# Twenty Years of Church Acoustics

*By: Jay Perdue*

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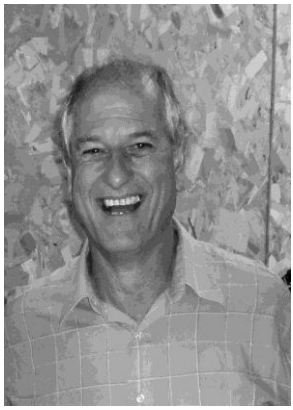

About the Author: Jay Perdue has been involved in church acoustics for over twenty years and he holds several patents in architectural acoustics (more patents than anyone else in actual production of products). Jay's passion for worship and music in the church environment, as well as clarity of the spoken word, has led to a strong conviction in the value of acoustics. Jay believes in the science of acoustics, and with over twenty years of working in the field, he has analyzed some tried and true ways to create effective church acoustics (and he explains WHY these methods are so effective). He will not waste a minute of your time. You'll find this book to be short and to the point on EVERY point. With this book, Jay hopes to give pastors and other decision-makers the knowledge on acoustics and the confidence to make successful acoustical choices.

***Acknowledgments-***

I would also like to thank Joab Perdue, manager and COO of Perdue Acoustics. Without someone who will listen and carry the torch of the message, any leader is really just out for a walk. Thank you for both following and leading. Thank you Joab, I love you very much,
Dad

And, I would like to thank Judy Andrew for being with us most of these twenty years and for reading and editing almost everything I've ever written of any importance. Thank you Judy!
Jay Perdue

And also, I would to thank my friend Shannon Erickson, President / Senior Staff Consultant of "OMEGA CONSULTANTS, INC", for the beautiful picture and room on the cover. It is their design, not mine, and utilizing Perdue Acoustics products…… Great job OMEGA!

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The truth about church acoustics and how they relate to the sound system

## Contents

# Chapter 1

# The Importance of Acoustics

I was a praise and worship leader and children's leader for several years for a church of over 1,000 worshipers. During this time, I experienced firsthand the frustrations of pastors and praise and worship leaders. I have also had the opportunity to be responsible for sound systems in large stadium venues, on the mission field, in new facilities, renovated facilities, and converted facilities. I saw, felt, and heard sound problems from the church perspective.

Though speakers, microphones, and sound boards make sure that people can hear the message being given, the acoustics help to ensure people will *understand* it. The proper acoustics in a project help fine tune a room, create intelligibility and understanding, and make it possible to comfortably enjoy the effort put in by the sound equipment.

It's important to understand acoustics; without the application a room can feel too loud, seem full of echo, be impossible to understand, or too dead for the overall purpose of the room. It is extremely important to include acoustics in the sound consideration of a church. In fact, if a sound design company does not mention or address acoustics, but rather only talks about amplifiers, speakers, boards, etc., don't walk away… RUN!

Sound waves have specific "wave lengths." A 10,000 Hz frequency (the range of high sounding cymbals or the sound of an "S" or "T" in diction) has a wavelength of about an inch, a 1,000 Hz frequency (about the pitch of a police siren) has a wavelength of about a foot, and a 100 Hz frequency (just above the range of a kick drum) has a wavelength of about 10 feet. When these sound waves bounce off a reflective wall they can be in perfect harmony, or they can reflect off the wall and completely cancel the frequency (or one of many problems in between, depending on how reflective the surface is).

The problem with these sound reflections is amplifiers and speakers that were designed just fractions of a decibel from being perfectly flat from 50 Hz to 20,000 Hz are put into the room and become plus or minus **100 times** that because of the lack of acoustic treatment in the room.

I recently visited the Nashville showroom of one of the best-known home theater sound companies in the country. I noticed something that I'm not sure most people would notice; all of their demonstration listening rooms were FIVE-SIDED ROOMS. Will they ever sell a system that will go into a five-sided room? Probably not. They just know something that most people don't know; parallel walls create echoes, and parallel walls don't exist in five-sided rooms. The "flat" speakers stay sounding flat. The problem starts when you get the speakers home into your four-sided room and the automatic button to adjust the system to fit the room doesn't work. You just cannot fix a room that has bad acoustics with equalization.

