Modern Control Room Design and Construction

By Malcolm Chisholm

Ever wonder why all those things look alike?

Simple. Form follows function. A recording control room has to do three things which dictate it's shape and size. Specifically, the room must:

1. Keep outside sound out; inside sound in. Control rooms must be soundproof. That mandates building materials as well as some of the construction details
2. Allow the mixer a view of the musicians. Windows are a must.
3. Give the mixer a clean shot at the monitor speakers, without interference from the room. Acoustically, a control room should do nothing at all. It is a laboratory environment for the monitor speakers and the mixer.

A room that does nothing sounds easy. Just wallpaper it in Sonex or whatnot. No reflections, no room effect, no problem.

But: Those of us who have tried it know that working in a dead environment drives mixers out of their minds. You need room sound around you to hear properly.

Since a control room's reflections can't be eliminated, they have to be managed so as to avoid messing up the monitor sound. That we know how to do. In fact, we've been doing it as long as we've been recording.

As a case in point, the writer worked for some years in a control room built for WGN Radio in 1932 that did nothing about as well as possible. It was monaural, of course, but it was a dandy.

The room was thirty-odd feet wide and about twenty deep with a sixteen foot ceiling. The front wall and ceiling were very dead, the back and side walls had been left untreated and reflective.

At eight feet, the speakers were too close to the mixer, but otherwise that 60 year old room would probably have met the current standards for a high tech monaural environment just as it stood.

Only probably, because it was never measured; but probably nonetheless, because of the location of the treatment material (fluffy brown paper on the wall, peculiar looking tile on the ceiling), and the size of the thing. Sounded great in mono and better than most in stereo.

It sounded good for the same reason that a lot of old control rooms sound good. They're enormous, and dimensions are critical to control room acoustics. Room dimensions (and geometry) control reflection times, which are the primary design parameter for modern rooms. While excellent (although huge) control rooms have been built since the 30's, putting together good small ones was a terrible problem until a few years ago. They sounded cluttered, the stereo positioning was fuzzy to nonexistent, and they were very tiring to work in. We did good work in them anyway, but it was hard. Real hard.

Then, about twenty years ago, there was a revolution. Without getting into detail, several exceedingly bright research people exchanged a raft of data from differing fields, and worked out why the small rooms sounded lousy.

It had to do with the difference in time between the arrival of the direct sound from the speakers and the arrival of the first strong reflection from a wall as heard by the mixer. Seems that a short reflective second path to the mixer's ears generates a comb filter which the hearing mechanism confuses with it's own method for determining the elevation of a source signal; a series of comb filters generated by/in the fleshy outer ear (pinnae). This confusion raises hell with hearing as the brain tries to make sense of false elevation cues. Very muddled, very tiring.

The solution to the problem is obvious. Eliminate the short reflection paths. Working out a design which would actually do it was not obvious at all. In fact, it required a room that was totally different from anything that had been built up to that time.

The first designer/builder to come up with a room that worked was Chips Davis, and through Synergistic Audio Concepts, who were largely responsible for the information exchange, trademarked the performance specs as Live End Dead End (LEDE), mostly to keep unethical types from building the same old bad rooms and calling them the hip new name.

Having developed the LEDE(tm), Ol' massa Davis went out and built a bunch of them. So did a few others, as Syn-Aud-Con's newsletter had published the design parameters in considerable detail.

His worked every time. Other designers had somewhat less luck, probably because he understood the concept better than they did. Some did well, some not so well, particularly when they just followed the shape of the Davis rooms rather than designing to the theory. There were several bears in those woods, the meanest of which was back wall geometry.

The back wall bear was shot dead a few years later when Peter D'Antonio put Schroeder formula Quadratic Residue Diffusers(tm), on the market, as they made back wall treatment both simple and reliable, and everybody started building Davis look-alikes.

Any number still do. Some of them are thoroughly competent designers whose rooms meet all the Davis specifications and can be certified as LEDEs, but mostly they're studio owners trying to save a few bucks by doing their own design work. Unfortunately, the latter usually call their rooms "ledes", as they're not aware of either the trademark or the licensing involved in the term. Makes things confusing.

The majority of look alike rooms aren't certified, and can't be, because they were made to look like George's, which was copied from Sam's, which resembles Fred's, which was a crude copy of a real LEDE. It's the old repeat the story around a circle of people trick. Doesn't work for stories, doesn't work for control rooms. I've been in a few that came off worse than an ordinary living room with a couple of speakers hung in it, and a lot more that started out as fundamentally sound (sorry 'bout that) designs, but were royally screwed up by adding unnecessary stuff to the original furnishings.

The sad thing about bogies is that many of them cost as much as the real thing and were beautifully crafted by their owners, who spared no effort to make them perfect, but who ended up with nearly useless rooms because they didn't understand the basic rules of the game. I really feel for those guys, but it's too late for the majority of existing rooms. Retrofit is time consuming. If the studio's busy, the down time losses are killer. If it isn't, there's no money for the work.

Important Note: There is no substitute for professional help. Designer / builders not only supervise the construction work, they guarantee the results. They also know enough tricks to save a client most of their fees. Sometimes more, as owners usually over-build.

For the dedicated do-it-yourself types who plan to put something together in the future, or fix a not so bad room, however, the rest of this article should prove helpful.

Since huge control rooms are old hat, we'll assume minimum space available.

The first critical dimension is from the mixer's ears to the back wall, which has to fall into a real world Haas zone at about 20 milliseconds. Eighteen is known OK, fifteen may be, but why gamble?

Don't go too long, as you'll start to hear double attacks at 40 to 50 milliseconds.

The nominal 20 milliseconds works out to a wall 11'-3" back of the mixer's ears. It's time x 1127 over 2. A foot less is about 18 milliseconds, and it would be nice if the mixer could push away from the console, so 11-1/2 to 12-1/2 feet is reasonable.

