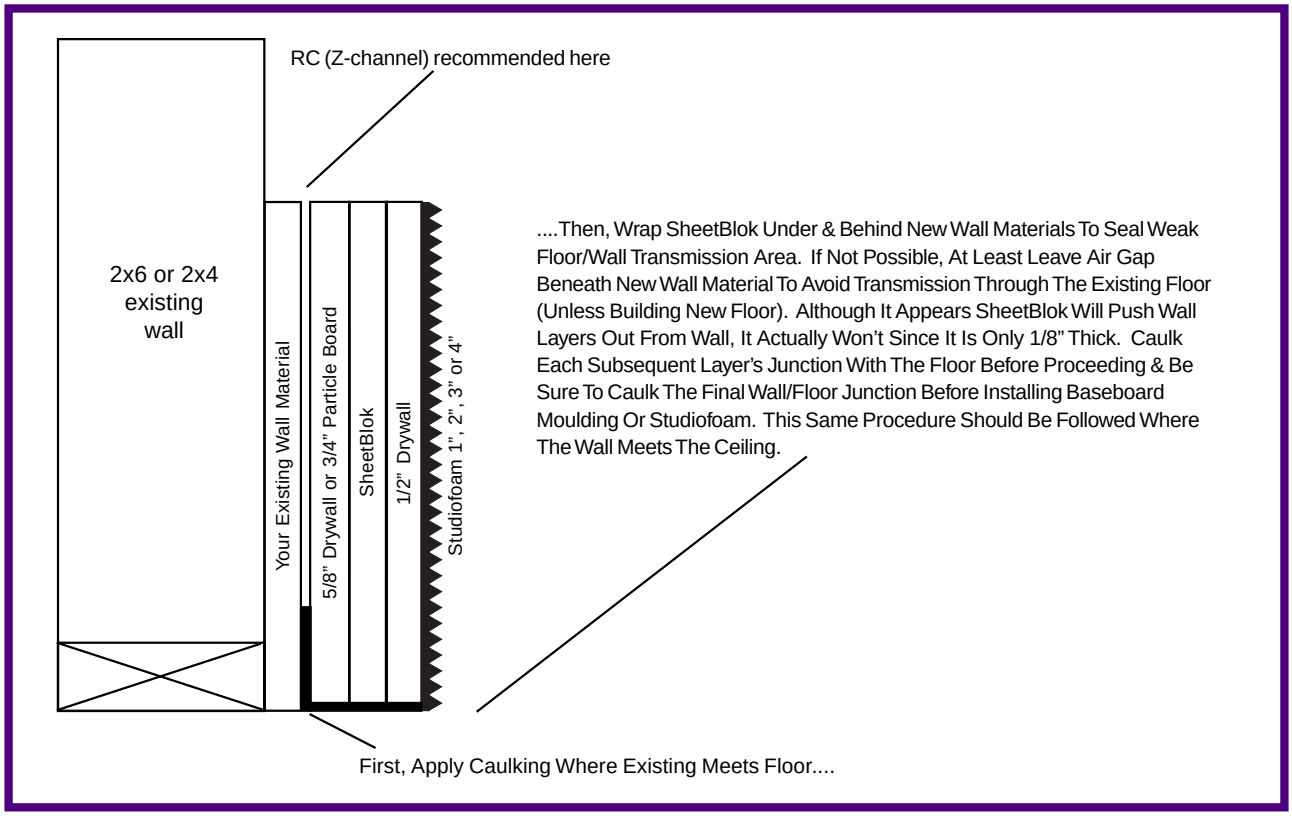
(An aside: I don't want to get into a highly technical discussion here of the physics involved in absorbing low frequency sound, but I will mention that the percentage of perforation that a typical piece of pegboard exhibits is only about 2.75% of its total surface area–a figure which may be slightly incorrect to tune to the absorber to your particular offending frequency range. Thus, sometimes acousticians who use pegboard as their trap face enlarge the holes to try to get the percentage of perforation up in the 4% range depending on which frequencies they want to trap. Please don't call and ask me for specific details; they're available at your library.....standard pegboard will probably suffice quite well for your needs.)

This method works well for those of us who desire absorption "up there", but what about those of us who desire our space to sound more live, yet controlled? Then, instead of using pegboard, which obviously isn't pretty enough to be left uncovered in most studios, we build our face out of strips of (reflective) 1x2, 1x3 & 1x4 lumber (normally pine, but that's your choice; based on your budget you might want to try oak or some other hardwood), installing the slats in an alternating, random fashion (1x2, 1x4, 1x3, 1x3, 1x4, 1x3, 1x2, etc.....you get the idea) and leaving spaces of varying widths between them (¼", ½", ¾", etc.....you get the idea). There are formulas in books available at your library that you can use to determine the "exact" widths of your slats and the "exact" spacing between them. I've heard "random" widths and spacings work just as well, though, so I'll leave the busy work up to you if you desire to jump through hoops. I will tell you that a percentage of perforation that'll work well should be no less than .42% & not more than the 4% range to yield any useful amount of bass absorption; different percentages change the frequency at which the trap is the most effective and the trap's effectiveness overall.

The last variation on this theme is to substitute ½" plywood or ¼" masonite for the pegboard, caulking the plywood tight to the ceiling surfaces so you end up with a sealed, resonant air cavity; this is technically known as a panel resonator bass trap. You then cover the face of the plywood with Studiofoam to broaden the effective range of the trap and help control your room's acoustics.

