Churches are not concert halls.

They are Supposed to be better!

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What! Are Churches supposed to be better than concert halls?

That's a joke, isn't it? No, this is not a joke. The world is at war with the church and followers of Christ. Like the story of the Tower of Babel in Genesis 11:1-9, where the people scattered when they were given different languages, the same thing happens when attending a church where the acoustics and sound gets in the way of hearing clear and unaltered speech and music. In studying an abundance of existing churches, it becomes clear that there is a direct correlation between acoustics, sound quality, congregational health, and attendance. It would be fair to say that this correlation is throughout church history.

Just as the serpent deceived Eve, the serpent has been using houses of worship as a battlefield in waging that war ever since. Throughout the Bible, there are hundreds of warnings of deception, liars, false teachers, false gods, Baal, and other idols of worship. Satan, the great deceiver, will do anything to keep people out of heaven and build up his own kingdom. Any person tricked or deceived out of choosing Jesus and the salvation message is being added to Satan's domain. With Satan and all his forces against us, we need every tool possible to properly preach the full Gospel message.

Throughout the New Testament, there are many warnings and declarations of the importance of everyone understanding the full Gospel message. Here are some examples.

1 Corinthians 1:10-11. Now I urge you, brothers and sisters, by the name of our Lord Jesus Christ, that you all agree and that there be no divisions among you, but that you be made complete in the same mind and in the same judgment. For I have been informed concerning you, my brothers and sisters, by Chloe's people, that there are quarrels among you.

1 Corinthians 11:17-19. Now in giving this next instruction I do not praise you, because you come together not for the better, but for the worse. For, in the first place, when you come together as a church, I hear that divisions exist among you; and in part I believe it. For there also have to be factions among you, so that those who are approved may become evident among you.

2 Peter 2:1-2. But false prophets also appeared among the people, just as there will also be false teachers among you, who will secretly introduce destructive heresies, even denying the Master who bought them, bringing swift destruction upon themselves. Many will follow their indecent behavior, and because of them the way of the truth will be maligned;

In the past, churches have split because of issues such as the color of the pew Bibles, Hymnals, and whether to have wine or grape juice for communion. Likewise, a misunderstood word or phrase caused by sub-quality sound, regardless of being acoustical or amplified, can set people off as well, which has led to church splits. Just as words can bring people together, it can also set people against each other.

To that end, a church building is supposed to be a tool that doesn't get in the way of hearing clear and unaltered speech. It is meant to be a safe place for the followers of Christ. It must have the right characteristics for the engagement of His people, to be participants in the whole worship, and for the preaching of the Gospel. For this reason, a church must outperform any secular concert and recital hall and all entertainment facilities at every level, period. However, it is not in the way most church people think.

The following is a walk-through explaining the differences between concert halls and entertainment facilities and how worship spaces are supposed to be unique in how they are to perform. It also includes a church sound standard lifted directly from the Bible. A standard about church acoustics, building design, and function, with the full weight of the science, that supports the scriptures. In studying and working with hundreds of churches over the last 40 years, the impact of upgrading a church to Biblical standards, has resulted in a consistant increase in church attendance. These attendance increases have been steady at every upgraded church, from 5 to 25%, years later. Who knew that the Bible has so much to say about science, acoustics, human anatomy, and how it all works together.

Introduction

As a specialist in church acoustics and having worked on over 1400 churches between 1981-2022, a person gets to learn a thing or two. Being a Born Again Christian and focused on the preaching of the Gospel helps too. Sadly, not everyone who helps churches with their sound issues is committed to making preaching the Gospel and improving the quality of worship to Biblical standards their main goal. Rather, many churches are sold on hype and technology while everyone involved doesn't consider if the Bible has anything to say about it at all.

For those who design or get to fix concert halls, as individuals, such experts may work on 10 to 50 acoustical projects during their entire careers. The acoustics companies they own or work for, such businesses may have worked on hundreds of projects, but the number of concert halls and worship spaces an individual will work on as a solo project is often limited to a handful. As a result, the scope and breadth of experiences and exposures are such that concert hall experts never seem to get

out of learning mode. One would think that they would learn from their own past mistakes. While they say they learn from other people's blunders as well, they make the same errors repeatedly, hoping for a different outcome[1].