The next bit is speaker distance. The reason for using speakers rather than 'phones has less to do with keeping your ears cool than getting a little distance between yourself and the instruments. The sound from a mike inside a bass drum is not only weird, it's not real good for the earbones, so headphones are out. If they weren't we wouldn't have to spend all that money on control rooms and monitor speakers.
A little distance has been commonly agreed as something between 12 and 15 feet, which is about right for listening to a real rhythm section. At any rate, most control rooms put the monitors in that range. It's known to work, so go for it.

The final question is how far apart to place the speakers. Distance apart equal to distance from the mixer seems logical, but an awful lot of mixers like the speakers a little over-stereoed to broaden out the panning. Something in the area of 1.3 to 1.4 times the speaker throw looks and sounds about right to most, but it's a personal choice.

There's probably a firm rule in there someplace, but I don't know what it is.

In any case, speaker separation governs minimum room width, and distance off the mixer locates the front wall. For a monitor distance of 15 feet the separation would be 20 feet at 1.35 to 1.

Adding the width of the speaker cabinets puts the room at 24 to 25 feet wide. Mounting the speakers is more complex. Simply hanging them in the front corners of the room is a no-no. For one thing, cornering a speaker brings up it's bass response by anything up to 8 dB, which is a long way from flat.

For another, the sound will reflect off the corner walls beside the cabinets at a foot or two, which is a millisecond or two, and there's no way to absorb speaker sound evenly at that distance. The pressure levels are too high, the angles of incidence are all over the place, and the woofer waveforms haven't properly formed; that last being why speakers are measured and specified at one meter or four feet.

Hanging the speakers a few feet out from the corners takes care of those problems, but it leaves the corners in place, and it looks hokey. Corners sound funny anyway, so they're usually walled off or not built at all. A pair of eight or nine foot walls across the front corners of a control room at 50 to 52 degrees eliminates corner effects and makes a great place for mounting speakers to boot. That's such a good idea it's nearly universal practice in control rooms. The walls must be very rigid, though, or they'll vibrate and muddy up the low end.

Whether the speakers are mounted in doghouses or hung on the speaker walls is dealer's choice.

Each system has good and bad points.

Monitor speakers hung directly on the corner killing walls with nylon line and some felt padding on the backs are easy to move, service, or change.

Simple, quick, cheap.

Doghousing is harder. The monitors have to be floated in the doghouse, or the cabinet's bass vibrations will travel through the walls to the floor and get to the mixer before he hears bass through the air. Sound travels a lot faster in building materials than in air.

Additionally, the space around the speaker should be sealed off to keep it from acting as a Helmholtz resonator. Stuffing it with Fiberglas will lower the resonator output level, but at the expense of broadening the frequency range. Lower Q. Since floating dictates no solid contact between the cabinet and the doghouse, sealing off the cabinet gets interesting. An oversize doghouse with a closely fitted front panel can be sealed with bathtub caulk, and there are other solutions, but a doghouse essentially builds the monitors into the walls, so they have to be unhoused in order to do anything with them.

On the other hand, the bass response is somewhat better, they take up less room space, you pick up about 18 inches of mixer-speaker distance, and doghouses look professional as hell.

Dealer's choice. However, bearing in mind that you'll probably be in business awhile and this year's king of the hill is likely to be next year's turkey, it would be smart to build doghouses big enough not only to accommodate different speakers but to change positions and angles as well. A new console will probably shift the mixer position, which means the monitors will have to be moved to restore the geometry.

This brings up general design rule one (of one). Keep it flexible. You don't know what's going to happen nest. A control room is too expensive to rebuild every time you acquire new equipment or a new line of work, so build it as a mainframe. Plug in the stuff you own now, plug in new stuff as things change.

Back to the walls. There are two good reasons for not building speaker walls at 45 degrees. One is that they would play directly into the back corners of the room (if any) and the other has to do with stereo monitor horizon.

If only one person in a control room needs to hear the monitors properly, they can be pointed directly at that person. As a rule, however, there will be at least one other pair of ears that need feeding, and they belong to a producer. Since the producer is generally paying the bills it makes sense to let him (her?) hear where the money's going, which makes broadening out the monitor horizon a Real Good Idea. There are limits as to how wide a near perfect field can be spread, but the only thing that will spread it at all is over-convergence of the speakers so that as a listener moves closer to one monitor he also moves a little out of it's axis and into the axis of the other.

The degree to which speakers need to be cross-eyed depends on the tweeter type. High Q tweeters of the kind found in UREI monitors, which yield outstanding imaging accuracy, need more convergence than the much lower Q, somewhat less precise units used by Tannoy which have merits of their own.

This writer is not going to get handed his head by engaging in a debate on the merits of monitor types in this paper, because monitor choice generally involves the preferences of both studio personnel and clients, and whatever a studio uses is probably optimum for it's working situation. Nonetheless, monitor horizon is partly a function of tweeter Q, and since it can require extreme measures, the monitor type affects control room design. For example, I know one very competent designer who cross-eyes UREI's to the degree that they look really spooky and then hides them behind big cloth panels. They sound terrific, but the angle would be wrong for any number of other speakers. Among others, Tannoys need so little convergence that simply pointing them at the presumptive producer and second engineer positions works very well. If you don't know the angle for your monitors, experiment before you commit to a mounting angle.

You pays yer money and takes yer choice, but it's important to allow for changes in the angles if you doghouse the monitors. Very big doghouse with equally big front plates will do it. Want a different speaker? Make a new plate. Mainframe system.

The only remaining speaker dimension is height, which should be as low as possible, and will be dealt with shortly.

First, the window(s). Not whether. How big.

Since the only reason for putting windows in the front of a control room is to allow the mixer to watch the players, and since windows not only transmit bass but cost a fortune, small is beautiful.

A window six feet above the control room floor will permit a standing mixer to look a standing vocalist square in the eye. That's high enough. The low edge should be where the seated mixer's sight line is interrupted by the top of the console, usually at about two feet up. That's a four foot window, and while it ain't cheap, it beats hell out of a six or eight footer. It will also transmit less sound through the glass.