But that's not even the worst part; if the acoustics are bad enough, you may be able to *hear* the sound system, but you won't be able to *understand* it. It's not about hearing, it's about UNDERSTANDING. Unfortunately, most of the time people use the two words interchangeably, and they are not at all the same thing.

I remember when we were asked to take a look at the Lubbock Civic Auditorium in Lubbock, TX. The auditorium was a nice, large facility, but all the walls were reflective. The audience was able to *hear* the plays and musicals, but they were not able to *understand* what was being said. The facility had to offer headsets to guests to rent in order for the performances to be understood.

Because the facility was used by so many musical production teams, most performances came with their own sound system. Each sound system ran into the same problems of understanding. This facility provided the best proof that the sound systems were not the problem; the room acoustics needed to be addressed!

The design and installation of the acoustic treatment was to control echoes and excessive reverberation. The very first performance after the acoustic installation was a musical. People came early to get the headsets they normally needed in order to understand the performance. The Lubbock City Manager called to tell us about the "miracle" that occurred that night; every single one of the headsets was turned in at intermission! Every one!

In this facility, where they had fought to understand what was being said on stage for years, the performance had become clear, and it has stayed that way performance after performance, different sound system after different sound system. That's good acoustics!

# Chapter 2

# NRC and STC

Sound Transmission Class (STC) refers to acoustic energy transferring **between** spaces (how much sound gets out of the room to adjoining rooms) and Noise Reduction Coefficient (NRC) refers to acoustics **within** rooms (how much and how long the sound bounces around within a space). STC and NRC refer to two completely different worlds of acoustics, and they require two completely different lines of products to treat each one.

Most soft and fuzzy interior acoustical products are targeted at "Noise Reduction Coefficient" (NRC) problems. When a room is echoing or excessively reverberant, it is considered loud, boomy, indistinct, or distorted. In fact, most professional acousticians consider a reverberation time of more than two seconds to be excessive, and it is at this point that diction of the voice and overall clarity are lost. Therefore, even when maximum reverberation is desired it should not exceed two seconds. A simple test can be given to indicate the reverberation time of a room; shout or clap very loudly and see how long it takes for the sound to go away.

There are specific formulas that tell how much of a certain absorptive material is needed to reduce the reverberation in a room to a specified reverberation time. Clarity, intelligibility, and the ability to understand what's being said are lost proportionally as reverberation time rises above two seconds. There is no such thing as a highly reverberant room that retains clarity. Adding acoustical treatment is the best way to eliminate echo and negate reverberation in a room, restoring clarity and understanding.

Sound Transmission Class problems are altogether different. STC simply refers to how much sound is transmitted from one room or area to the next.

In my time as a children's church leader, I LOVED having fun with the kids, and we would often get very LOUD. I believe children's church should teach, inspire, and be fun! LOUD goes with FUN! But when the sanctuary is in quiet moments of decision, the people don't need to hear the loud children's church. Conversely, when the children's church is having those same special "moments," they don't need to hear the music from the sanctuary.

This same problem is found throughout the church, from classroom to classroom, office to office, classroom to sanctuary, even bathroom to hall. These sound transmission problems cannot be treated using acoustical wall panels within a room. In an STC situation, cinder block walls filled with sand or double studded sheet rock walls with insulation woven in between become more important in initial construction than anything that can be done after the fact.

Sound takes the path of least resistance, so even the best built wall can have sound transmission problems if the door is not sealed correctly or the room has a drop ceiling and the wall does not go all the way to the roof deck (in this case, sound from one room goes up through the thin ceiling tiles over the wall and down into adjoining rooms). However, there are some helpful hints if the facility is already well past the construction phase.

The cheapest and best fix is to blow insulation into the ceiling as thickly as possible, or add blanket-type insulation tightly packed, eliminating voids. Another way to fix STC issues is to carry the walls up to the building's roof deck. After construction, this can be hard to do in some cases, but it may still be possible. It is also very important to address air vents and ducts. Special duct silencers are available, and board insulation can be used to line the last 2' to 3' inside of the ducts before the air enters or exits the room. Weather stripping around doors and windows also helps to seal the room and further eliminate STC problems.

# Chapter 3

# Echo and Reverberation

Many people think echo and reverberation are the same, but once you learn the difference, you'll be amazed at how it will catch your ear. You'll not only know the difference, you'll hear the difference.