Concert Halls are for Entertainment

From everything that concert halls and performance spaces have in common, those spaces are designed for the sound to travel from the stage to the audience, creating the best immersive sound experience. The audience is passively sitting while the performers do all the work, generating that wall of sound. In some of the better concert halls, not only does the audience have a great experience as passive listeners, but the performers can share similar feelings when they can hear themselves. When that happens, all the musicians on stage are more supportive of each other, making their performance much better. For the musicians to hear themselves, it helps them to perform as a stronger, tighter team, rather than feeling like individuals that can't risk a distraction for the whole show without the danger of ruining a performance. It's no wonder why orchestras and performers end up exhausted at the end of a show when performing in concert halls or performance venues where they are forced extra hard to fight the room to get their sound out into the space.

When it comes to churches, for most of them, whether it is about speech or music, neither the performers nor the minister has a good experience in their task during worship. They are in a constant war with the room when compared to performance spaces. When a person can't hear themself, they become unaware of any mistakes or how the room changes their message.

Home Entertainment

When a person invests in a home theatre or stereo system, the goal is to have a setup that gives a similar experience, as if being in the best seat of a concert hall or on stage where the music is being performed. There is something special about being in an immersive experience. In a great listening or home theatre room, all that is needed are two good quality speakers and a sub for good to great sound – depending on the preferred music. For a movie theatre experience, adding more speakers will make sound effects more realistic. The quality of these experiences is very much dependent on the quality of the room – regardless of whether it is high-end audio or budget equipment.

With headsets, technology has advanced a lot in recent years and is a commonly accepted way to hear music. In headsets that fully cover the ears, adding two or more miniature speakers within each ear covering is another way for people to capture that immersive wall of sound on a budget.

Secular vs. Contemporary Christian vs. Biblical music

Music has a way of stirring emotions in people. All secular music is crafted to stir a person's emotions. This is done by lyrics, or by the way the music is crafted, or both. The lyrics tell a story. Often the stories are about life experiences that range from joy to hope, from relationships to sex, pain and rejection, and everything in-between. Generally, secular music is focused on self, love, experiences, and relationships[2]. Broadly speaking, worldly music focuses on things of this world.

Biblical music is very different. Most of it testifies about God or Jesus or both. Within that context, there is a full range of emotions too – but the motivation is very different. The songs written in the Bible are about a relationship with God or about

[1] Some experts are of the opinion that this is a definition of insanity.

[2] Most often about inappropriate relationships outside of marriage.

teaching people about God or between a husband and wife. Teaching about God includes sin, confession, punishment, justice, anger, love, joy, peace, hope, and knowing God better.

Christian music adds the testimony of Jesus. Many lyrics of hymns teach or celebrate the Gospel. Other lyrics bridge the Old and New Testaments. As Jesus said in John 15:26,

But when the Comforter is come, whom I will send unto you from the Father, even the Spirit of truth, which proceedeth from the Father, he shall testify of me:

Just as the Holy Spirit testifies Jesus, Christian music should do the same – testify Jesus. Some songs celebrate Jesus, which is in keeping with the overall Biblical message.

However, in recent years, music that is called "Christian Music" has moved away from testifying Jesus or the Gospel. Instead, much of it sounds like begging or pleading to God for a better life here and now. In many of these new Christian songs, the lyrics mix in "new age" ideas. Then, by tossing in words like Jesus, God, or the Holy Spirit – it seems to be automatically classified as a Christian message. For the new music that testifies the Gospel in the context of the Biblical message, singing such songs during a worship service is fine. However, a lot of the new Christian music written since the 1970s came up short in the Gospel message, and they should not be sung during Christian worship. Many of the expressions and terms used are not biblical, or they are too abstract in making any kind of truth statement. Such songs should be classified as wholesome Christian Entertainment music. Such songs sung during a Christian Concert outside of worship would be a more appropriate time to perform them – but even then, some of these new Christian Songs have misleading messages, which can give non-Christians the wrong ideas of what Christianity is all about.