The glass is generally 1/4 inch thick with the outside pane mounted dead vertical and the inside tilted down at eight to nine degrees for a twelve foot mixer-front wall distance, to keep the inside glass from bouncing rear wall reflections into the mixer's ears. The offset distance is eight inches for a 4 foot window.

If the front wall is further away a lower angle will work. More usefully, a very strong case can be made for raising the console from a standard desk height of thirty inches to thirty six or more. The extra altitude reduces the necessary angle on the window, creates more room under the console (of which more later), and fights off the most common control room disaster; monitor sound reflecting off the board into the mixer's head. Returning to first principals, the fundamental design parameter of a modern control room is to make sure that the first solid reflection the mixer hears after the direct speaker sound comes from the back wall at something about 20 milliseconds.

When monitors are set high enough on the front wall to bounce off the console control surfaces they will produce a second path time of less than 2 milliseconds. Therefore; If the speakers must be mounted above the window, keep them as low as possible or raise the console height or, if all else fails, tilt the console, but on your life avoid monitor-console-mixer reflections. I've seen this problem in several rooms, and it is absolutely fatal.

Whether the speakers are put above the window or beside it depends on studio geometry. If it's long and thin, a single window will allow decent vision. If it's short and wide or just plain big, the window will have to extend around the speaker walls with the monitors above the glass.

While you're thinking about windows, think about cleaning the inside surfaces every few years.

Unless they're hermetically sealed, they'll film over and look terrible after a while.

If you hinge the wooden frames in which the outer glass is mounted now, it'll be easy to swing the pane down for cleaning later. If not, you're gonna have to live with dirty control room glass.

Don't bother with a seamless wraparound window. If you can see around the front door posts on your car, you can certainly manage the equivalent supports for a control room window. Just sway a little to one side and away you go, at half the cost.

It would be cute to tilt the side windows to match the front, but it ain't really necessary, and involves some very delicate glasswork. Not recommended.

Having got the front walls, the speakers, and the console position, we go next to the back wall.

There are at least four ways to handle this one, ranging from Chips Davis's first design with carefully angled zig zag panels to Peter D'Antonio's curved wall tastefully decorated in RPGs. All of the treatments work, because they all do the same things; they disperse most of the speaker sound reflecting off the back wall while bouncing a smaller amount of flat smack directly into the mixer's ears from the back corners. This combination of diffuse and direct reflected sound puts the mixer in an aurally live space with a clear sense of his/her own position in the room, as well as bringing about a feeling of "being there" which tends to hold down monitor volume, while the 20 millisecond delay leaves the sound clean and uncluttered. When it's right, the sound seems to come through the walls behind the monitors rather than from the speakers with no straining or reaching for it, let alone the feeling that it's somewhere back of you, as happens with a dead back wall. No effort, no fatigue, no clutter.

A couple of points here. First; QRDs and RPGs are called diffusers by their manufacturer, RPG Diffusor. By definition, a diffuser has something going through it as opposed to bouncing off it, and having been successfully accused of being a purist on at least one occasion, I prefer to call them dispersers. Don't try to order them that way, though, or they'll laugh a lot. Second, proprietary units are not the only way to disperse sound, just the most practical.

Any irregularity in a wall will break up sound down to a frequency of it's depth under 560. That comes to 15 inches for 400 Hz, which is the commonly used low point for dispersion. Human ears are relatively insensitive to direction at low frequencies, so there's no point to dispersing them.

As an example of any irregularity, ordinary cardboard boxes taped bottom out on a wall will disperse nicely down to 400 Hz or better and soak up gobs of excess bass to boot. Good for basement practice rooms.

Old auditoriums use niches with statues and vases for the same purpose (without the bass absorption), as do the zig zag walls in movie theaters. There's nothing new about using dispersion to improve the sound of a room.

What is new is the QRD-RPG design, which makes dispersers small and efficient. QRDs reflect near perfect dispersed sound at about half the depth of an equivalent box or wall, and they are so effective that it's usually cheaper to buy them than to construct the alternatives. They're also guaranteed to work, which is nice.

The flat smack reflection to the mixer comes from (what else) flat panels at the back corners.

They can be 3 to 4 foot panels as such mounted on ball joints for aiming, or they can be built into the room as 45 degree corner killers.

In either case they are called Haas Kickers. No mail, please, I didn't invent it, I just use it.

There are legitimate arguments about using flat smack Haas kickers, but I like to use 45 degree back walls as kickers, partly to eliminate back corners and even up the reflection time, but mostly because they provide a lot of storage space. As the working types know, there's no damn place to keep anything in a control room, and with solidly latched doors a pair of 45's will give you enough room to hide the body. Maybe two or three. Also handy for HVAC ducts or even a small air conditioner. The kickers don't have to reach the ceiling; eight feet up is plenty, but everything in back must be absolutely rigid or the bass won't bounce. If you don't like the flat reflection, QRD the doors.

I learned about that some years ago while doing a few dozen sessions in a control room built with a flimsy back wall of Masonite over 2 x 4s. It reflected the top end perfectly, but the bass thundered past like a freight train and vanished into nothingness. Found myself continually looking over one shoulder to see where it was going. Spooky.

More importantly, it was distracting. The disappearing bass trick was more interesting than the session sound. Blew my concentration.

Anything that makes a control room interesting is bad design. It's a tool, and like any other tool, it's not supposed to be interesting. It's just supposed to work. Inconspicuously.

Concerning non-parallel side walls; unless you really lust after being trendy, don't bother. These things are so popular I've seen echo chambers built non-parallel, but on balance they're probably not worth the aggro or the expense, as flutter echo is remarkably easy to exterminate. All it takes is a tiny amount of absorptive treatment or a wall offset of one inch in ten feet. So if the mixer hears slap echo in the front of the room, drop in a couple of 2 foot absorbent squares to kill it.