Reverberation is sound returning to you without definition, and echo is sound returning to you with definition. Echoes can be problematic in smaller rooms, but the larger the room, the longer sound travels, and the more negatively it can impact the listening experience. To successfully eliminate echo from a room, the large, smooth flat areas that allow echo must be removed.

Since speakers from the platform are aimed at the back of the room, when there is an echo that returns to the stage, these echoes are often referred to as "slap back echo." Echoes from ceiling to floor or between side walls are often called "flutter echoes," simply because the sound seems to "flutter" really fast between these surfaces due to the shorter distances. These echoes, when distinct and drastic enough, can make it impossible to *understand* the sound system, no matter how good the sound system is.

Any echo robs a room of clarity, no matter how distant or slow or close and fast the echo is. Slow echoes can double double everything everything you you say say, while fast echoes can double a certain consonant such as s, t, or d (D-D-D-DID-D-D-D I SAY THAT-T-T-T?).

Reverberation, however, is sound that comes back without distinction. That simply means that you clap your hands and the sound excites the room and it comes back to you seemingly from everywhere, but it doesn't sound like a handclap. In fact, it doesn't sound like anything, you're just aware that a sound has happened in the room of some kind, very indistinct.

Where echoes are categorized solely by their separation in time created by distance, reverberation is specifically quantified in length of time (or how long reverberation goes on). The longer the room allows the sound to reverberate, the harder it is to understand what's being said.

A reverberation time (RT-60) is the time it takes for a sound burst to decay 60 dB in a room. Since 40 dB of ambient room noise is common, I like to say, "The time it takes for a sound burst to decay from 100 dB to 40 dB." In some cases, 90 dB down to 30 dB is adequate.

For existing facilities, tests can be performed to see exactly what frequencies are reverberating and at what times. For an immediate close "guess," a loud hard clap, starter pistol, or snare drum whack and a stopwatch will tell you most of what you need to know (or just go with the loud hard clap and count slowly).

For facility planning, with a study of the proposed interior finishes, any acoustician can closely predict the RT-60, and look at the overall shape to predict areas of echo production. Because of their very unique intelligibility-robbing qualities and characteristics, we all strive to create rooms of various reverb times but without any echo whatsoever.

Because digital delay is equal to echo and robs the speaker/singer of clarity, it important to use controlled reverberation, NOT digital delay, to add life into the room without robbing it of clarity. Very slight amounts may be desirable for vocal performances, but never a good idea for a speaking voice because the echoes will rob the clarity and intelligibility of the message.

# Chapter 4

# The Various Church Environments

Every acoustical environment imaginable can be found in churches today; from the smallest fellowship hall to the largest sanctuary, from live acoustics for limited or no instruments to dead acoustics for all out contemporary praise and worship. Every room needs to be treated individually, but the acoustics serve the same purpose in all environments; to create intelligibility and understanding.

In auditoriums, special attention is given to the ceiling so that the sound from the stage can naturally be reinforced to the back seats, or those furthest from the stage. The use of reflection in a very specific way creates a ceiling where sound is focused to the back, and over midway to the back, to help keep the volume to all seats in the auditorium as equal as possible.

Because modern praise and worship is often treated like a concert, and the fact is, all praise and worship should be participatory, in most sanctuaries, above and beyond the job of the auditorium, the ceiling has the added job of being the “mixing plane.” The ceiling is how the front of the congregation hears the back, the back hears the front, the left side hears the right side, the right side hears the left side, and everything in between. All congregational singing goes up and reflects back down and that’s how we hear each other and don’t feel like we’re the only one singing.

When the music stops in all churches, the preaching and teaching begins, and announcements must be understood. It is important to acoustically treat a room to not only allow praise and worship, but to be able to understand the message being presented. It is proven that unless rooms have less than two seconds of reverberation and little or no apparent echo, our minds cannot connect the dots of the sounds we hear to understand what is being said. We all experience listening fatigue or can't understand what's being said at various levels of echo and reverberation, but two seconds of reverberation maximum is a good, safe number to remember.

We lose our hearing, usually, from the highest frequencies first. Those frequencies are the diction frequencies and sounds we make. I feel so sorry for older folks in our congregations sometimes, because they are missing these very important enunciations for them to be able to understand and then we make it even worse with bad acoustics and even more added low frequency.

