WSR's Holosonic™ Home Theatre System

Part II — The Noise Control Acoustical Foundation

GARY REBER
PHOTOS BY DAVID KESSLER STUDIO

Widescreen Review's New State-Of-The-Art Reference Theatre At New Facility

This is Part II of a series of articles on the design, development and execution of a new state-of-the-art Reference Home Theatre Laboratory at *WSR's* new office facility.in Temecula, California (north of San Diego, southeast of Los Angeles) that serves as *Widescreen Review's* and Surround Music's review laboratory. Part I appeared in Issue 48. Part VII concludes in Issue 53 (October 2001).

Our dedicated theatre measures 26-feet deep x 21-feet, 8.6-inch wide x 13 feet, 11.9-inch high, or approximately 8,000 cubic feet in volume.

The entire home theatre room and the rear-projection room were constructed with the complete QuietZone® Noise Control System build-materials package from the Owens Corning Science and Technology Center Acoustical Design Division. In this Part II group of articles, Harry Alter and Norman Varney of Owens Corning write about the application of the QuietZone approach as our acoustical foundation for the theatre. In a separate piece, acoustican Norm Varney discusses Owens Corning QuietZone building materials and their application in our theatre. This is followed by an article written by Ken DeLasho, who designed the Noise-Lock Sound Control Access Systems manufactured by the Industrial Acoustics Company. With this interated system of QuietZone building materials and IAC acoustic doors we were able to achieve a Sound Transmission Class rating of STC-63 for the theatre construction and a STC-61 rating for the doors. STC is a single number (laboratory) rating of how well a structure (wall, floor, door, window partition) reduces sound passing through it. A minimum STC-60 (partition) performance level is recommended for home theatre.

Feeney Acoustical Builders, based in Grass Valley, California, and Hodges Construction (who also served as our general contractor on our new building) of Murrieta, California, were retained to construct the room. John Feeney and Jeff Hodges are certified specialists in fabricating acoustical sound home theatres using Owens Corning QuietZone building materials and Industrial Acoustics Noise-Lock doors.

The following articles and the On Screen conversation with Norm Varney are very informative and provide an excellent insight into the particulars of actually building a state-of-the-art dedicated home theatre from scratch.

The following is a collage of pictures taken during the QuietZone construction phase. The pictures were taken by either myself or Dave Kessler, proprietor of the David Kessler Studio. ■

Acknowledgements

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Acoustical Builder John Feeney Laying Out QuietZone™ Wall Studs For Left Side Wall

Left Side Wall View With Acoustic Batt Insulation, Which Presses Snugly Against Tilt-Up Concrete Wall For A Room Within A Room Structure

Acoustical Builder John Feeney Measuring For IAC Noise-Lock Acoustical Door Access

QuietZone™ Wall Framing Using Patented 14-Foot 2x6 Wall Studs Connected By Acoustically Resilient Metal Clips

Inside Rough Framed Interior Looking Towards Projection Room

Inner View Of Skeleton Theatre

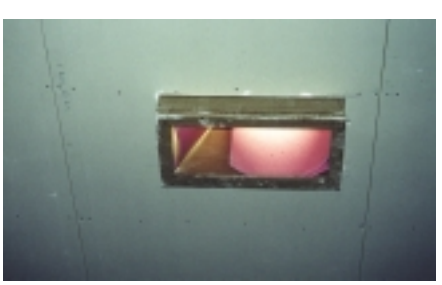
Double Thick Dry Wall Insulation

Interior View Of Insulated Theatre From Equipment Access

QuietZone™ Acoustical Batt Insulation Applied To Rough Framing

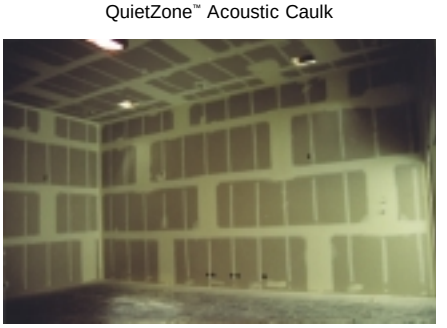
Acoustical Builder Jeff Hodges Applying First Dry Wall Layer

Acoustical Builder Jeff Hodges Applying QuietZone™ Acoustic Caulk



MDF Speaker Box In Ceiling To Support Dunlavy Signature Series SM-1 Professional Monitor

Dry Waller Taping Dry Wall Seams Prior To Painting



Dry Wall Taped Room Ready For Paint Primer

Primed Theatre Ready For Finish Black Coat

Laid Out QuietZone™
Over 6-Inch Thick Concrete Subfloor

Worker Laying Out Carpet Pad
And Thick Gray Carpet

Painter Julio Ortez And Sprayer

Workers Applying 2-Inch Thick Light Weight
Concrete Over QuietZone™ Floor Mat

Electrician Laying Out Conduit Runs For
Electrical Outlets And Communication Lines Over
QuietZone™ Floor Mat Near “Sweet spot”

Worker Trimming Off Excess QuietZone™ Floor Mat
At Intersection Of Wall And Concrete Floor

Owens Corning's QuietZone™ Noise Control System

The Acoustical Foundation Of WSR's Holosonic™ Home Theatre System

HARRY ALTER & NORMAN VARNEY

Introduction

Controlling noise levels into or out-of a critical listening environment requires a multi-faceted way of thinking. It's never just one noise control product that provides all the answers, but a multitude of products and installation techniques intimately linked toward a final noise control solution. If one product is by-passed or installed incorrectly, it quickly becomes the weak link in the system causing all other noise control efforts and products to lose much of their potential effectiveness. This is why Owens Corning calls their approach to providing customer solutions "System Thinking." And if there was ever a system that requires System Thinking it would be those measures necessary to provide an effective noise control solution. Owens Corning calls their noise control system "QuietZone™" and it entails a number of products linked to providing a variety of noise control solutions.

Each of the QuietZone noise control acoustical products manages sound and controls noise by incorporating four important basic acoustic principles.

1. QuietZone Acoustic Wall Framing "**break**" sound vibrations from one side of the wall to the other.
2. QuietZone Acoustic Batts "**absorb**" sound energy in wall and ceiling cavities.
3. QuietZone Acoustic Caulk "**block**" potential noise penetrations.
4. QuietZone Acoustic Floor Mat "**isolate**" sound vibrations through floor.

These four principles play an important role in any noise control system and integrally weave their way through each product. If noise control is to be effective then taking care of these babi's is essential.

Vibration Breaks

Lets start with vibration "**breaks**." One of the most detrimental characteristics of poor noise control is what is called the "coupling" of sound vibrations. Once airborne sound becomes structureborne (traveling into the solid wall and floor/ceiling assemblies) the sound will follow the path of least resistance. Wood, as it turns out, is an excellent (stiff) conductor for sound energy to travel through walls, floors, or ceilings. An old analogy of coupling sound vibrations is the tin cans and string (telephone) experiment we did back in elementary school science projects. The two tin cans can be compared to the two surface sheets of drywall on a typical wall assembly and the string is like wood studs connecting the two sheets of drywall together. In the same manner in which we hear each other talk through the use of a string and two tin cans, we can hear what's