Better yet, you won't have ten feet of parallel side walls if you hang a QRD at either side of the mixer's head as suggested by Doug Jones. Great idea, strongly recommended, saves a fortune. Buy an extra tape machine with the savings.

The floor: Since most studios are built into commercial properties, we're usually looking at a concrete slab. Worst floors in the world. Miserably uncomfortable, no place to run equipment cables, can't be soundproofed.

Example: When Universal Recording built new studios in the late 50's Doc Sabin (no less) designed a 90 dB soundproof wall between A and B. The wall was about four feet deep and worked beautifully, but somebody forgot to cut the floor slab, so the bass from one studio transmitted almost perfectly to the other. With two sessions running at the same time it got pretty funny watching a band trying to hold it's tempo while hearing a different tempo from the other studio. The clients didn't see the humor in it, though, so studio B got 2 inches of industrial cork and a second brand new floor over the first brand new floor. Bah, humbug.

Uni was designed as a second floor addition to a building in construction, so the slab could have been cut. Most studios are on the ground floor, though, and slicing up a foundation slab is verboten. The control room must have it's own floor.

As a first step, seal the slab. Untreated concrete will wick up an amazing amount of water from the soil beneath it. The water will produce 100% humidity under your new floor and wreck it quick.

By way of checking, lay a sheet of plastic food wrap on the floor slab overnight. If it's beaded up in the morning, paint the slab. If not, give it a wash coat of shellac anyway. It might rain.

There are several specifications for a control room floor. They include, in no particular order, comfort, soundproofing, good looks, durability, a place to run cables, and cleanability. (see good looks, above)

Starting with cable space, the floor needs to be elevated enough to make runs underneath. Standard 27 pair snake cable is about 7/10 inch thick, so 2 x 4s laid flat will allow one cable to cross over another with room to spare. Unless you want to use the underfloor space for air conditioning returns there's no advantage to going higher.

Isolation from the main slab is achieved by laying the 2 x 4s down on 1 inch felt weather stripping to prevent solid contact. The principle here is that sound travels slower in soft materials than in hard, so going from hard to soft attenuates it rather like going from high resistance to low in an electrical circuit. Similarly, soft to hard does nothing.

No nails in the felt, please, but you can use the office stapler to hold it in place if you bang the staples down deep with a hammer.

Keeping flexibility in mind, use short 2 x 4s with serious space between them so you can make cable runs in any direction. Two feet long with 6 inches gaps in each direction is about right, as the castors on tape machines and such concentrate their weight on very small areas, but whatever spacing you use, build and use a gauge for it. Precision counts.

That's a lot of little wiggly chunks to lay a sub floor on, so run a bead of vinyl caulk or silicon adhesive between the felt strips to keep them put until you lay a sub floor.

Before laying the sub floor, get a bag full of nylon clothesline and run it side to side and end to end between every damn 2 x 4 on the slab. Fishlines. Given a known starting point and exact spacing, you'll be able to drill little holes and fish new cables for new equipment from anywhere to anywhere else in future. Saves ripping up the floor when (not if) things change.

The sub floor will likely be single 3/4 inch plywood or staggered double 1/2 ply. Either is good.

Don't nail it down. Common nails attract rot, especially in the high humidity one finds under an airtight floor no matter how well the slab was sealed. The best thing is galvanized building screws. They don't rot the wood and they grip so well you only need about a third as many as with nails. Very fast. Start the sub floor at the edges instead of the middle of the room and shim the panels an eighth inch or so away from the walls so you can caulk them in without actually touching.

All that produces a floated, airtight, soundproof sub floor. After a coat of shellac to guard against cleaning leaks, you're ready to consider the finish flooring.

I like parquet squares. They're not the cheapest thing available, but they meet all the specifications for a control room floor and present two outstanding advantages over the competition. The first is that the pattern of dark and light wood will hide the damage that inevitably occurs when things get dropped on and/or dragged across the floor. The second is that if a square has to be replaced because of new cable routing or what not it won't stick out like a sore thumb. Hardwoods don't change color over time. Neither do the modern finishes used on parquet tiles when they're properly treated.

Proper treatment involves wax. Old fashioned, slippery, hard paste wax. Sounds obsolete, but it's been around forever simply because nobody's come up with anything better.

Why wax? Because the killer damage to working floors is made by scrapes rather than gouges.

Scrapes leave big, highly visible marks. Gouges don't. That makes anything you can use to cut down on scrape marks a Real Good Idea. Dumb 'ol paste wax not only defends against scrapes by lubricating the floor surface, it helps clean up small gouges if it's properly applied.

As usual, the proper way is the easy way. Paste wax is best applied using fine steel wool with a half inch or so of water in the wax can. Old trick, used by half the world's janitors. The trick is that the steel wool cuts off the old wax and dirt while the water sets up the small percentage of Carnauba wax (the hard stuff) in the blend. This results in a thin, hard, even coat of clean new wax that's half polished as it's put down. The steel wool also polishes out scuff marks and rounds off the ragged edges of gouges and nicks, converting them from ugly nasty eyesores into marks of character. In consequence, a parquet floor, like old leather, looks better and better as it ages. I wish I did.

All this waxing business looks to be time consuming, but it isn't. One solid coat on a new floor followed by touch ups in the wear areas from time to time will do it. Paste wax is surprisingly durable stuff.

Whether the platform floor extends to the front walls or stops at the front edge of the console depends on how the mike and speaker cables are to be run, the location of the peanut gallery and whether or not the mixer can see any part of the floor between the mix position and the speakers.

Last first; If the mixer can see the floor between the mix position and the monitors there will be a short path reflection to the mixer which must be eliminated. Short of leaving all that space unused, the only practical treatment available is carpet, as the usual materials don't take kindly to foot traffic.

As to the peanut gallery, the writer has a long standing preference for seating visitors in front. Keeps 'em away from the console (and me), reduces the conversational level, and lets me keep track of who's where doing what. Given that the area up front will probably need carpet for acoustical reasons, it makes sense to set a wide sectional couch up there as well.