Christians are being robbed of their time of fellowship with the Body of Christ

For example, Joseph Brooks, a secular songwriter, wrote the lyrics for "You Light up my Life." Debbie Boone, a famous Christian singer, performed the song, and it immediately became a very popular song in the 1970s. Many thought this secular song was Christian. Many churches started to sing this song during worship. It was a song about a woman finding a man to fill her loneliness at night and happiness during the day. The final verse says, "It can't be wrong, when it feels[3] so right." Doesn't that imply an inappropriate relationship at the end of the song? This last verse makes it clear that this is not a Christian song.

Everything up to that point describes a Biblical romance leading to a marriage relationship. Whether intended or not, Joseph Brooks was giving men a step-by-step lesson on how to win a vulnerable woman to join them outside of marriage. In seeing the movie with the same title, the meaning of the song becomes more evident.

Many songs with a message of hope, love, or something better have become Christianized, and such songs should be kept out of worship no matter how good they make a person *feel*. There needs to be a dividing line between Christian Worship and Christian Entertainment. The reason for this is that in the context of Christian entertainment, the audience is not expected to be part of the show. For Christian worship, in any room that minimizes the ability for the audience to fully participate, especially in singing, the Christian is being robbed of their time of fellowship with the Body of Christ and engaging with God's adopted family during worship. Where this dividing line should be, is a contentious issue, and every church must decide on which side of the fence they want their worship experience to be. Worship is worship, and entertainment is entertainment, and blending entertainment into worship just confuses people, and it is dishonoring to God.

Getting Emotional

For most churches with challenging acoustics, the people who seem to encounter the highest emotional experiences are the musicians performing on stage. They often get that emotional feeling as an isolated experience, not as a group event. Why doesn't the audience have the same experience? This is another example of how the room gets in the way of real worship for everyone.

For many of those worship spaces where people are fighting the room, most church leaders and elders have submitted to the notion that it is easier to put on a Christian-style, semiprofessional performance (which is no different than putting on a show) than to work extra hard to get people singing. For churches making that extra effort, there is a return, but the battle never ends. Getting the audience to participate in singing the worship songs as intended is a constant struggle. Somewhere in all of that, they hope some are getting a blessing from it.

A failure to participate

For most churches, it has become acceptable to have less than 25% of the audience singing. At the same time, in some churches, some of the audience will stand as non-singers with their hands up and swaying to the music[4]. Then there are people standing who just mouth the words. Church leaders seem blind to the concept that when people are standing when singing songs, and the audience can't contribute or participate in communal singing, it dampens the expectation of the sermon

[3] The words, feel, or feels, or feeling, appears only 9 times in the KJV Bible. There is no example of feelings in terms of relationship with God. God want our love and loyalty, not a feel-good relationship with His followers.

[4] As how many behave at a live show or rock concert.

that is to follow. In the middle of that kind of atmosphere, many people are bored, messaging on their phones, checking their social media, and thinking about everything else except worship. When people are not engaged during hymns, turning to Christian Entertainment style of worship seems to be the trend to get a handful more people to participate. As it is said, a little gain is better than nothing.

However, this barrier has resulted in many ministers transforming from being preachers of the Gospel to being just teachers. They fill everyone's head with knowledge, being entertainers and story tellers. Many ministers are turning to feel-good messages and to teaching that is outside of the scriptures but has the appearance of being Biblical in nature. Once again, these are the extraordinary steps where ministers are trying anything to engage or grow the church membership. This is an unrecognized and hidden way where a false gospel message can creep into the church community. This could be what contributed to the start of the seeker-sensitive movement, Word of Faith, NAC, prosperity gospel, and other religious fades have started.

These are a few examples of how congregations are in a constant war, fighting the acoustics of a hostile Worship space. This war has unintentionally shaped the modern styles of Christian worship and is somewhat at the root of allowing a confusing and corrupted Christian message to slither into the church community.