The church has a message, and that message has to be understood. Understanding only happens in rooms where the acoustics are tuned to the frequencies and volume of what's going on in that space.

If you are going to be LOUD you have to have shorter reverb times to keep it understandable. Volume is a factor of selecting the right RT-60 for a room. The louder the volume, the shorter the reverb time needs to be. The softer the volume, the longer the reverb time can be, but never more than two seconds.

Putting thinner acoustical products in an acoustical environment that has low frequency volume present may help have an RT-60 of two seconds from 500 Hz and above, but the low frequencies will still be booming around the room for three, four, maybe even five seconds. Remember the older folks? This is totally unacceptable.

Whatever is put into the room must be controlled. If sound is being put into the room down to 500 Hz, the room must be controlled down to 500 Hz. If sound is being put into the room down to 250 Hz, the room must be controlled down to 250 Hz, and if sound is being put into the room down to 125 Hz, the room must be controlled down to 125 Hz.

The fundamental of the male voice is about 125 Hz and the fundamental of the female voice is about 250 Hz. An NRC number used to test and compare acoustical products only **starts at 250 Hz!** The NRC numbers published for all acoustical products start where the female voice starts and goes up from there (the absorption values don't even include the where the male voice is!).

Carpet absorbs sound effectively from about 1000 Hz and above. One-inch thick acoustical absorbers made of mineral wool and fiberglass board absorb sound effectively from about 500 Hz and above. Two inch and three inch acoustical absorbers made of mineral wool and fiberglass board absorb sound effectively from about 250 Hz and above. The only thing effective at absorbing sound in the 125 Hz range are super thick manufactured and built-in acoustical absorbers of mineral wool and fiberglass board, including my own patents of the MegaWedge™ and 180° Diffsorbers.

This goes to show that we cannot put some carpet or half inch ceiling tiles on the wall and call it an acoustical treatment. It may appear to sound better to the untrained ear, but the truth is we've still left the room booming with low frequency energy. That's what the older listener is having the most trouble with. It garbles the sound for all of us.

Several years ago, I was working on a job for a Church of Christ in Pennsylvania. I called to explain my recommendations to the pastor. I started out my explanation letting the pastor know that I was recommending a thinner, less expensive acoustical product because we were dealing with only vocal frequencies, not with the lower frequencies of instruments, especially that of drums and bass.

"I really appreciate your heart in this," the pastor replied, "but you'll have to refigure our church." He went on to explain that they were a Church of Christ with a full contemporary praise and worship band. I had to refigure the product recommendation and add low frequency absorption into the room. I was able to successfully treat the room, but it's important to note that it does cost more to do an acoustical treatment correctly when low frequencies are involved. It costs money to fill a room with low frequency, and it costs money to control it.

# Chapter 5

# Acoustics vs. Aesthetics

For twenty years I've seen aesthetic choices take precedence over acoustical choices in churches based solely on "what looks good." This war has been waged for so long it demands a close look…even a biblical look.

The Bible declares Satan to be the author of confusion. I believe that the author of confusion has slipped into our churches in this regard and is winning battle after battle in this area.

First of all, whether it looks best for the walls to be smooth and flat or to have angular or rounded shapes on them is an opinion, nothing more. After years of treatment of flat, smooth walls in churches with our chunky, angular MegaWedge™ or half round 180° System I can tell you as many people like the change as those that do not.

What is never opinion is whether or not they can understand better. Now, people can understand the words to the songs that are sung, they can understand the announcements being given, and they can understand what the preacher is trying to get across to them.

One choice creates an environment where people can understand what's being said and clear communication is obvious. The other choice creates confusion and confused communication so that clear communication is either hampered to various degrees or altogether impossible!

Now, who did the Bible say was the author of confusion? Which way creates confusion? Aesthetically, the choices are a matter of opinion! Acoustically, the choices are fact.

Flat walls echo. Hard walls reverberate. Echo ruins intelligibility. Excessive reverberation creates an environment where clear communication cannot exist. When did the color and shape of the walls become more important than getting the message of salvation into the ears of the people? When did contour of the structure get to be more important than understanding the very words of the Ten Commandments when spoken in these environments? The day we started putting aesthetic choice over acoustical fact; that was the day.