Using any of these methods is viable; which you use is really up to you and depends on how much time you want to put into the device. Unfortunately, I haven't spent thousands of dollars on testing for you to help you decide which of these variations to build. They ALL work, so just pick one depending on your needs. For example, the last variation (with plywood caulked tight) yields more sound isolation than the others, so if you're experiencing too much thunderstorm noise through your roof, this would be the way for you to go to increase your isolation. Add a layer of SheetBlok & Studiofoam to the back of the plywood and the device becomes even more effective over a wider range of frequencies. Some people have even combined a couple of these variations; for example, I've seen wooden slats placed over the face of the plywood for extra reflection and diffusion.

Wall Construction



An often overlooked method of gaining extra bass trapping in a small room is to "steal" some of the wasted space that may be above an adjacent room. Famous acoustician and talented surfer dude Chris Pelonis (who often uses LENRDs when 90° angles are involved) has built Helmholtz resonator types of bass traps in the attic space over rooms adjacent to studios & control rooms. This is a great way to give a room's low frequency waves more room to develop and breathe and to utilize what's often wasted space. Put on your thinkin' cap & like figure out an awesome & way cool solution of your own.

Unfortunately, the basic walls built in most homes and businesses are simply not dense enough or thick enough to be good barriers to neighboring sound (see NRC data earlier in **Acoustics 101**). This page will show you proven methods for adding additional layers of materials to your existing walls (ceilings, etc.) to make the most of them. For those of you doing new construction, these tips are applicable as well. The choice of how to retrofit your existing walls, ceiling, etc. is entirely up to you, your ears & your pocketbook. This booklet is simply to make you aware of some proven methods that have worked for others.

Existing Walls

First, determine as best you can what the materials are which comprise your existing walls (ceiling, etc.). You *hope* you find out that you've got 2x6 walls, heavily insulated, stringered and caulked, floated on SheetBlok, then covered with a layer of 5/8" drywall, a layer of SheetBlok, a layer of 1/2" drywall and surface treated with Studiofoam.

If so, go directly to Park Place, collect $200 and have dinner at a fancy restaurant. If not, read on.

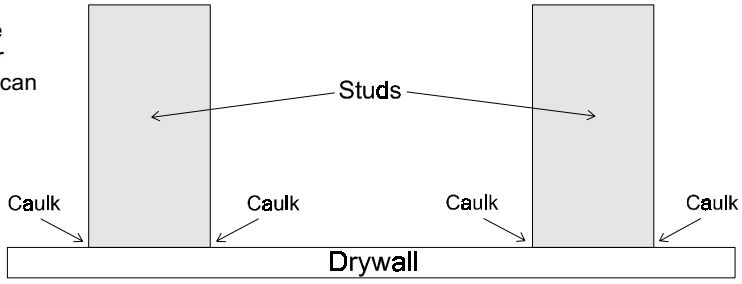
Since we're not at your location charging you by the hour to determine how severe your problem is, you must. If your problem sounds severe to you and you learn that the existing wall has no insulation in it, I advise *getting* insulation into it, either by removing the drywall & adding some or by blowing insulation into the wall with a machine (see your local hardware store). It's important to note that you don't need to buy some specialized type of insulation; the standard kind will do, just make sure it's as thick as possible. Don't mistakenly think that "denser" is better, in this case it may not be. "Thicker" is better because it traps more air and is permeable enough for sound to get into. No need to pack it in real tight like some people think.

Having done that, the more closely you can retrofit your wall to resemble the one shown in the diagram above, the better off you'll be. You can choose to alter materials or leave off layers, but the performance of the wall may be lessened, so delete or change at your own risk. Naturally, you should use good construction techniques, taping, mudding & caulking seams all the way, making sure to stagger all seams and rotate adjoining layers 90 degrees from each other.

If you determine your problem to be relatively minor, you might be able to get by with as little as adding one more layer of drywall. If you previously found out your existing wall is one layer of 1/2" drywall or plaster over lathing, add a layer of 5/8" drywall. Hanging your additional layer(s) on Resilient Channel (RC) will improve the wall's performance by a few dB as shown earlier.

Do you want to go to the trouble to fir out from your existing wall to hang your new wall boards on? Probably not. Firring strips don't really do alot for you in the way of creating a dead air space big enough to do you much good or even to physically decouple your new layers from the existing wall. Resilient channel, on the other hand, really does a good job in each regard, so I highly recommend using it to hang your drywall on after first applying a layer of SheetBlok.

New Construction



Lucky you! You've got the chance to build your place taller to allow for a false/lowered ceiling & to give your studio more cubic space. There are a couple things I can add that you might implement to improve on the wall/ ceiling described above.

You should definitely build yourself a "room within a room," meaning that there is air space and no physical contact between the exterior walls and the new walls of your studio! There is no substitute for doing it this way–period. You can build just one wall and can add layers to the wall 'til you're blue in the face and poor as Patty's pig, but chances are that you'll never achieve the level of sound transmission control you will if you go the extra mile and build a room within a room. You know what they say about an ounce of prevention.....

If you're building on a concrete floor which is shared with neighboring spaces, consider cutting it under where your wall(s) will be placed to stop flanking transmission. If you're building raised floors as described elsewhere in this booklet, whether on concrete or wood, strongly consider building each neighboring room's floor separately, then building good, 2x6 floated walls on top of each floated floor.

A Word About Foam & Transmission Loss

Although foam rubber is not generally sold as a sound barrier, testimonials from our customers & our own experience have proven that the thicker the foam, the more the transmission loss it offers–somewhere in the neighborhood of 5-10dB depending on foam thickness. So, if you're gonna delete any layers I've specified, thicker foam might not only give you a better room sound, it might make up for some of the isolation you've given up by leaving out a layer.

Sound slips through even tiny gaps which might seem to you to be insignificant, so it's of **extreme importance** to construct your place as **airtight** as humanly possible. When humanly possible still isn't good enough, caulk and expanding foam sealant can be of great benefit & save your you-know-what. So, do the best installation job you possibly can & keep the caulking gun handy!