This assault on the church is creeping in one sermon or one issue at a time. When a congregation is limited to a passive level of participation during congregational singing, and the sermon message is watered down or not about the Gospel, issues such as CRT[5], social justice, woke, and the sexual wars, these false teachings creep into the church. The leadership fails to warn people of the dangers at the doorstep. Before long, a whole church denomination is caught up in something that weakens the body of Christ.

Change is coming

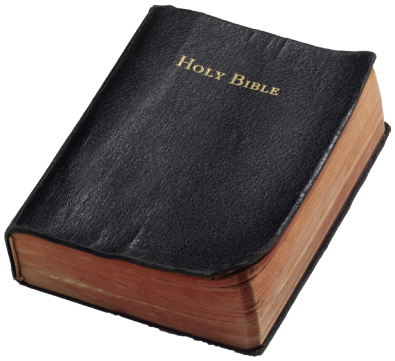
However, what happens if the worship space allows the congregation to hear themselves and to encounter the same emotional experience as the musicians feel? What happens when the congregation experiences worship as detailed in the Bible? What happens with a congregation is fully engaged in the whole worship service? Is that even possible? Yes, it is, and the good news is that in recent years, hundreds of Churches have been experiencing this every week.

Since 1998, over 400 worship spaces have been transformed, including 30 plus new church buildings, which have all been upgraded to the sound quality as described in the Bible. The Bible lays out an acoustics system where the preaching of the Gospel is in a relaxed atmosphere which in turn improves people's understanding of the Gospel. It details how the audience and performers can experience and feel worship beyond what any concert hall can ever deliver. The Biblical plan works on the principal that the audience is not static or passive as in a concert or entertainment hall. Instead, the acoustical plan includes the audience as active participants in the worship – an ability that no known concert hall is famous for. The Bible has a plan for church sound, which most congregations all over the world pray for, but never get to know or practice. Biblical acoustics engages congregational singing without any effort. It is about including everyone within the worship space, to be immersed in the full meaning of fellowship in song and experiencing a taste of heaven now. What does the Bible say about the whole worship?

Beginning with the Scripture

Worship is divided into two parts – the spoken word and congregational singing. There is much said in the scriptures about singing and music. There is nothing said about the quality of speech, but from the clues, science, and the secular communities' learned experiences, the description, and details of Solomon's Temple, it points to and addresses the perfect support for speech and music. While those details are found in 1 King chapter 6, here are other verses that outline music and singing.

Seven times in the book of Psalms, it says – "make a joyful noise"



Psalms 66:1 Make a joyful noise unto God, all ye lands:
Psalms 81:1 Sing aloud unto God our strength: make a joyful noise unto the God of Jacob.
Psalms 95:1 O come, let us sing unto the LORD: let us make a joyful noise to the rock of our salvation.
Psalms 95:2 make a joyful noise unto him with psalms.
Psalms 98:4 Make a joyful noise unto the LORD, all the earth: make a loud noise, and rejoice, and sing praise.
Psalms 98:6 With trumpets and sound of cornet make a joyful noise before the LORD, the King.
Psalms 100:1 A Psalm of praise. Make a joyful noise unto the LORD, all ye lands.

Then there are over 50 verses that describe singing praises to God as a group activity. Here are some of them.

Psalms 144:9 I will sing a new song unto thee, O God: upon a psaltery and an instrument of ten strings will I sing praises unto thee.

In Ephesians, Paul is teaching the Ephesians how to behave as a person and when in fellowship.

[5] CRT - Critical Race Theory

Ephesians 5:18-21 And be not drunk with wine, wherein is excess; but be filled with the Spirit; Speaking to one another in psalms and hymns and spiritual songs, singing and making melody in your heart to the Lord; Giving thanks always for all things unto God and the Father in the name of our Lord Jesus Christ; Submitting yourselves one to another in the fear of God.
In Hebrews 2, the act of singing in the middle of the church is also an act of confirmation of salvation when reading from verse 11-13.

Hebrews 2:12 Saying, I will declare thy name unto my brethren, in the midst of the church will I sing praise unto thee.