The only downside to a front peanut gallery is the people who move in and out of it, blocking your view of the players. You can hold down that kind of traffic by using the kind of low, soft, bean-bag couch that's hard to climb out of. Better still, take the legs off. That'll really anchor 'em.

Two small problems remain. One is that a couch only holds a few people, and we occasionally get mobbed with visitors. The other is that ordinary carpet has virtually no low end absorption because it's so thin. For a small area that's no problem, but this thing is big enough to unbalance the room with it's top only effect. In passing, don't use nylon carpet. It reflects at very high frequencies.

Both these difficulties yield to a single solution. Cut off the platform floor at the console to make a 3 inch pit up front, and fill the pit with padding and shag carpet. The bass absorption will be greatly improved, the carpet will be soft enough to accommodate surplus visitors, and if you cut it out around the couch you will effectively lower it even further. They'll never get out of it. Or want to.

Cable runs to the studio for microphones, tie lines, cue circuits and the like are most practically carried in standard electrical trough. It's not pretty, but it gives great shield, it's easy to seal at the walls (wet newspaper), and you can't beat it for running new cable. It'd be a damn shame to turn down film work because you'd run everything in the walls and couldn't drop in coax for video monitors in the studio.

The only dimension left is ceiling height. If it's high, leave it high. There is no acoustical advantage to a low ceiling other than reducing monitor power a little. Against that, a low ceiling requires a lot of short path absorption. It's a wash, except that cozy control rooms turn into claustrophobic coffins on long sessions. A mixer sometimes spends a lot of time in a control room, so think of it as your home. The bigger, the better.

So much for dimensions and geometry. Next; on to materials, lighting, equipment location, airflow, and (oops) a door.

Part Two: How To Do It

MATERIALS: There's a very old gag about making a silk purse from a sow's ear. Start with a silk sow. Not real funny, but it makes the point. Use materials that are appropriate to the job at hand.

The job of control room walls is to keep outside sounds out and inside sounds in. Soundproofing.

Actually, a reasonable degree of soundproofing. Nothing on earth will make a single room genuinely proof against all sound. Worse, attempting virtually perfect soundproofing is expensive beyond belief, so it's a Real Good Idea to define the degree of isolation needed for recording work.

Recording, that is, not gunfights in one room and meditation classes in the other. The idea is to avoid feedback from the monitors to the studio mikes, not to preserve the silence of death in the studio.

It's easy to figure. Worst case, you'll have a mixer listening at full thunder to a quiet singer six inches off a mike. That's 120 dB SPL for the mixer, 84 dB SPL for the mike. The difference is 36 dB.

Sounds wrong? It is. So add 12 dB for vocal limiting, yielding 48 dB, and then subtract 20 for the studio absorption. Final necessary is for the control room walls is 28 dB, which suggests that we overbuild control rooms something terrible. We do. And we don't.

As anybody with a little studio experience knows, the usual control room walls shut out the top end sound from the studio very well indeed, but if you sky a condenser mike the 30 to 50 Hz feedback will like to send the woofer cones across the room.

Fact is, most control rooms have marginal isolation at low frequencies as a result of wall construction, very big windows, and/or sound transmission through the floors and ceilings. We will deal with each of these one at a time, beginning with the control room walls.

To avid transmitting sound, a wall must be rigid enough not to drum head section by section, heavy enough not to move as a whole, and airtight.

The only ordinary construction that meets all those specifications is masonry. This is not a popular idea. In fact, it's usually met with disbelief, followed by sputterings about weight, costs, and problems with the landlord.

Most of the objections are based on misinformation, although the weight problem can be real. Even with the lightweight cinder block currently available, masonry walls come in at about three times the mass of the more conventional double wall with an inch of Gypsum board on each side.

So if the foundation slab won't take the weight, forget it. On the other hand, if there's any possibility of using masonry it would be real smart to look into it, as there are a number of advantages to the stuff. Among these are speed of construction, which makes the total costs very competitive, the cleanliness of the process in building a wall and tearing it down, and the fact that cinder block is a good acoustical material in and of itself. Primarily, though, block is rigid, with the result that it's inherent low frequency rejection is rather better than flexible materials.

The rigidity bit is what separates silk sows from standard oinkers.

Building a rigid wall with flexible materials is obviously absurd, and becomes embarrassing if one looks at the published data on Gypsum paneled walls. Not the STC figures, which are a form of average loss intended for rough comparisons rather than design purposes, but the more complex charts which list losses at various frequencies. A quick look at those shows that the 125 Hz loss of walls is commonly 20 dB or so less than the published STC loss. They're supposed to, because the STC contour has a built in 20 DB slope from 1.25 Khz to 125 Hz, but even allowing for that, STC is an unreliable figure for music isolation, where the bass is likely to be as loud as anything else, if not louder.

As an example, an STC 35 2x4 wall with 1/2 inch Gypsum board on each side loses 47 dB at 2 Khz, but only 15 dB at 125 Hz. Double the board thickness, the STC is 39 and the 2 Khz figure rises to 53, but at 125 Hz it's still 15. That's a difference of 24 dB between STC and low end performance. Build for 39, get 15. We need a minimum of 28, remember? So if you sky a drum mike......

While a 2x4 frame is nearly as heavy as one layer of Gypsum board, you'd expect that nearly doubling the mass of a wall would improve it's isolation. In fact, nothing happens at 125 Hz, and the 15 dB loss through the walls just detailed is 3 dB worse than for a single sheet on an open frame, which demonstrates that Gypsum board is a fairly strange material in terms of soundproofing. That's not to say it's no good; just that it's peculiarities have to be taken into account when designing for isolation.

Time for some hard data. The most common studio walls are 8x8x16 inch concrete block and double 2x4, 16 inch O.C. stud walls with 1/2 inch sheets of Gypsum board outside and 7 inches of Fiberglas between walls.