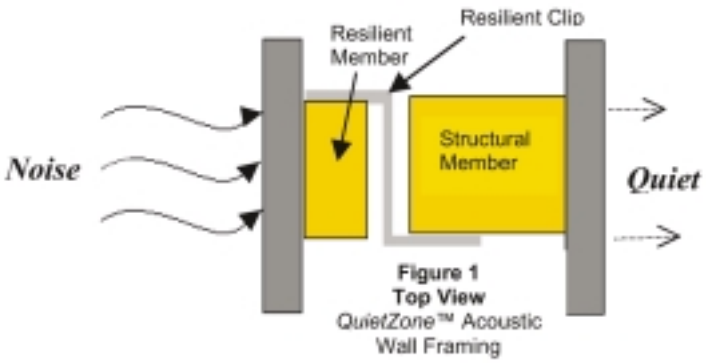
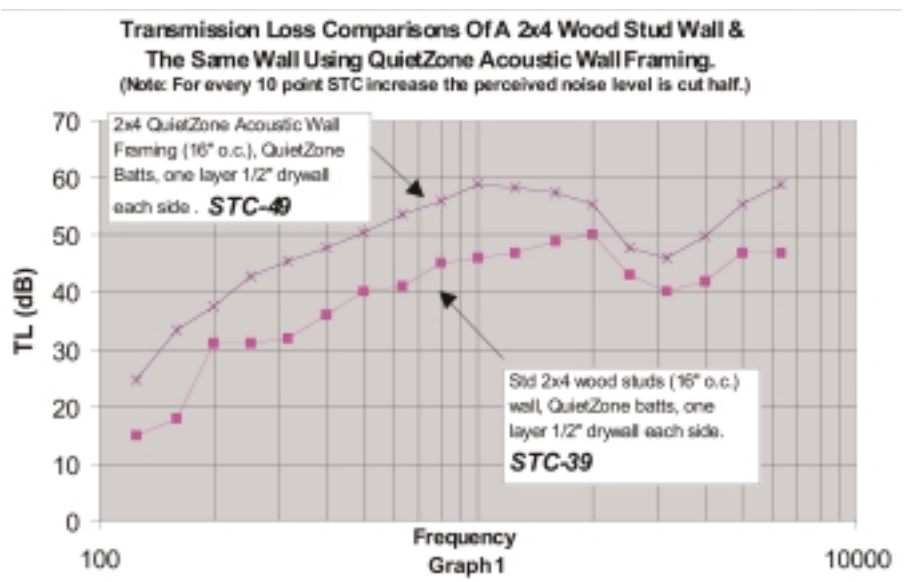


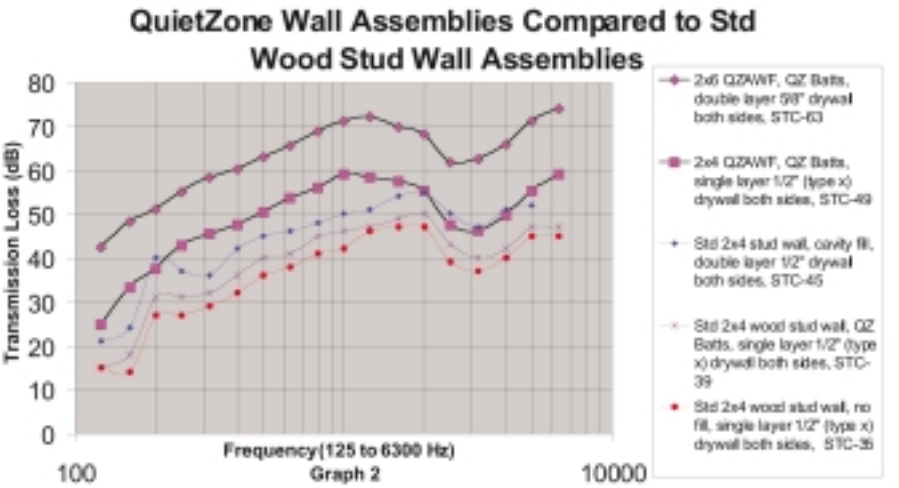
Figure 1
Top View
QuietZone™ Acoustic Wall Framing



on the other side of the wall via the transmission of sound vibrations through wood studs and two sheets of drywall. Just as the string is essential for the tin cans to transmit sound, the studs are one of the most detrimental noise control aspects of a typical wall or floor/ceiling assembly to transmit sound vibrations through the wall. So if we cut the string, so to speak, or create a "break" in the vibration path of the wood stud we "decouple" sound vibrations from traveling from one side of the wall to the other. The key here is reducing the amount of sound energy which reaches the gypsum drywall on the other side or the wall or ceiling. An important feature to remember here is that what we hear as sound or noise traveling through a wall is **not actually noise going *through* the wall** (unless there are actual holes or cracks in the wall for air to pass through). **The noise we hear is actually being *generated* by the wall** or floor assembly much like a vibrating speaker. Figure 1 shows how the QuietZone Acoustic Wall Framing stud is designed to allow one side of the wall to float, breaking the path of vibration traveling through the stud. The result is excellent noise reduction characteristics.

Acoustical testing at Owens Corning Science & Technology Center show that QuietZone Acoustic Wall Framing significantly outperforms conventional wall framing methods. The following graphs show the increase in noise control performance (what is called transmission loss) between two identical walls with the exception that one used standard 2x4 wood studs and the other 2x4 QuietZone Acoustic Wall Framing.

The Sound Transmission Class (STC) rating of a partition is a single number rating indicating the partitions ability to reduce noise transmission levels from one side of the partition to the other. (The higher the rating the better the partitions ability to reduce noise transmission.) As can be seen from the graph above, by simply exchanging standard 2x4 wood studs with 2x4 QuietZone Acoustic Wall Framing studs an STC increase of 10 points was achieved. Note that for every 10 point increase in the STC curve the perceived noise level is approximately cut in half and noise levels would perceptually double if STC points were to decrease at 10 point increments.



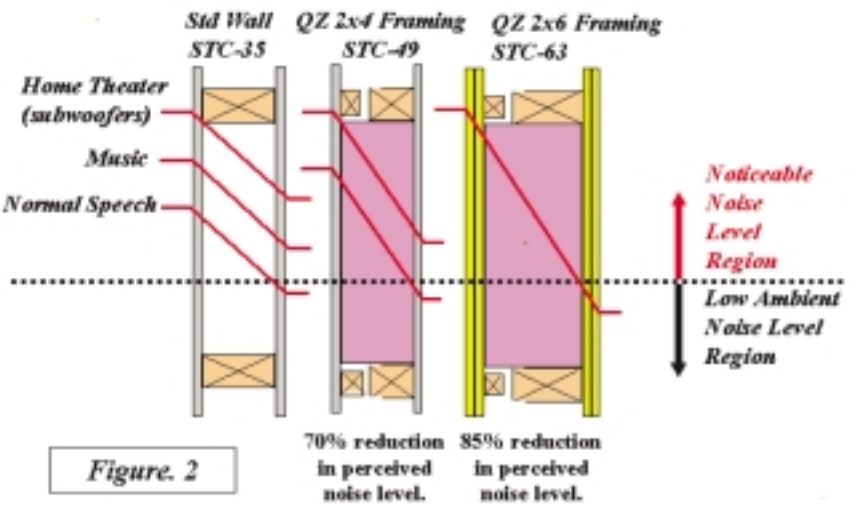
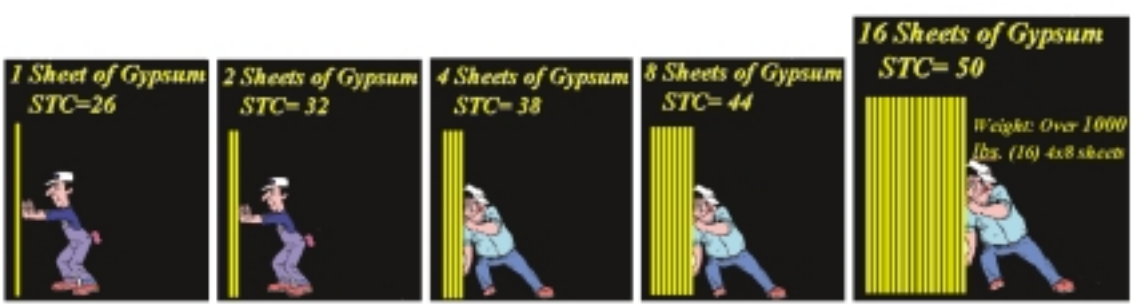


Figure. 2

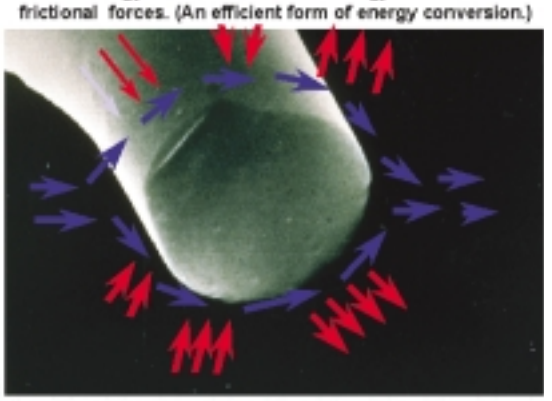
Increasing the acoustical performance of partition walls, in the past, has been largely due to adding more and more mass to the wall. Typically this approach has been to add more and more layers of gypsum drywall until the required STC rating is achieved. Using mass as the only factor toward increasing a walls STC performance, as can be seen from the pictures below, is not an effective method to approach a noise control solution. A single sheet of drywall typically achieves a STC rating of 26. It would take the additional mass of 15 sheets of drywall to finally achieve a STC rating of 50 or a total of over 1000 pounds of mass.