The author of confusion has gotten into our choices, and when the wrong choice is made, the end result is continual confusion. Will aesthetic choices change the understanding of the message? No. Will acoustical choices change the understanding of the message? Absolutely! Every time!

Increasingly, architects understand that churches are built and intended for communication. Communication of the Word of God in singing, in preaching, in teaching, even in the announcements. The Word of God is being communicated. From the time we walk in, until we walk out, it's all about communication.

In Mark 7:13, the Bible itself warns us that traditions are the one thing that can make the Word of God of no effect. "Ye make the word of God of none effect by your traditions." By following what have become "traditional" lines and concepts of church building structure and aesthetic choices, we build buildings where the Word of God cannot be clearly understood.

When we make choices that make the physical building right on the inside, the Word of God goes forth clearly and "accomplishes that to which it was sent." Without these right choices, the pictures of our new building might look good, but on the inside it's so acoustically rotten we make the Word of God of no effect.

# Chapter 6

# The New Sound of Praise

The new sound of praise is full blown and full of frequencies; low frequencies, mid frequencies, high frequencies. We have the high sounding cymbals, the loud cymbals, the sound of the trumpet (the synthesizer), and every other instrument we can get on the platform!

I like it! I was raised in the Methodist church, and even though we have contemporary praise and worship in Methodist churches today, we didn't when I was a kid. I was a drummer, and I remember the first time I played drums in a church I felt like I was committing the unpardonable sin.

The fact is, we're putting ten times more low frequency into our church sound than we did when a half inch thick ceiling tile was considered an acoustical product. That is not an exaggeration! It might be an understatement when you consider both volume and the frequencies together that we're dealing with here. We're going louder and lower! Love it or hate it, that's the new sound of praise and worship.

It is impressive, it is loud, it is thunderous, it is awesome, it is heart pounding, it does move us emotionally, and we do like it. But let's consider these heart pounding low frequencies for a few moments, what makes them exciting, and what destroys their ability to excite us.

First that pounding kick drum. That super low frequency thump that gets the place rocking. It has to have power, it has to have depth, it has to be a force to be reckoned with, but more important than anything, it has to STOP!

It has to stop abruptly, quickly, suddenly, even powerfully…so it can come again, and again, and again. The power is in the punch, and without the punch it has no power. It gets its punch from going away as fast as it came so it can punch again. The power is in the speed of the punch.

The sound of a kick drum that is allowed to hang around in the room has no power. The last boom hasn't even gone yet before the next one comes in. Remember the RT-60 definition? The length of time it takes sound to come down 60 decibels? You can measure the impact, or punch of the sound, by how much it has come down before the next one strikes.

If the kick drum registers 110 decibels and only falls to 90 in the room before the next beat hits, it has an impact of 20 decibels. If the kick drum registers 110 decibels and falls to 20 in the room before the next beat hits, it has an impact of 90 decibels. What a huge difference!

It is common for a praise song to be at 120 beats per minute. That's a kick drumbeat twice per second or every one-half of a second apart. That's the "tick" and the "tock" of a clock. Tap that out in your mind. How powerful can the beat be when four other kick drum beats are still hanging around in the room at various volumes?

A kick drum at 100 decibels in a good, tight room, has a LOT more power and punch than a kick drum at 110 decibels in a room that is allowed to echo and reverberate that "pop!" into a low rumble and roar…that roar, remember, that drives the older folks craziest. And it doesn't matter if the room is tight in the upper frequencies. If it's not tight in the low frequencies, the rumble and roar will be there!

The use of thinner acoustical products that are incapable and ineffective at absorbing low frequency energy might be as tight as one second of reverb time at 250 Hz and above, but it won't mean a thing if 250 Hz and below are allowed to reverberate for two seconds. To that kick drum, it's a two-second room!

Most traditional sanctuaries have carpeting and/or curtains. Carpeting and curtains are "high frequency only" absorbers. It takes both thickness and mass to absorb low frequency energy. Carpet and drapes have mass but no thickness. Carved foam products may have thickness, but no mass. These types of products are poor low frequency absorbers. Check the low frequency absorption numbers.