A third, less common construction is double sheets of 1/2 inch Gypsum board on either side of single 3-5/8 metal studs on 24 inch centers, again stuffed with Fiberglas.

Frequency	125	250	500	1K	2K	4K	STC
Masonry	38	44	49	54	58	62	50
Double Stud	36	48	59	64	66	63	59
Metal Stud	39	46	55	61	63	55	54

Table 1.1

All three work at 125Hz, but the low end loss curve for the double wall construction is about 12 dB per octave, so 60 Hz should be 26 dB and 40 Hz, where the speakers pinch off, about 17.

The metal stud wall is better at about 8 dB/octave, and masonry shows the flattest response at 6. Unlike the others, masonry follows the mass laws, allowing it to be calculated at a firm 28 dB for 40 Hz.

That'll work.

At this point we have two basic kinds of wall; dumb 'ol masonry, which any apartment dweller will testify is soundproof, and lightweight, sophisticated wallboard construction that depends on design and fabrication to work properly. Leaving out the Fiberglas, for instance, will cost you about 10 dB of isolation.

There is nothing in the literature to suggest that using two sheets of wallboard on each side of a double stud wall will improve low end rejection, although two 1/2 inchers or one 5/8 on one side would probably be good for two or three dB. The problem lies in one side's resonating the other across the gap between them, so dissimilarity helps.

For a real difference, use stiff panels on one side of the wall. Stiff translates to hard, rigid, makes no sound when you hit it. In short, particleboard.

Particleboard is not the name of a product, but of a process.

Georgia-Pacific lists 63 varieties of the stuff, ranging from thin,flexible, incredibly cheap chip board to something called Lamiboard, at 200 pounds for a one inch sheet. The more ordinary products found in building supply houses comes in thicknesses ranging from 1/2 inch through 1 inch. They're 17 to 20% heaver than Gypsum wall board, but at 3/4 and one inch they're rigid.

Also expensive. Don't panic, though, as while a double stud wall control room without a back wall will use up close on three gross of 2x4s, it needs only 80 odd sheets of panel-ing, so the panels are a fairly small proportion of the material costs.

Size for size, common particleboard costs three to four times as much as wallboard, and the fireproof versions, which carry the same fire ratings as Gypsum, are about 2-1/4 times the cost of the standard, but even if you used the fireproof stuff for both sides, the difference would be about half the cost of the 2x4s. Best not, as you'd be back to two identical materials drum heading each other. Wallboard is dandy above 1 KHz, particle's good down low.

The resonance and drumming of wallboard has a nasty tendency to add harmonics to bass, giving the mixer a warm, smooth, false bass sound which leads to surprises when listening to the product in other rooms. One inch particle board doesn't drum much, and two inches won't drum at all, so using the stuff inside a control room, if only on the speaker walls, makes sense from a monitoring standpoint.

One inch board is easy to set in place and seal, as it has nice big square edges. At 125 pounds a sheet, you need a little help, but it supplies some, and it's less than half the work of two individually caulked 1/2 inch sheets of wallboard.

A 3-5/8 inch metal stud wall is not only superior acoustically but does better on costs. For one thing, the number of studs is about 30% of the double wall construction with an equivalent reduction in labor. For another, the studs themselves are about the same price as standard 2x4's but half that of the fireproofed version. If you're building in an area with fire codes that specify no combustible materials in a compound wall, metal stud construction reduces the frame costs to 15% of a wooden double. Finally, metal studs can be bought at any length, which makes building 16 to 20 foot walls simple, and for high walls or a little better isolation 2x6 metal studs are available at 50% over the cost of the 2x4's.

To summarize, if you can stand the weight and are willing to hire the work done, cinder block is probably the best choice for control room wall construction. If not, a single 2x4 or 2x6 Fiberglas stuffed metal stud wall with fireproof particle board inside and either that or two sheets of Gypsum board outside will likely prove lighter, easier, better and cheaper than double wood stud construction.

WINDOWS: While 1/2 inch glass set just inside the wall edges is common practice for control rooms, it is not optimum.

The figures for 1/4 inch glass are:

SPACING	125Hz	250Hz	500Hz	1Khz	2Khz	4Khz
2”	25	28	36	41	46	-
4”	28	34	38	42	40	-
6”	31	37	43	48	44	-
8”	40	42	49	56	43	-

Table 1.2

While figures are not available for double 1/4 inch glass at 4 KHz, those given for other thicknesses suggest that the isolation is higher than for 2KHz. In any case, the gap's the thing, and given a 40 dB loss at 125 Hz with a 2 dB per octave curve for an 8 inch spacing there seems little need to use thicker, more expensive glass.

It seems wrong to use the same size glass on both sides of a window, but measurements show otherwise. In addition, with one window tilted eight inches there is no probability of a strong drum head effect between panes at any single frequency.

The angle of the inner window, however, makes it take up eight inches on it's own, so the two windows will need sixteen inches between them at the top. Since most walls aren't a foot thick, this necessitates mounting the windows on, rather than in the wall. It's easily done by building a second 2 foot high wall outside the main wall to support the outside window or making a very deep set of sills and sides as an equivalent. The top of the outside window frame also makes a handy shelf for odds and ends. Put the excess width on the studio side. Nobody gets close to that wall anyway.

You can increase a windows' losses by 5 dB or more by lining the inside frame edges with Fiberglas. One inch ceiling panels or Linear Glass Cloth over 6 to 8 inches of 703 board will do, both reducing transmission and tidying up the gap between panes. Cute idea. Not mine, but cute. If that's not enough, 1/4 inch laminated (safety) glass shows 6 dB more loss than standard 1/4 inch plate at all frequencies. Costs more, does more.

The reason for using 703 board rather than glass wool inside the window is that for wall mounted material it's the thinnest treatment available for absorption down to 60 Hz. In fact, hard backed 703 takes about half the space of it's nearest competitor.