Likewise, 2x4 QuietZone Acoustic Wall Framing can achieve a STC-50 using a single layer of 5/8-inch, type x (fire rated) gypsum on each side. Again, breaking the vibration path is critical to success just as cutting the string between the two tin cans will also terminate transmission.



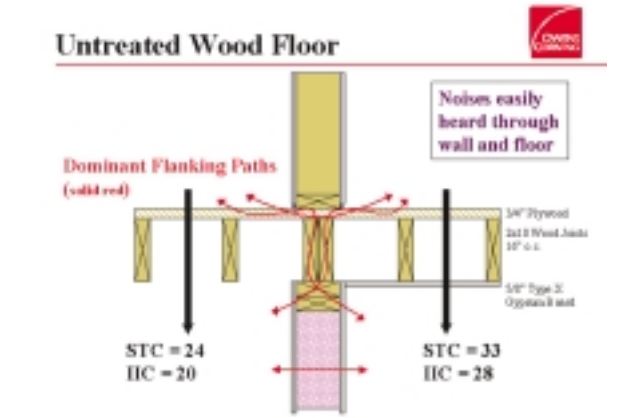
The recommended **minimum** STC performance for a home theatre listening environment is 60. The 2x6 QuietZone Acoustic Wall Framing assembly used for *Widescreen Review's* Holosonic™ Home Theatre has a STC-63 performance rating

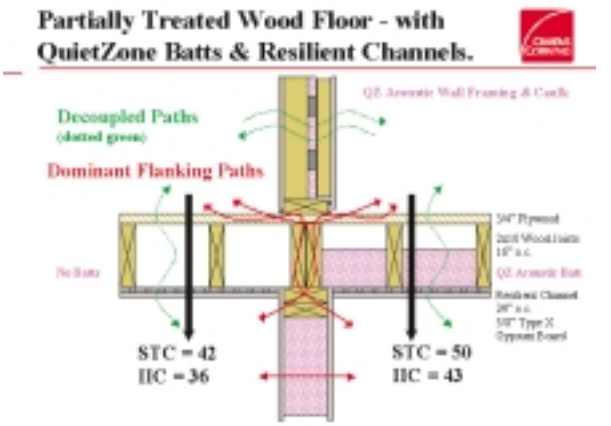
Sound energy is converted to heat energy as a result of frictional forces. (An efficient form of energy conversion.)

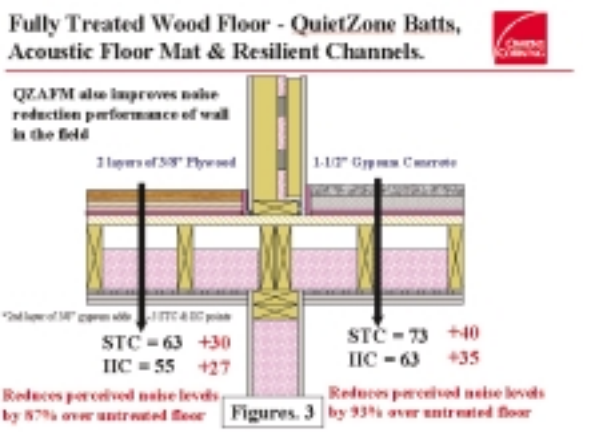


: Air Particle Velocities over a glass fiber

: Pressure changes over the glass fiber







Figures. 3

and is well suited to control noise levels associated with high level home theatre sound reproduction. The following graphs illustrates the progression of various wall assemblies using standard stud construction compared to QuietZone Acoustic Wall Framing.

Remember that different walls or floor assemblies have different applications for controlling different types of noise. A standard wood stud wall does fine to control standard speech sound levels, but introduce a TV or stereo music and this wall quickly has its serious limitations. Introduce a subwoofer or a home theatre and the majority of wall constructions do little to control noise levels. The following diagram shows how different walls control different types of noise levels associated with normal speech, stereo music listening, and home theatre (subwoofer) sound levels.

Sound Absorption

The "**absorption**" of sound energy within a wall or floor/ceiling cavity is a critical element to easily increase the assemblies noise control performance. Unlike what many people think, the conversion of sound energy to heat occurs within fiberglass insulation not because the fibers vibrate, but because the flow of air (sound) through the fiberglass causes pressure changes around the glass fibers. These changes in pressure (due to velocity changes in the air particle) cause the air particles to drag over the surface area of each fiber (much like how velocity changes over an airplane wing cause pressure changes and drag). See photo diagram.

An empty wall or ceiling cavity is much like an empty room. Sound energy entering the cavity from the vibration of the drywall or floor assembly is allowed to quickly fill the cavity space. This in turn sets the adjacent drywall or floor assembly into motion. The more energy in the cavity, the more sound vibration can be transferred from one side of the wall (or floor) to the other. QuietZone Acoustic Batts provide optimal cavity absorption to reduce this path of noise transmission. Using QuietZone Acoustic Batts with QuietZone Acoustic Wall Framing can actually increase the potential performance contributions of the acoustical insulation. Cavity insulation in standard wood stud constructions can only do so much because of the "coupling" effects of the stud. When using QuietZone Acoustic Wall Framing these coupling effects are significantly reduced. As a result, the effects of the cavity insulation is no longer degraded by the noise being transmitted by the wood stud.

Many people think that higher density

insulation provides better sound absorption. This is not necessarily true. The key to optimal sound absorption from an insulation is to balance air flow (what is called Air Flow Resistivity) with the surface area of fibers. More fibers (density) can increase the surface area but unless the air flow is also controlled the spectrum of frequencies that the insulation can absorb at can be seriously restricted.

Sound Blocking

I'm sure you've heard the phrase "The devil is in the details." Making sure a wall or ceiling assembly is properly sealed is paramount to the wall's ultimate performance. Gaps or cracks which amount to 1/10th of 1% of the wall area can take a STC-60 wall down to a STC-30. As you can see making sure the home theatre environment is well sealed is important. QuietZone Acoustic Caulk was used for *WSR's* theatre because of it's non-hardening acoustical properties and it's flexibility over time to not crack or break. QuietZone Acoustical Caulk is an important element of the QuietZone Noise Control System and is critical to the success of any noise control project. (As a side note, always make sure that proper air ventilation is considered in your home theatre design.)

Vibration Isolation

Sound vibrations can enter the floor assembly by two means, either via airborne sound transmission or via structureborne sound transmission. Once the floor is set into motion from sound vibrations there are a number of detrimental effects to adjacent walls, rooms, and floors. Airborne sound is transmitted through the floor assembly the same as through walls with coupling occurring through the subfloor and joists. But unlike walls, floors also incur impact noises from a variety of sources such as walking, running, sliding chairs, appliances, and even subwoofers. Another attribute of unisolated floors is "flanking noise." Flanking noise is noise which travels around walls and floors to other rooms in the home via the homes internal structure. Because floors are linked to the rest of the home's structure, the vibrations which find there way into it will set adjacent floors and walls also into vibration. The result is for noise to potentially penetrate every room in the home.

Isolating these vibrations before they reach the walls and main floor assembly is an excellent method to control these vibrations. Excellent vibration isolators absorb vibrations via what are called "mass-spring-mass" isolators. The QuietZone Acoustic Floor Mat utilizes a closed cell polyethylene foam which acts as this spring mechanism. Basically the spring mechanisms of the QuietZone Floor Mat allows deflections to be absorbed rather than "coupled" to adjacent structures. The result is a reduction in sound vibrations transferred to the rest of the home.

Two installation approaches for QuietZone Acoustic Floor Mat can be followed, either a plywood raft is floated on top of the foam floor mat or a 1-1/2-inch thick lightweight gypsum concrete can be poured into the floor mat layout. The latter was used in *WSR's* theatre. The floor assembly above the isolating floor mat virtually floats away from the main floor assembly and walls. Vibrations which impact the finish floor or find their way into it via the airborne sound transmission are greatly dissipated. (For home theatres built on concrete floors it is still recommended to float the floor on top of the concrete since the floating floor will retain floor vibrations within the home theatre room and provide a tactile experience of floor vibrations while being seated in the room.)

Besides using STC (Sound Transmission Class) ratings for floor assemblies, IIC (Impact Isolation Class) is also used to rate the structureborne transmission of impact vibrations through floor assemblies. Again, the higher the number the better the floor's ability to reduce the transmission of floor vibration noise. The following graphs show the beneficial effects of using the QuietZone Acoustic Floor Mat system.