Singing is a response to emotions. If a person is happy or cheerful, sing to God.

James 5:13 Is anyone among you suffering? Then he must pray. Is anyone cheerful? He is to sing praises.

Praying and singing go together for God's children – His adopted family.

Acts 16:25-26 But about midnight Paul and Silas were praying and singing hymns of praise to God, and the prisoners were listening to them and suddenly there came a great earthquake, so that the foundations of the prison house were shaken; and immediately all the doors were opened, and everyone's chains were unfastened.

The Joy of Worship

The Bible is clear. Singing in worship and just praising God is for everyone. Singing brings joy, peace, healing, and miracles (miracles that testify Jesus.) For hundreds of years, Christians have been reading such verses, and many people can only imagine what all that kind of singing could sound like. However, in the real world, few houses of worship can support the kind of singing and worship as is described throughout the Bible. Christians have been hearing from ministers for centuries that the singing in heaven will be amazing during a worship service. Do we really have to wait until we die to experience that kind of singing?

Another thing that is often said within and outside of the Christian community. At the end of countless musical presentations, people have used the phrase – "that performance was heavenly." These performances can be anywhere – including churches, but such occasions are single events, rarely repeated. Why are high-quality performing worship spaces so elusive? When will churches have the kind of acoustics as detailed in the Bible, or is that an exclusive experience waiting for us in heaven? If that is the case, why mention anything about the quality of singing for worship in the Bible?

The wait is over!

The wait for that kind of acoustics is over. Getting that kind of acoustics in a worship space has been elusive for the last 3500 years. It is believed that in 1998 this all changed. There was a breakthrough where science and the scriptures came together in a way that made sense of the design of Solomon's Temple. This breakthrough solves the problems that plague all churches that are not acoustically managed, as detailed in Solomon's Temple. Solomon's Temple moves from the past into the present as a blueprint for Christian Churches in how to design, build, and furnish the interior. Essentially, God gave man the perfect design for a worship space for Christians. It is a space where everyone can experience a complete, high-quality service with singing and hearing relaxed speech every time they gather. Imagine for a moment that every time people gather, they can have that heavenly encounter. The good news is that every existing worship space can be transformed.

When Worship spaces became a nightmare

Short History Lesson

This all started with the House of God, designed by God. Solomon's Temple was built and remained standing for 400 years. Soon after the Temple was erected, the leaders, the priests, and the people started to turn their backs on God. The people of Israel drifted from a people that loved God to a people that loved the law, apart from God. Perhaps God's patience with Israel was like it was with Lot and the story of Sodom and Gamora. God spared the temple from destruction until there was no one left who loved God enough to keep the temple and the nation of Israel from destruction.

The leaders of Israel believed that the Temple was a symbol of power to the surrounding nations. As long as it was standing, they thought they were indestructible. God allowed His House to be destroyed after many years of the people of Israel turning their backs on Him, allowing idols and pagan worship to take place in God's house. The corruption of the Israelites was so bad, the only way to snap them back to their senses was to take away the symbol that they worshiped instead of God – the temple.

After the exiled people of Israel realized their evil ways, they repented. They began writing down the scriptures they memorized and recorded their entire past. It was while they were captives in Babylon that they detailed the construction of

the Temple. When Israel was released from their captivity, they built a new temple. History doesn't say how much of the original temple was replicated. There is no mention of wood-covered walls with the same carvings over the stone in this new temple. It is a detail often mistakenly thought of as decorations or the introduction of idol worship in the temple. This is perhaps why most churches today are finished with bare flat walls.

Israel never became a nation of prominence and power until the 21st century. At the time of Jesus, Israel became an enslaved people under Roman rule, and the corruption of the religious leadership was so bad that the priests, Pharisees, and scribes, used the law to control the people and elevate themselves, becoming powerful and wealthy at the same time. The leadership took advantage of the Roman method of government to get the people to serve two masters with themselves in the middle, using their religion to control the people. After Jesus rose from the dead, everything changed. From the ashes of Israel rose a new way for all people to have a relationship with God. It was called the Way or Christianity.