Once again, the figures are:

A: 3-1/2" Fiberglas Building Insulation

B: 6-1/4" Fiberglas Building Insulation

C: 3-1/2" Fiberglas Noise Barrier Batts

D: 2" Fiberglas 703 Insulation Board, Unfaced

E: 4" Fiberglas 703 Insulation Board, Unfaced

	125Hz	**250Hz**	**500Hz**	**1Khz**	**2Khz**	**4Khz**	**NRC**
A	0.34	0.85	1.09	0.97	0.97	1.12	0.96
B	0.64	1.14	1.09	0.99	1.00	1.21	1.05
C	0.38	0.88	1.13	1.03	0.97	1.12	1.00
D	0.22	0.82	1.21	1.1	1.02	1.05	1.05
E	0.84	1.24	1.24	1.08	1	0.97	1.15

Table 1.3

As can be seen, 4 inch 703 is a better low end absorber than 6-1/4 inch glass wool, and about equal to seven inches of Noise Batts.

According to the good folk at Owens-Corning back when they had a testing lab, doubling the thickness of a treatment should shift the figures down an octave. Real measurements show it's not exact, but the principal holds.

Segueing neatly into control room treatment, don't equalize the speakers! Build a flat room, install flat monitors. Sounds better, costs less. Sell those third octave things to somebody with a room problem.

In order to build a flat room, however, it's necessary to use flat treatment. Except for a hung ceiling, that means thick treatment, with about eight inches of 703 board as a minimum, which at least in theory will put you down 1.6 dB at 62.5 Hz. Close enough.

So how is it everybody doesn't use thick treatment? Especially since all those other rooms seem to sound great with thin stuff?

Those other rooms are surfaced with open backed wallboard on 2x4's which, without any Fiberglas to damp vibration and suck out transmitter sound, show acoustical absorption of 4% in the midrange and 29% at 125 Hz. Since wallboard's not porous, it's sure as hell not absorbing the bass, so it must be transmitting it through the wall. It is, and the rooms are not particularly soundproof.

Same applies to glass, and a few other non porous flexible materials. The point is that with the walls drum heading and leaking bass out of the room you won't hear a lot inside.

Less helpfully, if you can feel the walls vibrating to every bass note, you can bet your boots they're faking up the bass sound by adding lots of harmonics. Gives a nice, warm, false bass sound that is not repeat not what you're putting on tape.

Put in a proper non vibrating wall, you'll get no added harmonics and true bass sound, but you'll need to soak up as much low end as top, so you'll need to use thick treatment.

A foot or more of glass wool is fine for a studio, but takes up too much space in a control room, so 703's better there.

You'll need to treat the front and speaker walls to kill bounce to the mixer from the back wall, possibly some treatment on the forward side walls to soak up speaker bounce to the mixer from them, and unless the ceiling is really up there, you'll have to treat it for reflections from the speakers to ceiling to mixer position.

Locating treatment is easy. Buy a cheap plastic decorating mirror at a tile store, run it along the walls, and hang some absorption anywhere you can see the speakers from the mix or producer/second positions. Ditto on the front and speaker walls for the back walls. Ditto again for the ceiling. You'll probably wind up with most of the front and a good deal of the ceiling fuzzed, which is why it's called the Dead End.

How much fuzz involves the studio. Specifically, the control room should have a shorter reverberation time than the studio because if it's equal or longer you won't be able to hear the sound of the studio room as such. For medium and big studios ranging from a half to one second it's no problem. For small ones it can be big trouble, as while one can hang fuzz all over a studio, the back third of a control room has got to be left live to feed the QRD's.

Treating everything possible, a standard control room such as the one illustrated at a base 25 x 25 x 16 feet will come down to about a quarter second. For a rationally treated live studio the minimum size for a quarter second (.266) is 14,400 cubic feet.

For smaller studios, one can lower the control room ceiling, which reduces the volume and so the reverb time. As it happens, using a ceiling height of studio volume over 1000 comes out pretty close, although with an 8 foot high control room for an 8000 cubic foot studio things get very, very cozy.

If the control room's time is too long, it's not a disaster. It'sjust that you'll play hell hearing the live sound of the studio itself. Basic laws of physics. All the other good stuff works nicely.

Where to put treatment is easy. How's not much harder.

The writer strongly recommends hanging acoustical treatment on the walls rather than building it in. It doesn't have to look horrible, it's less expensive, and it's the mainframe way of doing things. You might need to put equipment up there one day.

One simple way to hang treatment is to box it. Use 1/4 inch plywood to build 8 inch deep frames, screw the corners together using 2x2's, staple some chicken wire across the back, and cover the front with Upholsterer's Burlap.

The burlap is good looking, won't sag, takes paint (non sealing, please), and compensates the nonlinear response of 703 at very high frequencies.

Don't like burlap?

Try ceiling panels. For damageable areas there's no substitute for Tectum. Tough as nails, takes paint, looks very good. Looks rather like Shredded Wheat made up of wood fiber. Too thin and heavy for standalone panels, but terrific for protecting Fiberglas against public clumsiness.

As drawn, there should be no glancing blow, low incident angle reflections in the room. If you plan to make some with small speakers, lights and such, use Sonex to kill them. Nothing touches it for the purpose, but restrain yourself from wallpapering the room with it, as the base is so thin it's got no absorption at the low end. Read the specs.

Ceiling treatment is best done with a conventional grid system using 1-1/2 inch Omega Fiberglas panels or whatever 3 Pound glass board.

Omega is the best available, but the panels are 20 x 60 inch. The 3 Pound generic stuff is nearly as good, and can be got a 2 x 4 feet. Get the numbers from the supplier, read the specs. Some ceiling panels are much more equal than others.

THE DOOR: There are a number commercially available steel soundproof doors which come in their own steel frames. They work every time, but I have a couple of problems with them. First, they're not a wide as I'd like and second I've seen three tape machines trip on the thresholds and fall flat on their faces. One was a 24 track which made very impressive noises in the process and took about half an hour to restore to service. It takes two people to get wheeled equipment over a threshold, and you haven't always got the help available.