System Performance

Individually these products have their own value, but their true benefit lies in their interaction as a noise control system. For example:

1. Within residential homes using typical plywood subfloor/wood joist construction, a STC wall performance above 50 can not be achieved without floating (isolating) the finish floor away from the subfloor assembly.
2. Cavity insulation provides added acoustical benefits to wall and floor constructions when vibration breaks are introduced to eliminate the detrimental ("coupling") effects of solid wood studs or joists.
3. Gaps and cracks left unsealed (without the use of acoustical caulk) can dramatically degrade the overall performance of a wall or ceiling/floor assembly.
4. Establishing compatible wall, door, ceiling, and floor designs is essential to the overall acoustical performance. The weakest link in the system will typically overpower the other links and dominant the performance level. See attached room matrix for determining appropriate wall performance level. ■

Recommended STC Rating To Determine QuietZone Wall Construction Based on Adjacent Room Location.
Residential Interior 2x4 (and 2x6 for min. STC-60) Wall Noise Control Matrix

Room Description	Quiet Rm	Noisy Rm	Living Rm	Family Rm	Dining Rm	Home Theatre	Kitchen Bath or Laundry	Corridor Foyers	Home Office Library
Quiet Bdrm	39	49	39	49	39	60	49	39	39
Noisy Bdrm	49	49	49	49	49	60	49	49	49
Living Rm	39	49		49	39	60	49	39	49
Family Rm	49	49	49		49	60	49	39	49
Dining Rm	39	49	39	49		60	49	39	49
Home Theater (Min. STC-60 or Greater)	60	60	60	60	60		60	60	60
Kitchen/Bath/Laundry	49	49	49	49	49	60	49	49	49
Corridors, Foyers	39	39	39	39	39	60	39		39
Home Office/Library	49	49	49	49	49	60	49	49	49

Note: Locate the type of room needing noise control on the left then find its adjacent room along the top. Where the two meet indicates the recommended STC wall rating.

Acoustican Norm Varney Discusses Owens Corning QuietZone Building Materials

The Acoustical Foundation Of WSR's Holosonic™ Home Theatre System

GARY REBER

Introduction

Last year I visited the Science & Technology Center of Owens Corning in Granville, Ohio to investigate the science behind the company's QuietZone building materials for use as the acoustical foundation of *WSR's* Holosonic™ Home Theatre System in planned new office facility in Southern California. During that visit I spent a lot of time with Norm Varney who is the Acoustic Design Center Lead. During the planning and implementation stages of our new home theatre laboratory facility in our the new building we were constructing Norm was a valued advisor. Norm has contributed an article on the QuietZone building system and as well discussed this approach to noise control construction in an On Screen conversation held in our new office facility with myself and Perry Sun, *Widescreen Review's* Movie Sound Editor.

Gary Reber, Widescreen Review: When most people hear "Owens Corning," they think of glass, Fiberglas and those kinds of products. Right?

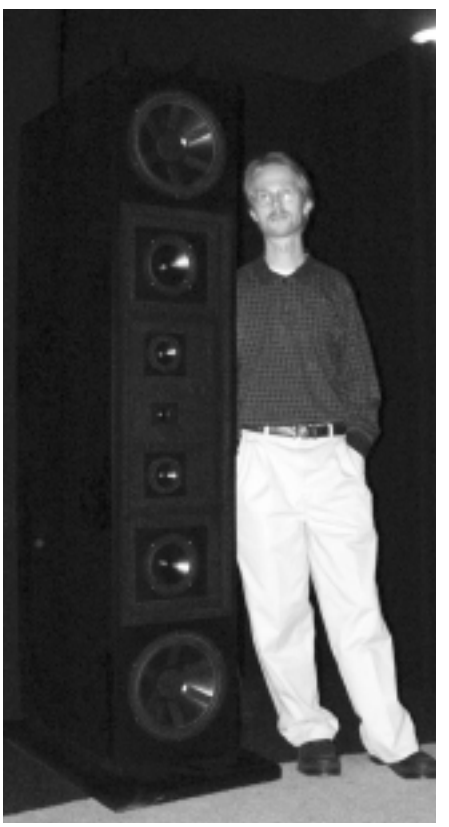
Norm Varney, Owens Corning: Right. That's what I did, too.

WSR Reber: Now, here I am building a state-of-the-art home theatre laboratory, and we're using Owens Corning framing materials.

Varney: Building materials.

WSR Reber: Building materials. So, how did that all evolve? How did this all start and why?

Varney: Well, the company got its start when researchers were looking for something to make with glass besides bottles, windows and tumblers. In the 1930's they knew that glass fiber had great thermal properties and that it would be a big success as insulation if they could just make the fibers in commercial quantities. One of Owens Corning's parent companies began



Norm Varney Standing Tall
Next To A Dunlavy SC-V

producing Fiberglas for insulation in 1933. Owens Corning was established as an independent company with a focus on Fiberglas materials in 1938. From there they kept growing to amass a larger share of the market. Fiberglas insulation was going into the construction distribution channels, so they started looking into new building materials. We have chemical labs, composites, mechanical, roofing, exterior, insulation, acoustics, etc, so we can come up with many new materials for use in building residential and commercial property. They also knew that Fiberglas has some wonderful acoustic properties, too. When I started working there, which was just a couple of years ago, we made numerous building materials for the home, however, two exceptions would have been the sheetrock and the wood framing. But now, with the Acoustic Wall Framing, we even engineer the studs. We have a mock-up of a home at work at the Science & Technology Center that shows many of the building materials supplied by Owens Corning and how these products interact with each other to form a building system for the home. For example, Owens Corning materials make up the windows, the siding, the roofing, all the different types of insulation, doors, etc.

WSR Reber: Let me ask you about Fiberglas as an insulation material. It has insulation properties for what? I mean, what's it ideally suited for?

Varney: You mean thermally?

WSR Reber: Yes, thermally. What else?

Varney: Acoustically.

WSR Reber: Acoustically as well. Why is that? What properties does Fiberglas have that makes it ideal acoustically?

Varney: With Fiberglas you have all of these fibers going every direction and as the sound wave propagates and enters the Fiberglas, it produces pressure changes which produce drag. The sound energy is now converted to heat, and dissipated that way. Fiberglas is about the best way of doing that. It does so very evenly across the audible frequency range. There are other materials out there that may absorb certain frequencies this much and at other frequencies this much, and so forth, but Fiberglas does a very even job of that. It just depends on how thick the Fiberglas is relative to how low the frequency is to be absorbed.

WSR Reber: So that brings me to the batt insulation in the QuietZone acoustical framing product line. What makes it unique from other Fiberglas products?

Varney: QuietZone Acoustic Batts are PINK Fiberglas batts designed to help control noise between interior walls and ceilings. They achieve similar STC performance when compared with our more dense exterior-application Fiberglas products. They also feature a pink kraft paper facing with images of the "shushing" Pink Panther™ to emphasize the noise control application. QuietZone batts are dimensionally stable and will not slump when properly installed in wood stud wall cavities. Lastly, these batts have no labeled R-value as they have been designed and tested specifically for Noise Control applications.

WSR Reber: Please explain the whole concept of the QuietZone framing system.

Varney: There are several products in the QuietZone family. There's the Acoustic Wall Framing, the Acoustic Caulk, and the Fiberglas Batt and the Acoustic Floor Mat. The idea behind it is to allow for sound to be contained within a room. For example, if you're interested in a low-noise floor, and you have a sound source that you want to be isolated from, you could either take that room that you're in and QuietZone it, or take the sound source and QuietZone it. When I say "QuietZone it" I really mean providing a noise control solution using any number of products offered by Owens Corning. In a home, that might be the laundry room so that that sound is contained there and not heard in the rest of the house, or it might be an office or a bedroom, or, in your situation, a home theatre. Here we have a sound source that has lots of energy and could easily be distributed through the entire office facility via many means. One of the biggest, most difficult noises to deal with are low frequencies. Low frequency flanking noise goes from one room to another via vibrations being transmitted through the structure of the house, and then transmitted to other areas. With QuietZone Acoustic Wall Framing, you have a two-wood stud and members combined with resilient clips. The wood stud members are engineered lumber made by TrustJoist. The reason being is this is straight lumber, as you just can't use regular wood or you're not going to get the straight lumber that is needed. The QuietZone stud incorporates a smaller piece of wood that stands off from the structural portion of the stud via the resilient clips. This smaller wood section called the resilient member typically faces the interior of the room. Now that type of acoustical design forms a vibration break as far as sound transmission is concerned, and is also a means of isolation. It allows you to actually float that wall. The sheetrock is attached to the resilient member, which does not have a direct connection to the structural portion of the stud. So sound waves that hit the sheetrock, and even penetrate it, are essentially now isolated from being transmitted through the stud that is connected to the rest of the house. There's a vibration break. This is especially helpful for low frequencies where other types of systems out there don't do a very good job. Low frequencies have long waves with lots of energy.