Converting traditional spaces into contemporary praise and worship spaces is a special challenge. The high frequencies are usually already in range for the reverb targets of contemporary praise and worship. It's the mid and low frequencies that are out of whack, and the lower you go the worse it generally is.

Balancing high frequency, mid frequency, and low frequency absorption is the trick, and the lower you go the worse it gets. One trick we've learned is to use absorbers that are efficient at absorbing low frequency energy (that would be the really super thick ones), and cover them in vinyl or micro-perforated vinyl. The plastic under the cloth or vinyl reflects the high frequency energy back into the room while the mid and low frequencies will pass right through and will be absorbed by the core of the product. This brings an out-of-balance room into perfect acoustical balance.

Another thing we need to talk about at this point is a thing called "diaphragmatic absorption." At some point, depending on the thickness and the type of absorption material used, "soft and fuzzies," no matter how thick and what type they are, will become more and more ineffective at absorbing sound in the extreme low frequency range. At this point, movable hard surfaces become better absorbers than do any of the "soft and fuzzy" products that are usually related to sound absorption.

For instance, a sheetrock wall will "shake" to the beat of a kick drum and thus absorb the energy of it, while a cinder block wall or tilt up concrete wall will throw it right back into the room fully!

When you consider the square foot area of the entire wall area, this can be the most substantial sub-low frequency absorption in the room, ever. A huge consideration when building. Of course, a wall inside a wall is always possible and a good idea for this, but don't forget to fill the cavity between the cinder block wall and the inside sheetrock wall with insulation.

Speaking of insulation, let's talk about the difference in fiberglass and mineral wool insulation for a minute here. Most of my patents in acoustics are based on mineral wool insulation rather than the much more common fiberglass board insulation products. They issue patents based on improved results, so what are the improved results of my patented mineral wool products?

Overall better sound absorption; about 10% better. But the bigger picture is exactly what we're talking about here: twice the low frequency absorption of fiberglass board absorbers because the rockwool, stone wool, mineral wool fibers--it's called by all three names --are thicker and longer than fiberglass fibers. The same thing that makes sound takes out sound. Low frequency waves are longer and so it takes thicker products to affect them, and if that absorber product is made of longer, thicker fibers, that's even better.

Another product that has been misrepresented in the acoustic world for years are these things called “sound diffusers.” The law for sound diffusion, simply stated, is this: “It takes a bump roughly the size of a wave form in order to diffuse that wave form.”

We’ll talk more about that in the next chapter, but for our discussion here, consider this. A 10,000 Hz frequency is about an inch long, a 1,000 Hz frequency is about a foot long, and a 100 Hz frequency is about 10 feet long. So what is a 4’ x 4’ bump on the wall that sticks out about a foot going to “diffuse?” Not much!

However, if properly designed, manufactured, and tested, that bump on the wall can make a great diaphragmatic low frequency absorber. I created one that is manufactured in both size and thickness to absorb 100 Hz at 96% efficiency - a great low frequency absorber.

It is true that low frequency implodes and explodes out of corners, so corners are a great place for bass traps, but it is equally true that bass is omni-directional and needs to be absorbed everywhere, on all surfaces, for a really tight room in the low frequency range.

Remember, tightness in reverberation in the low frequency range equals punch and power in the music. You cannot have a mushy and boomy low frequency room and have power in this area. This is where rumble and noise become power and punch in today’s contemporary church service!

# Chapter 7

# Acoustical Choices and Testing

There are five ways to judge acoustical absorbers when deciding the best value.

1. Absorption - and not just the NRC rating number, but absorption at all frequencies including the low frequency 125 Hz number. (type "A" mounting)
2. Aesthetics - Not just how well the company puts the product together and the color and texture choices they have, but the aesthetic choices they have. Do they just have flat looking absorber panels or can you choose angular ones, round ones, etc., to complement and change the look of your room.
3. Durability - Impact resistance is just the beginning. Some so-called absorbers will fall completely apart if they ever get wet, and others can be easily vandalized. Consider all the possibilities of durability and make sure your choices are right for your room.
4. Fire Protection - This has become a huge factor in recent years. Don't just check the surface burning and smoke characteristics of the product, but also find out what the whole product does in a fire. You never want acoustical products that contribute to the fire!
5. Value - When you consider all the other four factors and then put a price tag on it, which choice is going to give you the best overall *value*, not which product is the cheapest or cheapest per square foot. Cheapest per square foot can end up costing three times as much in the long run if the product doesn't meet your needs.