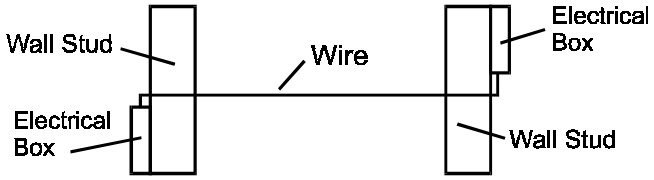
A common use for these materials is to seal the holes in studs where wires go through or at the back of electrical boxes where wires enter. Believe it or not, these small openings can sabotage an otherwise excellent wall, so don't overlook them.

(Speaking of wires, before I forget, it's always better to keep wires away from each other than in big globs, especially audio, video & phone lines that might be in proximity to electrical wires. If wires have to cross, doing so at a right angle lessens the chance of interference occuring. Now, back to our story.....)

More Construction Tips

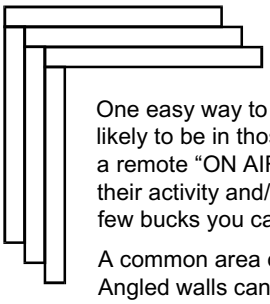
Never mount electrical boxes or connector panels back to back; always stagger them as shown in the diagram. Seal the holes your wires go through and/or run wire through conduit (PVC is great for this), stuffing foam or insulation in the ends to help seal the conduit so it doesn't resonate.

If you think about it, the less wires and boxes you have poking holes in your walls, the less chances sound has to get through where you don't want it. It may be prettier having all your boxes flush mounted, but there's a lot to be said for surface mounting your phone cables & jacks, mic connector boxes, light switches, etc. Not only does this method yield better isolation, your artzy friends might consider you "retro", "industrial" or just plain "cool."



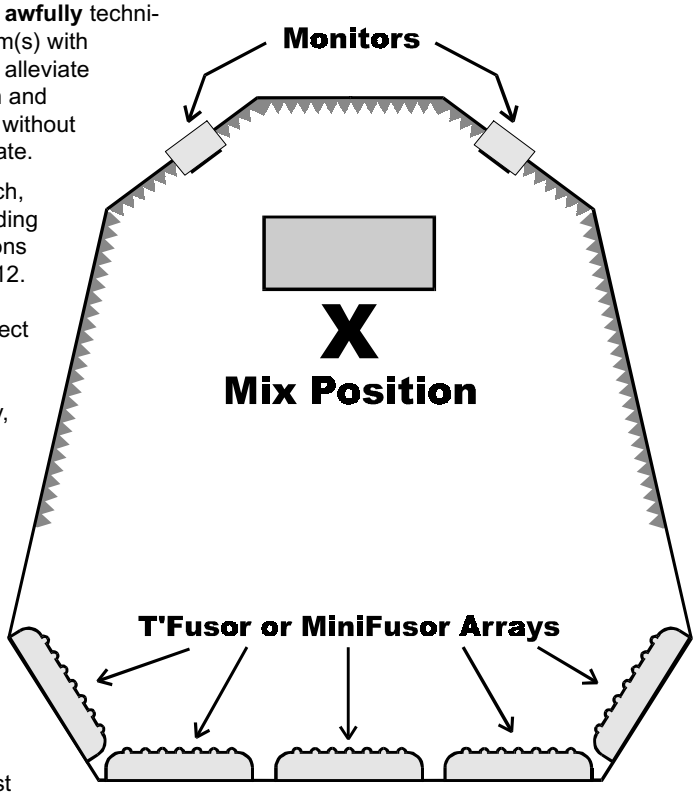
When adding layers of building materials or SheetBlok to adjacent walls, put a layer on one wall, then the other, then one wall, then the other instead of putting all one wall's layers on at once then moving to the other wall. As shown to the left, this gives sound waves a tougher path to snake through at the corners. Be sure to caulk or mud all joints before adding the next layer.

People often ask about using plywood in the construction of their studio. Plywood is not as wise a choice as particle or MDF board because these are considerably more dense and in many cases cheaper. If you *are* going to use plywood, you'll need to plan on using extra layers and should bear in mind that the less dense the material, the closer it should be to the sound source, i.e. you should use your densest materials nearest the studs or joists, kind of like how a hockey team's strongest defender is their goalie. Make your last line of defense your best.



One easy way to achieve better sound isolation from neighboring spaces is to enlist the help of the people who are likely to be in those spaces when you're recording. To help alert them that you're laying down tracks, why not install a remote "ON AIR" light or some other warning system outside your studio so they can easily know when to keep their activity and/or noise level down? All it takes is a light switch in your studio, some cable and a fixture. For a few bucks you can probably gain quite a bit of extra quiet.

A common area of misconception pertains to the necessity for angled walls in recording & broadcast facilities. Angled walls can be of benefit in the control of standing waves & room modes, but only if you do them right. The sticky part is knowing how to do them right, which can be **awfully** technical. In most cases, if you're going to be treating your room(s) with Auralex acoustic products, there's little need to attempt to alleviate standing waves with angled walls because our absorption and diffusion products are going to alleviate them for you, and without the detrimental effects improperly angled walls can generate.



If you're going to be constructing your room from scratch, one important thing to keep in mind is that the worst sounding rooms are always going to be ones whose three dimensions are all divisible by the same number, for example 24x36x12. There are very exact formulas you can find in acoustics books at your local libraries if you desire to build "the perfect room," but as mentioned in the previous paragraph, if you attempt to build the perfect room but do it wrong, you're gonna be in a world o' hurt. Don't take this the wrong way, cause I'm honestly not trying to sound like a salesman, but treating your room with Auralex acoustic products is actually a much safer way to take care of your room's (bad) contribution to your overall sound. I wish I had a dollar for every time we've been counted on to rescue a studio that someone tried to build "perfect" but failed–some have even been designed by the million dollar guys! At our new studios I didn't give any thought to non-paralleling the walls because I knew our Auralex treatments would take care of standing waves, room modes & flutter echoes. They did & the rooms sound *tight*.