There are several advantages with the Acoustic Wall Framing over, say for example, a resilient channel. A resilient channel is a zee clip and works similar in fashion, except for the fact that there's more labor involved and you can pretty much be sure that you're going to short it out somewhere. The sheetrockers will come and short circuit the system, meaning that they'll drive their sheetrock screws through the resilient channel to a stud, so now it's short circuited by being directly coupled. And if you do that, you're negating the whole purpose of that system.

With the Acoustic Wall Frame, this is preassembled lumber, so there's no way you're going to be able to do that. The only way you'd be able to short circuit this system is using a screw that's way too long. So, another advantage is guaranteeing results via installation. It also only takes half the time to put up compared to Z channels. Another advantage is the real estate savings. For example, in your theatre at *Widescreen Review*, you have a 2-inch x 6-inch Acoustic Wall Frame and two layers of 5/8's on each side, and you have a STC (Sound Transmission Class) rating of 63 with the batt inside. You've got an eight-and-one-eighth inch thickness for the wall. Now, that beats a double wall in terms of performance, material and labor cost and saves precious space.

A big plus to me is the fact that the installation you know is going to go up right. With the resilient channel you can be sure it won't be done right. As a matter of fact, we built a couple of those walls with two very meticulous guys, and they still shorted the system out.

WSR Reber: What does it take to short a system? I mean, I'm getting the impression it could be just one little screw.

Varney: That's possible.

WSR Reber: In an entire home theatre system? One screw could allow all of that energy to flow through?

Varney: Just like sound or…

Perry Sun, Widescreen Review: If you're turning that stud into a rigid member rather than one that's isolated by those clips…

Varney: Now the whole wall is vibrating and it's directly coupled to that stud, which will cause it to vibrate and move on to the rest of house, because it's all inter-connected. Also, sound works like light does in the fact that If there's a pin hole, or any leak at all, you're going to see it. If you're going to contain the sound, it's got to be airtight, or watertight, however you want to look at it. You're defeating the purpose if you go to the hassle, expense and time of building a wall right, and you have a penetration for a screen or a door or a window, or something like that, and you don't seal that up properly, the whole cost and purpose of that wall is gone. It's only as good as the weakest link, and in our situations, usually the weakest link is the door. People don't think about the door.

WSR Reber: Not in our case.

Varney: In your case, you got it. An IAC (Industrial Acoustics Corporation) door for most people is either too expensive or doesn't look like what they want. Or it's too heavy or whatever. So there again you can have this great wall all around, but it is only as good as the weakest link, and often that's the door. Sometimes it's the window; a window can be bad news.

WSR Sun: The STC-63 spec is specific to a two by six, double layer of 5/8 gypsum. Is it also specific to your metal clip reinforced stud?

Varney: That's what it is specific to is that particular system. For example, this two by four, single layer 5/8's used here in Gary's office is probably an STC of 35. In fact, we have all of this data because of our acoustic lab. We have one of the finest in the world. We've got all kinds of walls that have been built and we measure the STC. What's difficult about STC is that it only goes down to about a 125 Hertz, and that's what makes it limited. I can tell you that if we were to compare the resilient channel versus the acoustic wall framing, in lower frequencies the Acoustic Wall Framing is a better performer, but that does not show up in STC because it is limited down to a center band frequency of 125 Hz.

WSR Reber: So that's the limit of the measurement?

Varney: Yeah. And hopefully that will change. Like we discussed, especially with a home theatre, those low frequencies are the ones that are so hard to contain because you're talking about long wavelengths that have lots of energy.

WSR Reber: What's the benefit of sealing in the bass in terms of audio performance?

Varney: For sound quality reasons, personally I'm a believer in having walls that are semi-rigid. You want a balance. You

don't want too much mass, and I see that done a lot. Yes, that contains the energy from escaping and so forth, but it also means that it's containing all the energy inside the room and really you want some bass information to be absorbed by those walls. You want a double layer at least, and often dissimilar layers are beneficial. Just a regular wall, like this eight foot one here in your office, resonates at about 70 Hz. So, if you just went with a single layer, just that flimsy membrane, the wall acts as a capacitor. The low frequencies are going to penetrate this wall, they're going to be stored and released later in time. So, you hear the original 70 Hz or harmonic directly from the loudspeaker, and then you hear it coming back from the wall smeared in time, it becomes very muddy. Just the opposite will happen if we had nothing but cinder blocks in the whole thing. That's no good either. That's pretty unforgiving, especially for room modes and so forth. So, you want to have a balance and this particular system will give you that.

WSR Reber: In what way?

Varney: It doesn't allow the wall to resonate very much. It allows the wall to act as a diaphragmatic absorber. If we added another layer of sheetrock, for example, it would become too rigid and would not absorb enough bass. The wall in your theatre absorbs some bass, but not too little. Too little, and you're going to hear the wall play back into the room like a drum. So it is kind of a fine balance between the two.

WSR Reber: So, this is an optimized situation here?

Varney: Yes, from a sound quality point of view.

WSR Reber: I know the other alternative we had was to build it with one sheet of dry wall, instead of the double layer of dry wall. I didn't really have a choice to go to the smaller acoustical stud because we had designed for a 14-foot ceiling height.

Varney: From a sound transmission point of view, you could go with a single layer on the inside and a double layer on the outside. This is called an unbalanced wall, and I don't know if there's an improvement which has the double layer or not, but I can tell you from a sound quality point of view, if this is a listening environment, that double layer should be on the inside for the reasons we just discussed. From an STC point of view, to keep outside noises from entering or the home theatre noise from escaping, then that second layer on both sides is going to give you that much more isolation.

WSR Reber: We built the entire home theatre plus the rear projection room all in in the QuietZone product, so the whole room is one big acoustical system.

Varney: That's the way it has to be. Again, it's only as good as the weakest link. We should mention that you're planning to use our Black Acoustic Board in the projection booth. This room houses video projectors that produce noises from fans. It also has a big cut out for the video screen from which sound in the home theater can enter into, bounce all around inside and then return to the home theater with all the coloration's, delays and distortions of the projection room. Black Acoustic Board and Black Acoustic Blanket are black Fiberglas sheets from SelectSound product family. They are commonly used in cinemaplexes, performing arts venues and studios to reduce reverberation and sound transfer.

WSR Reber: We are installing three IAC acoustical doors, one at the main theatre entrance, one at the entrance to the rear projection room and a double six-foot wide door at the cargo entrance to the theatre. Those are terrific doors.

Varney: Yeah, it will kind of be like a vault.

WSR Reber: What's the next step? We have a room that is very lively as you have hard gypsum drywall all around, and it contains the sound. Now we want to treat that room to optimize the acoustical properties.

Varney: Let's not forget about the floor mat, too.

WSR Reber: Let's talk about how important the floor treatment is because we haven't touched on that.

Varney: Remember how we talked about with the Acoustic Wall Framing that we're essentially floating the walls? Now, none of the walls actually touch each other. They don't touch the floor and they don't touch the ceiling. The resilient stud members actually are short of that, and you would fill the gap with liberal amounts of our QuietZone Acoustic Caulk. Any cutouts and around these types of perimeters, you would fill in. Now with the floor, we want to do the same thing if we can. You're on a concrete slab, which is wonderful. A lot of people are not so lucky. A lot of applications for the Acoustic Floor Mat are simply residential footfalls and so forth. We talked about flanking. What happens is, let's say, there's a story above us here and somebody's walking, or air born sound impinging on the floor, we would be able to hear that. Not so much as the sound directly coming though the floor, but rather the vibration of the floor transmitted to the bottom plates and top plates, and being distributed to this room, that room, that room up there, that one and so forth. That's flanking. What we need to do is isolate the floor, so what you do is build a raft with this Acoustic Floor Mat. The Acoustic Floor Mat is a really neat product in that it works really well, it's very inexpensive and it's really easy to install. No skilled labor or special tools are needed.