**Absorption:**

To make wise acoustical choices takes knowledge, and just a little math. Sadly, there are those in acoustics who make a living selling "smoke and mirrors" acoustical products, and to make wise choices you have to know what the numbers mean. Beyond what you can see, it's all about absorption per dollars spent and absorption at what frequency! Low frequency absorption is more expensive than upper frequency absorption, and well worth it!

All acoustical products have an NRC rating. An NRC rating is simply a value per square foot of material of absorption.

**For a room needing 1,400 sq. ft. Sabins reduction:**

It would take 1,000 sq. ft. of NRC 1.40
It would take 1,400 sq. ft. of NRC 1.00
It would take 2,000 sq. ft. of NRC .70
It would take 2,800 sq. ft. of NRC .50
It would take 4,000 sq. ft. of NRC .35

These are not slight differences! 1,000 sq. ft. of a product with an NRC of .35 is NOT equal to 1,000 sq. ft. of a product with an NRC of 1.4; only **one fourth** the desired absorption is being provided! Now that you know how to compare these products, you can't be fooled.

It is important to note that the NRC rating averages only four frequencies, 250 Hz, 500 Hz, 1,000 Hz, and 2,000 Hz. Back years ago when this system was developed, tweeters and subwoofers were not even in common use. We are creating 10 times the low frequency energy we used to. For this reason, Perdue Acoustics always posts its low 125 Hz test frequency absorption. It is important to always check the 125 Hz absorption numbers and consider them when purchasing any acoustical product.

Always make sure the acoustical tests that are being compared are fair comparisons. Here are some tricks to watch out for.

- All tests should be Type "A" tests for comparison. A Type "A" test is done flat on the floor, which equals flat to the wall. Ceiling tiles are often tested 13 inches off the test chamber floor, which gives the illusion of a <u>huge</u> low frequency cavity boost that simply does not relate when fastened directly to a wall.
- All tests should be the product only, not tested with something else behind it that you don't know about or intend to use. This would be like a test of wood fiber strand board or ceiling tiles <u>over</u> a frame with six inches of fiberglass underneath. Without the total composite

construction, the result will be nowhere near the expected result. Read the fine print!

- Check the low frequency absorption numbers. It takes both thickness and mass to absorb low frequency energy. Carpet and drapes have mass but no thickness and carved foam products may have thickness but no mass. The numbers tell the story.

There is a product on the market that is called an acoustical absorber, and it is cheap. We were called in to treat a gymnasium that already had this product fully covering all four walls and the ceiling (and they still had a problem with both echo and reverberation). We were able to place our regular absorbers around the walls at one tenth the coverage and the problem was gone! That's because of the value of the absorbers we installed. One-third the square foot price with only one-fourth the absorption is NOT a good value!

**Durability:**

For the most part, an acoustical absorbers durability is measured in "compressive resistance" (how the panel reacts to an impact) and "tensile strength" (tear strength).

Many fiberglass manufactures face their cores with a compressed ⅛" layer of fiberglass to make them more durable; when one of these "high impact" absorbers is struck, the ⅛" board can crack a hole in the panel, taking the cloth with it. Our company utilizes a stranded fiberglass mat that is the same type mat that is used in the production of boat bottoms. The reinforcing mat flexes and regains 90% compression immediately, and the other 10% over time. You can break through, but it's much harder to do so. Our panels also have a very high tensile strength of 2,631 pounds per square foot! Just do not hang any cars from bottom of one of our absorber panels and you will be all right!

**Fire Protection:**

In the standard fire tunnel test, two things are measured: "flame spread" and "smoke developed." Numbers are then given to the product according to these standard testing procedures. For flame spread, Class A requires 25 or less, while the smoke developed rating is 150 or less for some and 450 for others.

The fact is that fiberglass board is rated barely Class A in most tests at flame spread 25. Every manufacturer I have ever researched uses a Class A cloth to cover their product and claims a Class A product, when the fact is the cloth, fiberglass board, and glue that holds it all together burn like crazy **as a unit**. I do not know how long it will be before the use of such products could be deemed downright negligent! Our products have a flame spread 10 and smoke developed 95 **as a whole unit**. Check local fire codes and make the best choice based on fire protection.