If you are building from scratch and desire to build the best stereo mixing room you can without getting drowned by formulas & equations, build your room as diagrammed. When used in conjunction with the proper Auralex treatments (see your salesperson), this shape–which is lifted from dozens of million dollar room guys' rooms–will be about the best you could ever hope for.

Exception: Tom Hidley, the world's preeminent & most expensive studio designer, doesn't diffuse any of his rooms. He provides heavy full bandwidth absorption of all frequencies on the ceiling, rear wall and side walls, but makes the front wall totally reflective if using soffit-mounted monitors. He thinks this yields improved imaging & fewer detrimental room reflections.

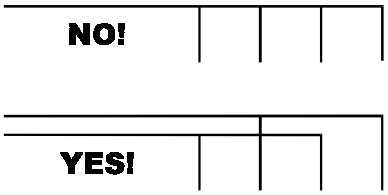
Problem Areas

HVAC (Heating and Cooling Systems)

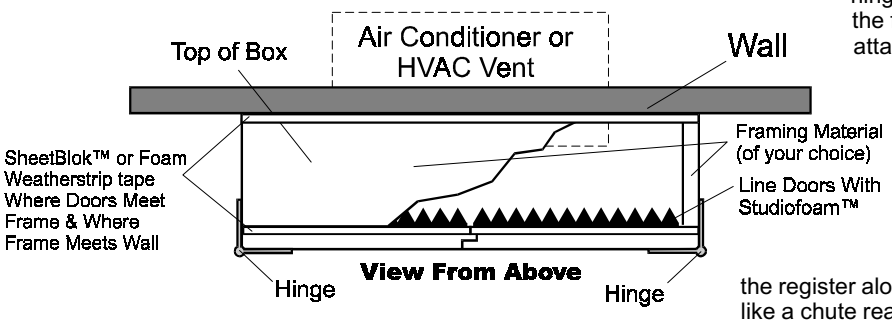
Most HVAC systems share a few common traits that cause us sound people headaches. In some instances you can overcome these obstacles by just adjusting your work habits, but in extreme cases you might be best to rip out the guts of your existing system and redo it correctly. Follow your nose (ears).

Common HVAC ductwork **(a)** moves small amounts of air very quickly and in straight runs from the blower (exactly the opposite of what we desire) and **(b)** is attached rigidly to the building structure (ditto). For HVAC to be successful, optimally the ducts should be larger than normal, include **rounded** bends, be lined with rigid, lightly-painted fiberglass board and be suspended by means of rubber tie-down straps (available at your hardware store) instead of being affixed to the structure with the common metal straps and nails. Ducts may be of the flexible type &/or wrapped with SheetBlok to help dampen their vibrations & sound transmission. Wherever possible they should only contact the physical structure with SheetBlok, rubber straps, caulking, etc. Be creative and do everything you can to physically isolate your HVAC system from your building.

If installing a new HVAC system & ductwork, make sure that you don't have drops (registers) in adjacent studios that are fed by the same trunk (main duct coming from the blower). Instead, add an additional trunk line and feed each other room as diagrammed. If you do your wall construction appropriately, you might even consider terminating your duct into the space between two wall studs, which you can line with fiberglass board, then venting that space into the room. We've seen this done and it proved to be very quiet! Also, don't let your HVAC system dump air between your ears and your monitors, as moving air distorts sound waves. Try to put no ducts on walls that are shared between studios or on outside walls.



If you're adapting an existing space for recording purposes and are on a limited or non-existent budget, try turning off your thermostat when you know you're going to have open microphones so the HVAC doesn't kick in at a crucial time. Or, if you've built a room already and the HVAC is the weak link in your chain, or if you're cooling your space with a window air conditioner, perhaps constructing a "trap door" or temporary cover that can be opened at will is your answer. As diagrammed below, it's crucial to isolate the frame from the wall and from the doors by means of SheetBlok-ing the junctions or lining them with foam weatherstrip tape. The doors should be routed at the closing junction so they overlap and this junction should be lined with weatherstrip tape. Instead of making the frame one layer of material, if space permits two layers of different materials glued together is beneficial, especially with SheetBlok between 'em (remember the resonance issue raised at the beginning of this booklet?). Should you desire the frame to be removable, it can be attached to the wall with angle irons (L brackets). **Do everything you can to isolate the frame from the wall and the doors from the frame.**



Another trick if you're retrofitting a noisy register cover, especially one that's on a wall instead of a floor– Build a wide box that covers the register & then extends away from the register along the adjoining wall. This box (more like a chute really) should be lined with lightly-painted 1" duct board to quiet internal air movement. At the other end of the chute, install another register cover, preferably much larger than the original one. The whole contraption should be caulked airtight and isolated from the wall by SheetBlok or foam tape.

Instead of putting an air conditioner and separate baseboard heater, space heater, etc. in your studio, GE makes a couple good ones that're affordable, quiet, physically small, easy to frame in as detailed above and offer plenty of BTUs for most studios. Their model numbers are AJK06LH (residential grade) and the ZoneLine (commercial grade) AZ21E06D. They should cost you $500-$700 and they're the same ones we use.

Windows

You can either adapt the diagram above for window treatment as well, or can modify the doors to be thicker (say, out of 2x4s) to accommodate a couple panes of glass with an airlock between them. This offers acoustic control while still allowing visibility. The doors can even be opened to let fresh air flow through the open window, so this solution is truly the best of all worlds. A cheap fix with some benefits? Hang a thick, vinyl shower curtain in front of the window and then a thick fabric curtain (like a theater curtain) in front of that. Or, for a more professional solution, you can sew some SheetBlok inside a thick drape.