WSR Reber: What's the property of the mat? What's it made of? How thick is it?

Varney: It's a closed-cell polyethylene foam. It's 3/8-inch thick. What you do with this is lay it down on your subfloor and extend it up around the perimeter sides, and then you can build a raft on top of it. Then, again, we are decoupling what's going to become the substrate above the floor mat from the side walls, and you do that with a couple layers of 3/8's or 3/4-inch exterior grade plywood, glued and screwed.

WSR Reber: Quality, high-grade plywood, not plywood that's going to warp.

Varney: Right. You'll also want to stack the plywood perpendicular to each other so that the seams overlap. Placing them perpendicular also helps to smooth out the floor and act as a single piece. So, you glue and screw those, and then put your covering, be it carpet or wood, or in your case, two inches of concrete, on top of that.

WSR Reber: We put the concrete right on top of the mat. We didn't opt for the wood floor.

Varney: Right. Your raft is concrete.

WSR Reber: And it's much thicker than one and one-half inches, too. We used two inches of concrete.

WSR Sun: We had to meet a specific height requirement.

WSR Reber: To raise the floor level to meet our height requirement for the ceiling in the room.

Varney: I see.

WSR Reber: So, we have two inches of concrete…floating in the room, including the rear projection room. (Laughter)

WSR Sun: I can see the advantages for a second floor facility, but what about for a first floor facility? What's the advantages of a floating acoustical floor?

Varney: Good question. For example, in this application here, what we're trying to do is keep any vibrations that would be transmitted via the floor to any side walls at all, and to keep the floor quiet. We don't want it to be playing along with the music. We want to hear just the speakers. We don't want to hear the room and the furnishings, and the construction materials that make up the room. And that leads us into what you were asking about before. The first thing that should be decided if you're going to build a good quality room is the room dimensions. When we do our design work, the first two questions we'll ask are: 1) What are the maximum dimensions that we have to work with as far as length, width and height? 2) And if it's a home theatre, we'll ask how many seats are desirable for this application? Then we'll look at the room modes and find out

what's most appropriate as far as length, width and height within that physical space. And that tells us everything. That will then tell us what room modes exist. First of all, we're going to optimize it, so we're going to come up with dimensions that have the most even distribution of room modes. Now that we know what the room modes are there and where they live physically in the room, we can determine where the speakers and the listeners best fit in that environment to avoid them, yet offer the best soundstage. That will dictate where the first order reflections are and it will also dictate, now that we have the center channel figured out, where the listener is going to go, what size screen, depending on the aspect ratio, needs to be and where.

WSR Reber: When I designed the theatre, I determined the real estate for a fixed theatre. I wasn't limited by an existing room that I had to convert. I started out with the selection of the loudspeakers, because, to me, every loudspeaker has a physical distance from the face of the tweeter in which the wavefront is focused into a coherent sound wave. That was my determining factor which impacted the size required for the room. So given that, I chose the Dunlavy Signature SC-V's, mainly because of their time and phase accuracy, and the fact that they are truly full-range transducers housed in a single, sealed box, and that their measured distance anechocially is 10 feet for their specified +/-1 dB frequency response of 20 Hz to 20, kHz. I then decided that I needed at least 20 feet, plus the depth of the speakers, to give me what the minimal length of the room needed to be.

Varney: Your minimum dimensions.

WSR Reber: Then, based on that, I looked at the screen size I could support with that room depth, which I determined was a maximum of seven foot wide. I didn't want to go beyond a seven foot wide screen anyway, because even the finest 9-inch CRT-based projectors don't optimally support a screen width beyond that with the necessary light output. We chose 9-inch CRT projectors for our main reference projectors because they still produce the best picture. That's how we came up with the room's depth measurement of 26 feet.

WSR Sun: And then we worked on the other dimensions.

WSR Reber: That's how we worked it. In other words, I started with the speakers. Now, let's say you started with a room that's much smaller, but has nice proportions. A smaller room would short circuit the use of a Dunlavy SC-V. You couldn't support a Dunlavy SC-V in a small room. You would be limited to much smaller loudspeakers, with less than full range optimal performance. These would have to be supplemented with outboard subwoofers to attain full frequency response at every vector point in a 6.1 system.

Varney: I agree.

WSR Reber: So, there's a compromise there that one is going to run into with smaller rooms because you can't support the massive loudspeaker systems that can really deliver all the signal that you're looking for.

Varney: That is absolutely true. If you have a speaker that is essentially flat down to 20 Hz, and you want to hear it, you've got to have a room that's big enough to support it. That's true, those are some of the considerations you have to look at if those things are already determined. In fact, we have a questionnaire that asks those things. What equipment is going to be used so that we can see those things. It doesn't always work. We've got a job right now where the room is too small for Wilson Whams, but that's what they are going with.

WSR Reber: You have to optimize the room for a physical distance out from the listener to the loudspeakers. You have to sit at a certain physical distance that the loudspeaker dictates for optimal full range focused response.

WSR Sun: In your house, you [Gary] have speakers that are too close.

WSR Reber: I know that the surrounds are a bit closer than ideal. It's a compromise, but I've always said that it is a compromise and I share that with most people in typical homes.

This is why I call this the Dream System, because I didn't have to deal with any of those compromises dictated by typical living spaces in a house.

While time delay can be effective with small two-way loudspeaker systems, it doesn't work well with four-way loudspeakers such as the Dunlavy SC-V's because you cannot cheat on the physical distance required for those loudspeakers to focus the energy from each driver into a coherent sound wave. It doesn't matter what your time delay is, it is still not going to come together as a coherent wavefront without the necessary physical distance required between the loudspeaker and the listener. So, we avoided all of that and optimized the room dimensions to support large, truly full range loudspeakers.

Varney: And you're right, we did play around with where you've got this circle of sound. You've got equidistant speaker placement all around you, but we did play with that circle to find where it lived best in the room. Again, to avoid boundaries, colorations and so forth, and primarily room modes, we don't want to put you or the speakers in a peak or valley of the primary modes to minimize them as much as possible. That's what we did. Something like an equidistant triangle, or in this case, Dunlavy told you exactly his correct convergent spot. And it just so happens this will work out. If we were looking at an NTSC signal, then our convergence for audio would be different than it would be for video. But with this situation, with scalers and high-quality video equipment that you're incorporating, we can now converge the audio and the video to the same spot, which is sweet. We couldn't do that too many years ago. It wasn't possible. You ended up with great sound, ugly picture. Too big.

WSR Sun: It's the no compromise theatre.

WSR Reber: The fine tuning of the theatre now is the balance between the loudspeaker energy in the theatre and the actual treatment of the acoustical property of the room. Diffusion. Absorption.

Varney: Actually, there's one more.

WSR Reber: What's that?

Varney: Duct liner. The HVAC…

WSR Reber: Oh, yeah. HVAC. The treatment that we did with the duct liner, and we also built oversized ducting channels…

Varney: Dedicated.

WSR Reber: There is a totally dedicated air heating/ventilation/air conditioning system in that theatre.

Varney: You can have a really quiet home theatre, well-isolated, like you've done, and then forget about the HVAC. And then here you are watching, a very quiet, suspenseful scene, and all of a sudden there's a gust or a rumbling, and it just pulls you right out of the movie. The duct liner is an Owens Corning product, and we have this neat little demo at the lab, and I remember being so impressed with it when I first saw it. It's just a box, it has a noise generator inside and it feeds two ducts. One duct is made of Fiberglas Duct Board and the other one is just your regular metal tubing, and you can hear this thing across the room, no problem. But you put your ear against the Duct Board vent, and you can't hear anything. You can put your ear right on it, and you don't hear a thing.

WSR Sun: Can it reduce rumbles?

Varney: Yes. It is flexible, and does not resonate. It's fantastic. You got to have it for a good home theatre, or for any kind of quality, critical listening. If you don't have that noise floor controlled, not only are you not going to get the dynamic range—you're going to limit your dynamic range to whatever your noise floor is—but you're going to be distracted because it goes on and off. If it was on constantly, you'll just miss the low level detail and resolution, but you probably won't even know you're missing it and you can tune it out. Yet when something is start-

ing and stopping, you're well aware of it and it's a distraction.

WSR Reber: So now, we've built this room. We've built an extremely quiet environment and now we have to do something with the walls, the ceilings and the corners, and the floor along with the carpeting. All of those things are important. From your perspective, how do approach that?