**Quality Diffusion:**

All that can be done with sound is absorb it, diffuse it, and reflect it. Most people understand absorption and reflecting; it is diffusion that is a little harder to grasp. Simply put, diffusion turns echo into reverberation. It scatters echo's distinction into reverberation. This has the effect of giving sound fullness and life without the nuisance of the distinct repetition of echo.

So we take a box…all parallel surfaces…an echo nightmare. We take diffusers and diffuse the walls so the parallel walls cannot echo. Now we have a room of no apparent echo, but it reverberates for 4 seconds. This is precisely why we combine units.

We need ceiling reflection to deflect the sound to the back of the sanctuary, and that is the plane or surface that enables the room to "mix" so the congregation can hear each other and be encouraged to participate. Just the right blend of absorption and diffusion will create a room without echo but with exactly the desired amount of reverberation.

But what does a good job of diffusion and what is a good value when diffusers are needed? Since waveforms come in all sizes, a good diffuser needs to represent as many sizes as possible. I patented diffusers in this arena of acoustics because I used smaller chambers within an overall larger "bump." The idea was to let the little chambers of various sizes diffuse the higher frequencies while the overall larger "bump" of the entire unit diffuses the lower frequencies.

These types of diffuser units seem to work best at diffusing the most frequencies for the money. Beyond that, it just gets back to value and aesthetics because most are durable.

# Chapter 8

# New Findings in Acoustics!

Many things in acoustics are moving forward at a rapid rate, but so much of what we do and use in acoustics is fifty years old (old products, old formulas, old test methods, old education, etc.).

Some recent findings negated the much touted Binary Amplitude Diffusion. This product was designed as an absorber that is supposed to have diffusive characteristics as well. The latest studies have shown that the diffusion that this type of product exhibits is extreme near-field, if any at all. When just a few feet away from the panel, the diffusion goes away completely and acts only as a high-frequency partial reflector. The product was found to be not much better than the less expensive vinyl covered absorbers.

Another recent development in acoustics goes a long way to add additional credibility and supports the findings of one of my own patents, the Wedge™ and MegaWedge™ Diffsorbers. The Wedge™ / MegaWedge™ system was created to maximize absorption on the face of the panel while changing the angle of parallel walls and the way they react to one another. Thorough testing of thick flat absorbers (products most commonly used in rooms) explains that thickness works with some frequencies better, while other frequencies just pass through the uniform thickness of the panel much more easily, creating a non-uniform absorption rate in the low frequencies.

The great thing about the Wedge™ / MegaWedge™ system is the varying thickness of the Diffsorbers, creating a much smoother absorption in the lower frequencies. Uniform thickness creates non-uniform absorption, and non-uniform thickness creates uniform absorption, which is something we all want.

Over the past few years I have had the privilege of talking with some of the greatest minds in acoustics – sometimes arguing with them, and occasionally being right! Thinking outside the box has its advantages. I see things in acoustics that may seem years away, but we are right in the middle of it – and I still have a few acoustical patents up my sleeve!

One of my newest patents is a system called the Wedge Riser System. This new product utilizes the same sloping absorber technology as the Wedge™ and MegaWedge™ Diffsorbers, but with a cheaper cost and much smaller shipping volumes. The Wedge Riser System is not nearly as durable as the Wedge™ and MegaWedge™ Diffsorbers, but in home theatres and church environments where durability is less of a factor, they can bring superior absorption at a smaller price.

*Variable room acoustics is another patent I have in the prototype stage. Many attempts have been made, but they almost always vary only certain frequencies or are extremely complex systems. I have come up with a system to transform a room from two seconds of beautiful, diffuse, reverberation into a room of 1.25 seconds of super tight absorption control. It's close enough now to become reality tomorrow!*

*With this new information, acoustical decisions and designs should be easier, helping you to create an environment where the Word of God is clear. If I can help you further or help you to better understand any of these amazing choices we have to make in acoustics, please do not hesitate to call our offices. I will respond to and help you personally whenever possible. THANK YOU for your time in reading this, I pray it will be a blessing to you in your work for the Lord!*

*Jay Perdue*