If you're going to do the double panes of glass thing, make sure the panes are as far apart as possible, are parallel to each other and never touch wood, only SheetBlok, foam weatherstrip tape (FrostKing brand 3/4" wide by 7/16" thick, closed cell heavy duty interior/exterior recommended) or silicone caulking as outlined elsewhere in Acoustics 101. You can either route out grooves for the glass to fit it or just block it in with small wood slats. Line the frame of the air space with Studiofoam to absorb standing waves and throw some packets of silica gel in between the panes to absorb the condensation that invariably forms there.

Garage Doors

The concept of the overlapping doors spoken of and diagrammed on the previous page is easily adapted to a solution for leaky garage doors, especially if you break down the solution into multiple "bifold" type doors that seal well where they meet. The better solution, however, is to build a false, floated wall next to the garage door, but not touching it, and isolated as well as possible from the existing structure using the methods previously described. If your budget permits, placing a layer of SheetBlok

over the interior face of the door before framing your new wall is advised. Most garage doors leak water, so you might want to raise the garage door the width of a 2x4 and then nail a treated, weather resistant 2x4 down under the garage door (floating the 2x4 as previously described with SheetBlok & sill seal, available at your hardware store) and caulking where it meets the concrete, door frame, etc.). Having done that, lower the garage door down to it and nail up a 2x4 above the top interior edge of the garage door to keep it from being raised. You're then protected from water & thievery and eveything you've done can easily be removed in the future should you or a subsequent property owner desire.

Monitor Mounting Solutions

Many times a recordist will build a decent wall then sabotage himself by (improperly) nailing up a shelf to support his monitors. The problem is, the monitors generate high SPLs (sound pressure levels), transmit the sound through their cabinets & into the shelf, then the shelf excites the wall and transmission throughout the rest of the structure occurs. So, if you must rest your monitors on shelves, do what you can to isolate the loudspeakers from the shelves and the shelves from the structure, such as covering the shelves with a layer or two of SheetBlok, foam rubber (either flat foam which can be provided by Auralex & your vendor or two pieces of Studiofoam nested) & lastly rest your monitors on pieces of masonite or some other material so they don't sink down into the foam. If supporting your shelves with angle irons (which are not pretty if left exposed, but very functional and easily hidden with Studiofoam), place a strip of SheetBlok or foam weatherstrip tape on the back of each angle iron, then screw it to the wall, preferably using plastic wall anchors with your screws no matter whether you're screwing into wallboard or directly into studs. The plastic anchors actually help filter the sound travelling through them. Remember: sound control is a game of inches. (I just made that up.)

Another monitor mounting solution, is to suspend your monitors from the wall or ceiling by using rubber tie down straps and eye bolts. The eye bolts should be screwed into sturdy studs and into the monitor cabinets at sturdy points. From there, rubber tie down straps can be used to adjust the monitors to the required angles. The obvious advantage of using rubber straps instead of metal chain is that the rubber straps help better isolate the monitor cabinets from the structure.

If you intend to set your monitors on shelves that rest on or overlap the top of your console, it's important to not only isolate your monitors from the shelves with SheetBlok or rubber feet (Radio Shack part # 64-2342), but also the shelves from the console. Remember...everything resonates (vibrates) at a certain frequency–even consoles–thus producing unwanted sound. Also–don't forget to foam the top of your meter bridge to stop those pesky early reflections.

For those of you who have large monitors that are to be flush (soffit) mounted in your walls, the old school of thought about resting them on concrete-filled cavities has generally been debunked. These days we know that concrete is so dense it transmits sound very well, so it's better to simply build good, sturdy soffits, then place the monitors in them using the aforementioned methods to isolate the monitors from the soffits. The inside spaces of the soffits themselves can resonate, so damp them appropriately, including floating them from the floor and walls. (Lining the soffits with flat, dense foam so your monitors are "wedged in" is beneficial.) Be extra careful when constructing your soffits to make sure the monitors are at precisely the same downward angle and precisely the same distance off the center line from your mix position because, as you may know, you and your monitors should form an equilateral (all sides the same length) triangle.

Stairwells, Sound Locks & Doors

Many of you will be building studios in your basement and sound travelling up your stairwell may prove to be a problem. If possible, enclose your stairway and put a good, solid door at the bottom to keep most of your sound out of the stairwell. In addition, or if enclosing the stairway just isn't feasible, apply as much 4" Studiofoam in the stairwell as possible to absorb as much ambient sound there as you can, thus making less sound available to travel upstairs. Stairwells tend to resonate quite a bit, so if enclosing and adding a door, do everything you can to float your new construction. If building a sound lock (small room separating the studio from the control room into which each of those rooms' doors opens), float everything you can and treat the walls **and** ceiling with the thickest Studiofoam you can afford. The best common doors to use are exterior grade, solid-core slab (flat, without mouldings) doors. You can add SheetBlok or particle board to one or both sides before installing the knob to provide additional transmission loss, then Studiofoam over the SheetBlok or particle board (Eddie Van Halen did this at his home studio). If you have the inclination, you can make a door sandwich out of (2) solid-core doors and a couple layers of SheetBlok in the middle (this is also what Eddie Van Halen did). Just make sure in advance you can find a knob/lock that'll work with your thicker-than-normal door. Double doors (back to back) are of some benefit if they are (a) attached to physically separate door jambs that are floated, and (b) are as far apart as possible given the constraints of your framing structure. Build your walls & double doors in such a way as to give you as much dead air space between the doors as possible.