Varney: From an Acoustic Room System point of view?

WSR Reber: Yes.

Varney: Our SelectSound products have to do with sound quality, while our QuietZone products have to do with noise control. The top-of-the-line system is our Acoustic Room System. There are three tools that you need to control acoustics. You have to have absorption, reflection and diffusion. You can't just have one, although a lot of people just deal with absorption.

WSR Reber: Most of the rooms that people pride themselves in, that I have experienced over the years, are just too damn dead. This has also been a philosophy of the Home THX approach except for surround envelopment, which is attained with suspended dipole loudspeakers that bounce off hard upper side walls and the ceiling.

Varney: It's kind of an "L."

WSR Reber: Yeah.

Varney: Essentially it's a live end/dead end. It's just that there's this "L" of dead and live.

WSR Reber: Most home theatre designers tend to make their room almost anechoic sounding.

Varney: Which is very unnatural.

WSR Reber: I've always preferred more live than dead, yet balanced.

Varney: There's a window. Because, you're right, a lot of the rooms end up being too dead, and they are uncomfortable and unnatural. And even if somebody is not a trained listener, subconsciously they're aware of this. So, what we do is offer a service called Room Modeling, as well as a service called Room Voicing. The Modeling I'm able to do at our lab, and here's where we gather all of the information that we can about the room, and maybe we're designing the room, and so forth. Anyway, what we're going to do now is estimate what the reverberation times are, the room modes and so forth. So, we plug in everything we can about the room. The dimensions, the volume of air, etc., and now the treatment that's going to go in there, and the furnishings that are going to be in there. We have the largest library of building noise coefficients known to mankind, so we'll pull from that. If it's this carpet or whatever, we'll know what kind of absorption properties this carpet has and what's the square footage that we're using. So now we're looking at a window that we want to be in as we don't want the room to be too dead, and we don't want it to be too live. There's this little window where it is just right. We'll plug in all those things that we know about, and then we have this panel system, the Acoustic Room System, and what it essentially consists of is two panels really. These panels are an inch and a quarter thick, and one panel is reversible. In other words, it has an inch of Fiberglas on one side, and then it is laminated to a quarter inch of gypsum. So, this is a reversible panel which allows us some flexibility. What's neat about that system, though, is that it's absorptive on this side, it's reflective on the gypsum side, but on that same hard surface, it works as a diaphragmatic absorber for frequencies down to about 125 Hz. Now with just Fiberglas, a quarter wavelength at that frequency is 27 inches. So in order to accomplish the same thing with just Fiberglas, it would be 27 inches of real estate on all walls, so this is a pretty neat system. And then we have a diffuser panel that also fits inside this inch and a quarter system, and it's a two dimensional diffuser, meaning that it scatters the sound back into the room in a semi-hemisphere. A lot of the diffusers out there, depending on how you have them oriented, just scatter it vertically or horizontally. Then there's the track system that goes around the entire perimeter and around cutouts, like doors or screens or whatever, and you stretch an acoustically transparent fabric over the whole thing, and so you have a completely flexible, completely tunable system that you don't even see. If you were to walk into the room, you wouldn't know that it has been acoustically treated other than it sounds good. So now with the modeling process, we're maybe figuring out the dimensions, then we're maybe figuring out the speaker/listener positions. Maybe not. Maybe those are already predetermined. Well now we can just do the geometry. We can figure out where the first order reflection points are, because we know we want to absorb those so that you don't have a smearing of not only tone, but also of spatial cues and so forth. So we want to treat those for sure, and for surrounds, we want to treat those first order reflections with diffusion. We know now where those points are so we plug those in, and we look at the overall reverberation time and figure out what we need to do with the rest of the room as far as the panels. Maybe the room's too dead, we can put diffusion where we put absorption for the LCRs, or something like that. If there's maybe heavy upholstery, carpeting and curtains, too, so it's totally flexible.

WSR Reber: So that system goes in once all the furnishings are in and everything is in place, and then before you stretch the fabric, you do all that final tweaking, or otherwise you'd have to rip out the fabric and make modifications in the acoustical treatment.

Varney: Now, that brings us to Room Voicing, and then you're correct. Normally, if it's just Room Modeling, we'll do the panel configuration. We'll have all that modeled and go with it. But there is a step beyond that, and that is where we actually come on site and voice it. Here we are able to optimize, or fine tune, the room to the utmost. And if there is an error here and there, we have the opportunity of correcting it before the fabric is stretched. The timing is critical. We want the equipment there, we want the carpet there and our ARS installer there when we come and do the voicing.

WSR Reber: I considered a fixed acoustic system approach but in the end I decided implementing the RPG VariScreen approach to acoustical room treatment because I wanted a room whose acoustics I could change at any time to optimize for different loudspeaker designs. I wanted to be able to change the acoustics depending on what speakers we had under review. So I didn't go with a fixed installation, although that option is still there. But otherwise the acoustical treatment principles are the same.

Varney: Most people are not going to be changing equipment out.

WSR Reber: No, most people aren't, so a fixed acoustical treatment installation is better for them…

Varney: But if they do want to, we can certainly remove the fabric if they wanted to change the furnishings around or whatever.

SelectSound Acoustic System Acoustic Room System Diffuser Panels that diffusse sound throughout the room.

It's really no big deal. The system is cut to fit onsite by trained installers, so it looks great and there are hundreds of fabrics to choose from.

WSR Reber: I consider our installation more of a laboratory than a home theatre. That is also why I chose to feel like a black hole in space, basically. You enter this chamber and you sit yourself down, especially in the sweet spot or as we call it "the chair," and you are carried away.

Varney: That's the ideal situation. To make the room disappear acoustically and visually so that all your attention is focused on the movie, and you experience what the artists intended you to. That's the whole idea. And most people have never been able to experience that. They don't know what it's like.

WSR Reber: I agree.

Varney: With a good room environment and a good system, it's magic that most people have never been able to experience. At our lab in Granville, at the Science and Technology Center, we have a couple of theatres that are built, and the audio system in them is only decent, and yet we've had people whom are very well-trained and exposed to really fine equipment in there and the experience has brought tears to their eyes, and it's because the environment acoustics are correct, so the room has disappeared. You can't take an expensive audio system and just put in any old room and expect anything out of it. We have these two home theatre rooms at our lab, they're identical in every respect except for one has acoustic treatment and the other one does not, same exact furnishings and equipment, all set up precisely the same. The difference between the two is that one has a real emotional impact on you. As a matter of fact, we had our onsite medical staff come out there and do metabolic testing of subjects, and the difference between the two rooms is the one that has been acoustically treated can raise your blood levels and heart rate, and bring tears to your eyes; the other one cannot. It is just the acoustic treatment. Can't put a $100,000 system in that untreated room and get results like that.

WSR Reber: That is so true. Did we miss anything that you'd like to convey to our readers?

Varney: I'd just like to suggest to your readers that they consider the room as the most vital component of the system. ■

For more information on Owens Corning QuietZone building materials please contact Paul Svoboda, QuietZone Business Manager, Owens Corning, One Owens Corning Parkway, Toledo, Ohio 43659. Paul can be reached by telephone at 419 248 7531 or you can e-mail Paul at paul.svaboda @owenscorning.com.

For more information on SelectSound acoustical treatments please contact Jim Graham, Business Manager, Home Entertainment Systems at 419 248 7498 or 800-733-1551 x7498 Voicemail, or e-mail jim.graham @owenscorning.com.

You may contact Norm Varney at Owens Corning Science & Technology Center, 2790 Columbus Road, Route 16, Granville, Ohio 43023-1200. Norm can be reached by telephone at 800 742 0852 ID#6314 or 740 321 6314, or you can e-mail Norm at norman.varney@owenscorning.com.

July—2001

Widescreen Review's

50th Issue

Don't Miss It!

Collector's Issue

A Decade Of Growth

The Essential Home Theatre Resource™
WIDESCREEN REVIEW®

IAC Noise-Lock Doors
Engineered Products Solve Home Theatre Access

KEN DELASHO

Noise-Lock Access System

Aside from the equipment, one of the more complex engineered systems for the home theatre is the entrance door. Every home theatre must have one and the success of the acoustic isolation begins and ends with the door.