On balance, it may well be best to build your own. The design parameters come down to how soundproof you want it, starting with a standard 1-3/4 inch solid core door at about 4 pounds per square foot and well under 20 dB of isolation at 125 Hz.

You may want to end there, as beating it will take some effort.

Doors are pretty much mass law devices, so building one for low losses gets you into walk-in refrigerator hardware for openers. If that's acceptable, go for it. If not, stick with a single solid core. Don't even think about double doors on either side of the wall. If they're properly sealed it'll take two men and a boy to get them open.

Vacuum.

A massive door can be made of multiple sheets of 3/4 inch particleboard at 3 Lb/Ft, one inch at 4 Lb, or one inch Lamiboard at 6-1/4. That last is 200 pounds a sheet, 175 for a 4x7 foot door. A couple of those will get you 24 dB at 60 Hz, and probably better if they're mounted on a flat 2x4 (2 ea 2x6 at the hinge side) frame stuffed with glass wool. On the other hand you're looking at a near 400 pound door, so moderation may be in order.

Laminated construction allows door to be built like a safe, with a 1/2 to 3/4 inch setback for each layer. That takes care of sealing three sides with no effort, and a rubber blade sealer can be used for the bottom. You can get them with an automatic push down mechanism, but it's probably overkill. Hiding the blade between layers in the middle of the door is real cute until it wears out and you have to take the door down to replace it. Not so cute then.

As a purely personal matter the writer has preferred to leave the control room door open during about 30 years as a full time music mixer, and some may agree. Others not. Dealer's choice, but sound proof doors are a pain.

LIGHTS: The purpose of lights is to see what you're doing.

Sounds real obvious, but engineers do a lot of things in a control room, and there's no one lighting system suitable for all of them.

For recording, you generally want the lights down so the musikers aren't distracted by movement in the control room, but up enough so you can see all those little damn knobs. Can't be done, and all of us have occasionally gone half blind trying to set equalization in low light situations.

Recording takes two lighting systems, one for the equipment, one for the general room. Equipment lights are easy. Get two or three little theatrical spotlights with barn doors, put them up on the ceiling, and set the barn doors so the light covers only the tops of the console and machines. The Fresnel lenses in those things are so efficient you can nearly burn the paint off a console at 12 feet and with the barn doors you can do it with no light on anything else.

For room at large indirect lighting is best, as it's so even that light levels can be held really low. The troughs in the drawing are an old film mix lighting system. Both the trough and the wall just behind it are lined with crumpled aluminum foil for maximum reflection; the lights are store showcase tubes or dimmable fluorescents. The showcase tubes are nicer, giving a peculiarly warm, soft, even light.

Bouncing the trough lights off a white enameled ceiling is pretty efficient, so they don't heat up the room a lot, and they produce perfectly even light without any bright spots to contract one's pupils, so the lights can be taken to amazingly low levels during sessions.

So low, in fact, that it's a good idea to hold down on the lighting just outside the control room. Makes a sort of visual decompression chamber between control and studio.

Soft, sexy lights are great for recording, but they suck for setup, cleaning, maintenance, repairs and the like. For that kind of work you need harsh, nasty fluorescents. So hang a bunch of industrial fixtures a foot or two below the ceiling back of the mixer. A bunch in this case means enough so the sun comes out when you hit the switch. As a minor bonus, the fixtures do a decent job of dispersing sound in the area, but make the spacing a little irregular to avoid a comb generator. Three to six inches is plenty, but it's important.

TOYS: All God's children got toys, even purists who won't use anything more than outboard equalizers and limiters. The problem with toys is where to put them, and some of the solutions are outrageous.

If the office girl can grab a sheet of stationary faster than you can get to a limiter threshold control, you might look at how she does that.

Having looked, consider that the Brits call a console a mixing desk.

I've been supporting consoles on toy racks for years, and am astonished that so few other people do, as it's such a sensible idea.

Cheap, too. Bud 31 inch open frame relay racks cost well under a hundred bucks per, mount 28 inches of equipment, and raise the console height a few inches. They're two-fers.

The extra height opens up the mix position and adds more comfort than you might think, but the chief advantage of mounting toys like desk drawers is that you can diddle them while facing the speakers. The alternative positions make no sense to me, as tweaking sidecar gear puts the mixer into monaural with one ear toward the speakers, and turning 'round to use equipment behind the mix position hardly bears thinking about.

The most frequent objection I've heard to this toy mounting method is that people will kick the knobs off. Maybe, but several years of experience says it doesn't happen. Ever. Setting the racks back 9 or 10 inches from the front of the console may have helped.

Second objection is that you can't see the knobs. Yes, you can, especially if you hang a shielded showcase light under the console to light them.

Two 31 inch racks at the front of the console will give you 4-1/2 feet of toys, with another 4-1/2 feet at the back for things you don't need to reach, such as power supplies and monitor amps. If nine feet of racks isn't enough you may be in the processing business, not recording. However: The racks are not particularly handsome, so you might want to cover the sides. Easy. Cement flat refrigerator magnets to a couple of nice looking panels, stick 'em on the sides. Quick on, quick off.

Don't forget to mount a fluorescent light stick back of each rack. Makes calibration and service simpler.

Try a computer monitor arm for machine remotes. There are a dozen or more on the market, and one of them should suit your situation. At worst, it will at least get the damn things off the console or out from in back of you. Might even have enough room for the slate sheet board.

They'll also swing Auratones and/or near field monitors out of the way if they can't be hinged so as to drop them in front of the console during sessions. Takes more Sonex that way, but you'll be able to see the players.

Finally, while a good deal of the foregoing is a little vague, construction details are available in the Owens-Corning Noise Control Manual, if you can find a copy.

Other sources include Armstrong, PPG, Georgia-Pacific, the USG Group, Klark Teknik's Audio System Designer manual, Davis's Sound System Engineering book (Sam's Publishing) and last and maybe best, your local building supply store.