Alternate your door knobs left to right. You can add surface mouldings to your slab doors if you want to dress them up. Studiofoam your doors, especially the sides that face each other, to even further increase the STL (sound transmission loss) through them and to absorb the sound that infiltrates the air space between them.

The biggest reason that doors are poor in the area of sound control often has little to do with the physical construction of the doors themselves, that is if you're using the solid-core, exterior, slab type outlined above. The weakest link in most doors is that they are not sealed well with the floor below them or with the door jamb/door stop around them. You **absolutely must** use a compressed rubber threshold below your door and you **absolutely must** make sure that wherever the door shuts and would normally contact the door jamb or door stop, it instead meets foam weatherstrip tape, neoprene rubber gasket or SheetBlok (which to work must be compressed by the closing of the door).

If you have the inclination, you can stick a little piece of SheetBlok behind the hinges on your doors where the hinges attach to the door itself and the door jamb. Bear in mind that you'll have to mortise deeper so the hinges fit appropriately.

For those requiring the "ultimate" in door-related sound transmission loss, you might grab your gold card and call Zero International @ 1-800-635-5335 or 718-585-3230. They specialize in highly-technical, sound-rated doors that do a fantastic job of blocking sound. Call 'em for a free catalog. (Note: Auralex is researching introducing our own line of windows & doors.)

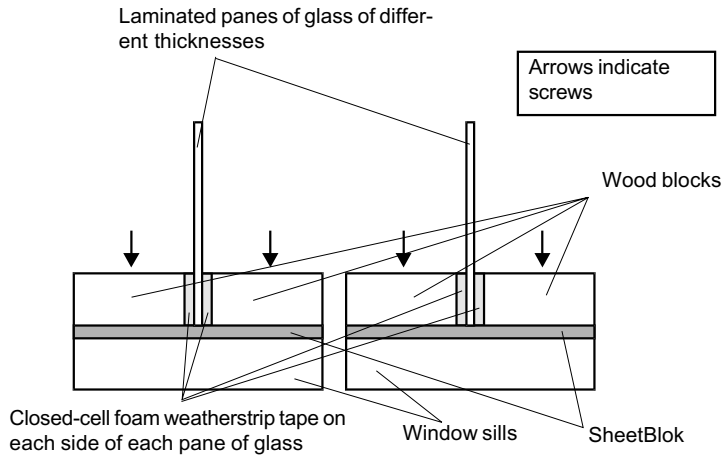
Control Room Double-Paned Windows

You want a double window between your control room and studio because single-paned windows are very poor at stopping sound. You want to try to keep the panes parallel to each other to maximize the dead air space between them and you don't want to use three panes because that lessens the contiguous dead air space. If you must angle your glass, angle only one pane, not both, and make it a slight angle.

No matter how you decide to construct your window, a good way to really clean your glass prior to installation is to mix 1 drop Ivory dishsoap gently with 1 gallon distilled water (old glass man's trick). Or just use Windex®.

The diagram pictured shows the preferred method of constructing your double-paned window. Make sure glass never touches wood and float the whole structural contraption- both below and above the window- on SheetBlok to isolate it from your control room/studio wall. Throw a couple packets of silica gel into the dead air space to absorb unwanted moisture that could fog your windows and line the inside perimeter of the dead air space with Studiofoam to help cut down on standing waves.

If using 2 separate sill plates as pictured, don't caulk the gap between them & the inside wood blocks. If using just 1 sill plate, but separate wood blocks as shown, caulk the gap between the blocks.



Electrical Service

If possible, install separate circuits to power your room(s), or even various components of your room(s) such as lights, HVAC, computers, audio processing, audio power amps, etc. While it's of supreme importance to keep all your gear tied to a common ground at the electrical panel, splitting things off on their own circuits lessens the possibility of various pieces of gear, lights, etc. from causing AC problems for each other. Avoid dimmer switches & flourescent lights because they can introduce whine and hash into your signal. Keep power lines and audio/video/phone lines away from each other and never parallel. Plug your gear into spike/surge/brownout protection devices and make sure your insurance policy covers your gear if lightning should take some of it out. (Phone devices and computers are especially prone to this. Yours truly has suffered these sorts of losses in the past.) Live near extreme RF (radio) interference? Ask your electrician about constructing a Farraday cage, basically a chicken wire or aluminum foil room within a room that ties to your ground rod (seek professional assistance on this if needed so you don't toast yourself). Eddie Van Halen did this at his studio with great success.

To really clean up your ground buzzes and hums, and to greatly lower the overall noise floor of your productions, look into the new balanced power conditioners being marketed by Equi=Tech and Furman. They do a fantastic job and can really save your fanny when your best grounding and isolation intentions go awry.

Other Tips

Never smoke in your control room 'cause it's bad for you and your equipment, to say nothing of the way it lowers your gear's resale value. Vacuum frequently, being careful to avoid static electricity. Cover your mixer with a clean towel when not in use. If you use a computer, turn it on *after* your power amps, etc. and make sure you turn your monitor (& peripherals) *off first & on last*. World's best & cheapest computer monitor anti-static cleaning wipes: used dryer fabric softener sheets. Cheap "talkback" control room-to-studio communcation tool: wireless intercoms (available at Radio Shack).

Case Studies

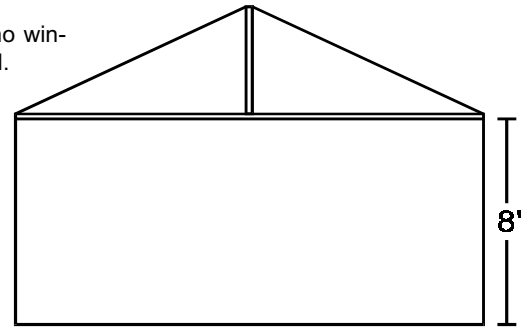
Following are some examples of recommendations we've given recent customers. Dissecting these discussions is a good way for you to follow our logic as to which products solve which problems and their proper implementation.