There are two basic design considerations for the home theatre. First is Sound Transmission Loss (STL), noise control, or containing the playback within the theatre so as not to disrupt surrounding living spaces. Likewise, one must consider surrounding noise entering the theatre and compromising the listening environment. The second design consideration is of course the listening environment or room acoustics—absorption (reverberation), diffusion and reflections (ADR). Since the sound control door assembly is part of the "shell" our discussion will focus on the first design consideration or the acoustic isolation of the home theatre.

But first, lets define a few terms.

Sound Transmission Loss (STL) is the effectiveness of a barrier (door) at preventing sound from traveling from one side to the other measured in decibels (dB).

Sound Transmissions Class (STC) is a laboratory single number rating calculated per ASTM E413. Transmission loss values are measured at 16 one-third octave bands from 125 to 4000 Hz. Comparing these values to a reference contour a single number rating is determined. Generally the higher the STC, the greater the transmission performance.

Noise Isolation Class (NIC) is a field test single number rating, per ASTM E366 in which noise reduction values are measured and compared to a standard contour similar to STC.

Access System is a sound rated door and frame assembly complete with leaf, frame, seals, hinges, glass, glazing, locksets, closers and finish hardware fully factory

assembled for installation into a pre-framed opening.

Technology today is successful in achieving complex sound reproductions at more and more frequencies particularly the low end (bass). Although some low frequencies may be below the audible spectrum, they play an important roll in the perception of the sound.

Feeling the thunder is as important to the listener as hearing it. It is very important to consider the 50 Hz to 100 Hz frequencies in evaluating the effectiveness of a noise control access system. Note that STC/NIC is based on frequencies between 125 Hz to 4000 Hz, which does not take into account the low end (bass) noise reduction. In order to acoustically isolate this type of source, high transmission loss walls, windows and doors are required. The laws of physics favor mass in this situation requiring multiple layers of gypsum board, double walls and steel doors. This level of attenuation is beyond the capabilities of wood doors. Engineered products are designed to minimize weight and deliver high in-field noise reduction.

Industrial Acoustics Company Inc. (IAC) is a worldwide leader in noise control products and systems. Since 1949 IAC has installed more than 100,000 acoustic doors in a wide variety of applications with STC ratings up to STC-70. IAC has a new line of engineered wood veneer access systems, which are laboratory tested and field proven with STC ratings from STC-51 to STC-64.

Acoustic doors come in many shapes and sizes and varying degrees of assembly. The basic wood door with a seal kit delivers insignificant noise reduction relative to the sources described herein; remember the listener must "feel the thunder."

The IAC Noise-Lock Wood Veneer door is factory veneered with more than 50 species of real wood. The process (vacuum application) allows the wood to be rolled over the edge of the door, giving a continuous wood look and feel. The door is field sanded, stained and sealed to match the existing wood finish and architecture. Frames are field cased with wood mouldings to complete the picture. Of course, if the traditional look is not yours, the metal door will provide the high tech look giving the theatre designer a full range of decorative options in between. The IAC Noise-Lock series is a fully factory assembled Access System and is shipped complete with leaf, split frame, seals, hinges and finish hardware. The unique split frame design allows installation at the end of construction (finish phase) protecting the door assembly from any rough-in work.

The doors for the *Widescreen Review* home theatre laboratory facility are steel IAC STC-61 Noise-Lock assemblies in both single and double leaf arrangements. They are flat black to complement the dark, non-reflective flat interior treatment of the theatre.

Hinges are cam-lift, allowing a barrier free sill condition. The door rises as it opens and falls as it closes.

Seals are magnetic type triple seal. Magnetic seals are most common in a refrigerator design and proven to deliver years of maintenance free service. The bellows of the magnet sleeve reach out to provide a continuous seal around the perimeter of the assembly.

Finish hardware is just about anything you want and is factory fitted and shipped attached. Push pull handles are popular since latching is not required to hold the door in a closed position, although locksets are available, which in the case of *WSR* were fitted to the doors.

With IAC you can acoustically match the door assembly to the engineered wall construction and feel the thunder without disturbing surrounding living spaces. ■

For more information on IAC Noise-Lock Wood Veneer Access Systems contact Ken DeLasho at Industrial Acoustics Company or visit the IAC Web site at www.industrialacoustics.com or phone 718 931 8000

Ken DeLasho is the Vice President of Architectural Market Applications at Industrial Acoustics Company Inc., Bronx, New York. Ken has designed and engineered the Noise-Lock line of Sound Control Access Systems. In addition to engineered access systems, IAC offers a complete line of modular panels engineered and lightweight to provide high in-field noise reduction. This type of construction is ideal for the "hidden" shell of the home theatre.

Footnote: At the time this article was written *WSR's* IAC Noise-Lock acoustical doors had not arrived. Therefore we are unable to provide pictures of their installation. Such will be published in a future installment of this series. Three Access Systems are used: one at the main entrance to the theatre, one at the entrance to the rear projection room, and a six-foot wide double-door access entrance next to the rear projection booth to load equipment, acoustical treatments and furnishings in and out of the theatre.

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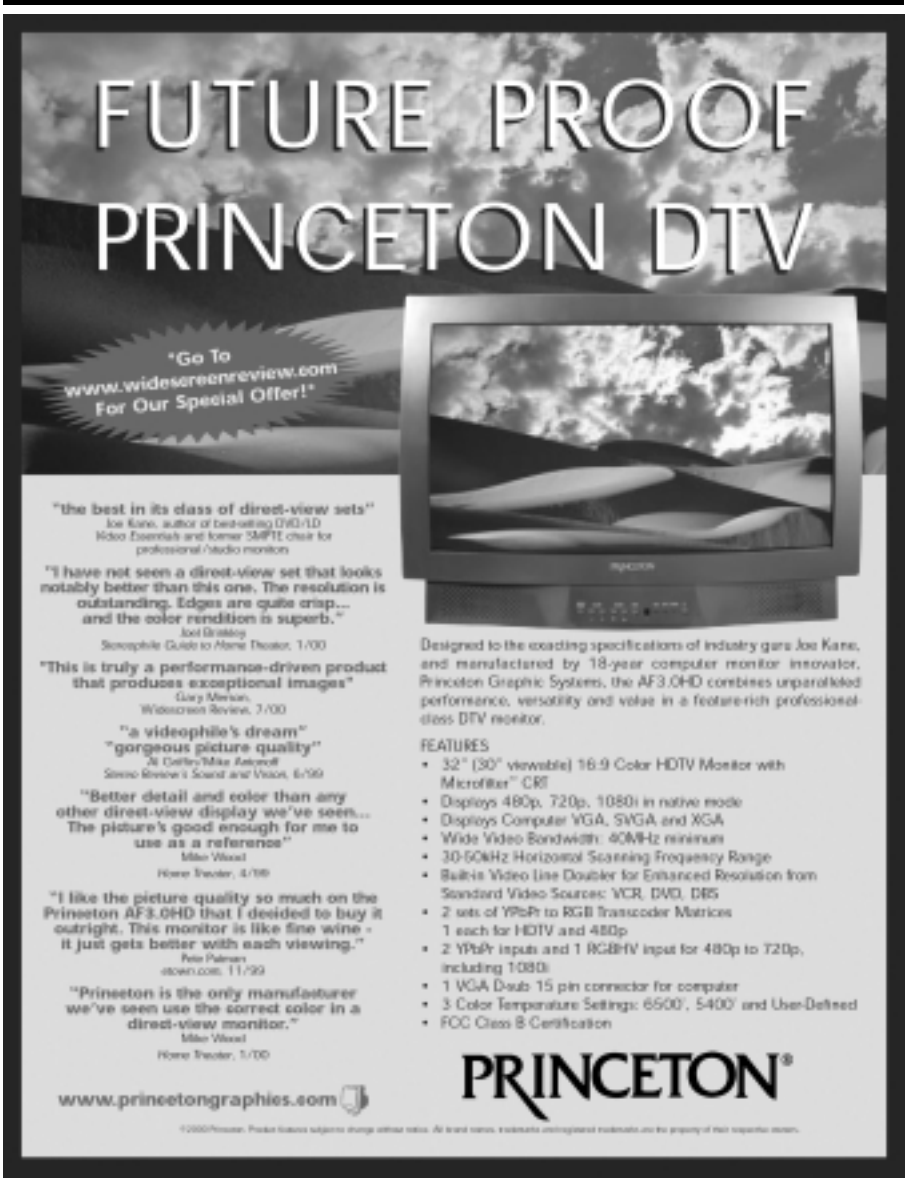

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