Case Study #1

The situation: a blues club with a residential apartment upstairs. The structure: concrete walls, concrete floor, concrete ceiling with suspended ceiling tiles 18" down. While the client noticed less-than-ideal sound in the club, the main problem he wished to combat was the structure-borne transmission of sound to the apartment upstairs.

Our response: Roll out 6" unfaced insulation over the top of the t-bar (suspended ceiling grid), then roll out a layer of SheetBlok over the top of the insulation (or at least back each ceiling tile with SheetBlok). The t-bar should be reinforced to support the added weight of the insulation and SheetBlok. Seal the juncture where the rolled out SheetBlok meets the structure by using the aforementioned tape. Stage itself: pull back the carpet and pad on the stage, then reinforce the stage framing members to make the stage as stiff as possible. Insulate between the stage joists with 6" insulation to cut down the reflected sound under the stage. Line the bottoms of the stage joists with SheetBlok to isolate the stage from the structure's concrete floor. Install a layer of SheetBlok on the floor of the stage itself, or at least a layer of 5/8" drywall and then a layer of 3/4" particle board cross-seamed, then lay the padding and carpet back down. If the pad isn't 6# rebond, replace it with this type or ComfortWear-200, which will offer 5-7dB of additional sound isolation. The stage should be kept as physically separate from the structure as possible as outlined earlier. For maximum control, build new walls adjacent to the existing walls as outlined earlier or at least add additional layers of drywall to the existing walls with Z channel or a layer of SheetBlok then a layer of 5/8" drywall hung on Z channel. The club owner was unwilling to do either of these, so we recommended he apply Studiofoam, realizing that 4" foam would alleviate more of the low frequency sound that is offending the apartment upstairs.

Case Study #2



The situation: a one-car garage 13'x19', carpeted floor, 5/8" drywall walls, no windows, 1 36" solid-core door, acoustical tile ceiling at 8' height as diagrammed. The room is used to teach guitar and rehearse with guitar, bass, drums & drum machine. Problem: excessive slap echo and reverb along with excessive low end buildup due to drum kit being located in one corner. Owner not overly worried about sound transmission to/from the outside, but would like some additional transmission control.

Our recommendation: roll out unfaced insulation over the top of the suspended ceiling tiles, thus increasing transmission loss through the ceiling while adding low frequency control to the room. Treat all four vertical corners with LENRD Bass Traps. Treat the walls with 2" Studiofoam, preferably cut into 2'x2' panels and applied in a staggered checkboard pattern with space between panels, easily adapted so no two parallel walls are mirror-images of each other. This method yields improved absorption *and* diffusion without costing any more money. Coverage minimum for a room of this size and with this intended usage is 60%; 70-75% is more appropriate. The customer originally thought he wanted to purchase Venus bass traps & 12" CornerFills for all 4 wall/ceiling junctures, but we recommended LENRDs instead because of his room's size. We advised 2" wall foam instead of 4" because the slap echo and excessive reverb, as well as high SPLs generated by guitar amps, drums, etc. dictate more coverage, not just thicker foam. If the budget allowed, 4" Studiofoam would be a welcome substitution.

Case Study #3

Ok, I lied. It's not a specific case study, but it comes up often enough that it bears mentioning. It pertains to isolation or voiceover booths. Booths of this size (small, rectangular) tend to have pretty severe low end buildup, so the obvious choices are 4" Studiofoam & 4" CornerFills, or 2" Studiofoam & LENRDs. For those whose booths serve as both voiceover (dry room required) and iso booths (often some ambience desirable), a good solution is to mount some of your Studiofoam panels on something like plywood, masonite or our **Vel-X Mounting Panels** (available through your dealer) so that they can be taken down randomly to tune the room as needed for a more live feel. T'Fusors or MiniFusors, especially if you drill small holes in their flanges so they can be hung on hooks on the wall, are very appropriate for those of you whose booths often play host to singers, sax players, violinists, flutists, acoustic guitarists, etc. These sorts of folks more often than not will want to **choke you** if you put them in a booth that's too dry for their palates. So, why not bass trap your corners (permanently, because that's absorption the booth will *always* need) and install your foam & diffusors in such a way that allows you to tailor your booth's sound to each session's specific needs? Gotta really high ceiling? Venus Bass Traps there with 1 or 2" Studiofoam on the walls sounds **great**. If you're lucky enough to be building your booth from scratch, consider building a 5'x6'x9' tall booth, which exhibits very good room modes. If you'd like us to run your booth through our room mode software to help you determine what your worst problem frequencies are, have your dealer contact us.

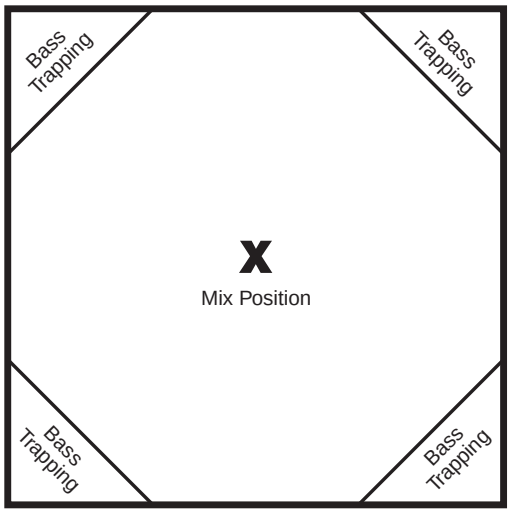
Auralex™ acoustics

Control Room Design For 5.1 Channel Surround Mixing

If you've been reading all the ink in the trades lately regarding top engineers mixing for release in 5.1 channel surround format and are considering making the move to a surround mixing setup yourself, there are some acoustic issues that must be addressed. Acoustically treating a control room to yield an accurate surround-mixing environment can be quite different from treating a "typical" control room in which stereo monitoring is performed.

In treating a stereo mix environment, we introduce large amounts of absorption at the front of the room to kill early reflections so the engineer hears only the direct sound coming straight to his or her ears from the monitors. We sporadically absorb the rear half of the room's side walls and sometimes ceiling to allow the rear of the room to breathe. We introduce broad bandwidth diffusion devices into the rear wall and rear ceiling area of the room to spread out the sound energy in the room without killing it, thus imparting a sense of space and envelopment at the mix position. Rear wall diffusion's contribution is not detrimental to the imaging and direct sound perceived at the mix position because the diffused soundfield is significantly delayed in time in relation to the direct sound, thus the brain/ear mechanism is not confused by the diffused sound.

5.1 SURROUND MIXING ENVIRONMENT



Heavy, Broad Bandwidth Absorption All Around

Conversely, a 5.1 channel surround mixing environment requires that absorption be used to yield early reflection control at the room boundaries near all 5 monitors, not just the front two used in a stereo mixing environment. Whereas 5.1 channel listening and mixing environments allow you to hear much greater detail in the program material, especially with regard to reverberation and other ambience, diffusion is not appropriate in these environments because it would make you think there was more ambience on your tracks than there really was and negate much of the painstaking work that went into the surround mix. Obviously this is not desirable.

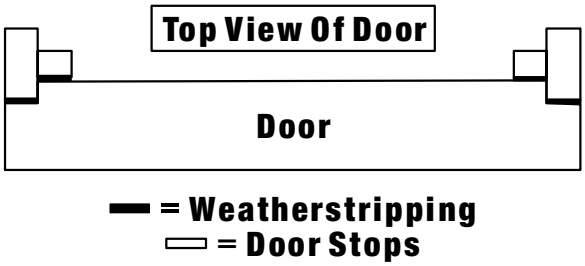
We advise room surface absorption all around and encourage the user to strongly consider beefing up the absorption materials used so that even, broad bandwidth absorption is achieved. Symmetry is **quite** important when implementing the acoustic treatments in a room in which accurate 5.1 mixing or listening is to be performed. Extra low frequency absorption is advised due to the .1 channel's extreme bass output capabilities. This being the case, we advise implementing bass trapping in such a way as to not degrade the symmetry of the room acoustically. Often this can be accomplished by treating the room's boundaries with absorptive materials that yield more low frequency absorption than would the "typical" treatments. In other rooms where lateral space is at a premium, the low frequency absorption that is needed can be introduced into the ceiling area without sacrificing floor space. By its very nature, implementing low frequency trapping on the ceiling tends not to degrade a room's symmetry.

If you're starting with a square room, you can chop off the room's corners as pictured and use the space behind the angled walls to achieve prodigious amounts of low frequency trapping. If not inclined to do this, apply Auralex LENRD Bass Traps here to achieve substantially the same effect.

As you can see, the acoustic treatments that might yield an ideal stereo mixing environment are not appropriate for a surround mixing suite.

Auralex™ acoustics

To: All Auralex Customers
Date: May 28, 1998
From: Eric "Fearless Leader" Smith
Re: Studio Doors



During the construction of a studio recently, we attained improved isolation by simply routing out all four leading edges of our doors as shown in the diagram to the right.

We routed a 1/2" notch out of each edge of the door, then doubled up our door stops as shown. What'd this do for us? It made our doors seal at 2 points on each edge of the perimeter—including the bottom of the doors where they met our self-made thresholds—instead of sealing at just 1 place if we'd left the doors "intact." The more seals, the better the isolation; this is why expensive luxury cars often use triple seals on their windows.

We covered both faces of our doors with SheetBlok™ Sound Barrier, affixing the SheetBlok to the doors with our new pressure sensitive adhesive (PSA) for maximum ease of installation and to negate the need to put any nails, screws or staples through the SheetBlok. As you may know, for a sound barrier to work at its optimum level, it shouldn't be penetrated by fasteners, so our new PSA-SB is a pretty smart solution.

We lined the edges where the doors met the door stops with closed-cell weatherstripping tape, which is available at any hardware store for a reasonable cost. You must use weatherstripping at these junctures to attain improved isolation! It's been proven that many doors sound "leaky" not because the doors themselves aren't occluding enough sound, but rather because the seals around the doors aren't tight enough.

Over the SheetBlok, we mounted Studiofoam™ by spraying both it and the SheetBlok with Auralex Foamtak™ adhesive for maximum bonding power. While it's true that Studiofoam isn't a sound barrier per se, it does offer a few bonus dBs of sound isolation.....plus it makes the rooms on either side of the door sound better.

Given that specialized, sound-attenuating doors are incredibly expensive—prohibitively so for most of us—we feel that many people's needs can be met quite adequately by using common, solid-core slab doors and the Auralex products mentioned above. Properly implemented, we believe the results should actually exceed most users' expectations and requirements. For additional notes on studio doors, see the Auralex publication *Acoustics-101*, available free-of-charge on the Auralex website at www.auralex.com.

Our PSA-SB comes in two sizes: 4'x10' and 4'x30' rolls. It couldn't be easier to use either: you just roll it out, smooth it onto the surface of the door (or the wall if that's where you're using your SheetBlok), trim it to length & peel the release paper away. That's it! Nothing could be easier.....or more effective!

PSA-SB is in-stock and priced right, so call Auralex or your favorite dealer today—but only if you want to attain **maximum sound isolation** and **save LOTS of money**!

Auralex. Acoustics For The Rest Of Us.™