A time for Hope

In 311 A.D., Emperor Constantine declared an end to the persecution of Christians and declared them normal citizens. Since then, Christians have been seeking[6] and building[7] worship spaces to meet their needs for a full worship experience. From the beginning, the church community has been looking outside of the scriptures for that ideal worship space. To this day, many modern churches are designed like the pagan Greek and Roman temples and theatres, where entertainment is the purpose of the design of those spaces, not as a place for Godly worship as described in the Bible.

In 1998, during an unexpected chain of events, science and the Bible were joined together in an unexpected way that was not really understood until then.

These are the problems all sound engineers discover and seem helpless to solve

As a person designing and installing church sound systems during the previous 12 years, there was a constant set of problems that kept surfacing in every church that asked for help with their sound. Excessive bass, standing waves, poor intelligibility, poor congregational singing, and limited ability to help the choir are some of the common problems that hamper the performance of most sound systems and the overall worship experience. Regardless of the best design and equipment, there was this threshold that no sound system could cross in terms of overall sound system performance. The room kept getting in the way.

It became apparent that an acoustical remedy would be needed to make things sound better. After trying several traditional acoustic treatments, it became clear that adding absorption panels and diffusers as a spot treatment method was mostly an exercise of exchanging one set of acoustical problems for another. In the end, the performance and worship experience was not improved. Sure, perhaps a part of the sound system's performance became better, but at the same time, other parts of the audio system's performance were compromised. For congregational singing, the acoustical installation was the same or worse. From the hundreds of churches I had been exposed to, absorption types of acoustical treatment made congregational singing worse. We could not find one example of an acoustical treatment applied in a church that made congregational singing better.

If anything, adding absorption to any church with carpeted floors and padded seating made the room sound bassy or as having excess bass. This would make the room sound muddier, which lowers speech clarity. The fix was usually to add more speakers on delays throughout the room. Absorptive panels are expensive, and adding more delayed speakers increased the costs further. The secular methods of managing church sound are an expensive approach, and these methods always degrade congregational singing. How is that good for the church? This is how most churches apply secular acoustical fixes today.

Fun Fact about Sound Systems

To an acoustical expert, a properly designed and installed sound system that is also properly setup and equalized will expose the condition of the worship space. Especially if the room has been equalized using the feedback method. All sound systems act like magnifiers of the acoustical condition of a room. Even if a sound system is poorly designed and setup, it can still show the acoustical condition of a worship space. The thing is, most acoustical experts and sound system designers, and engineers are not trained to recognize the sound systems' behavior[8] in showing the faults of the room.

The other fact is when most audio experts discover, identify, or mention that there is a room problem, most immediately offer a new electro-magnetic, digital technology that *may* help. The thing is, fixing the room often costs less than the new technology or sound system upgrade. Another reason why so many churches turn to the newest and latest technology is that the church had a bad experience with a previous acoustical

[6] Some of the first buildings Christians began gathering to preach the gospel and worship in were the vacant pagan temples left behind by the other religions, who no long had favor with the subsequent Roman Emperors.
[7] Many early Christian churches were modeled after pagan temples.
[8] If the data from acoustical measurement don't show a problem, then there isn't a problem. Rather, the data does show the problem, but the exporter are looking at the wrong data and therefore make the typical mistakes most churches are saddled with.

upgrade or someone told them that two sticks of dynamite[9] should do the trick.

Acoustical problems are always in layers

Another problem that was noticed is that acoustical issues were never a single problem. Acoustical issues are always in layers. When taking a deep dive into them, churches often have 6 to 15 acoustical issues at the same time. There are no examples of a church being treated to fix a single problem, and the result gave the church the acoustical performance suited for a full worship experience.[10]

This was when it was discovered that when fixing one problem, another issue was exposed. For example, fixing an echo can be fixed with either absorption or diffusion. Regardless of the method used, after making that improvement, the treatment exposed or created issues, such as excess bass and/or standing waves, that would now dominate. Most churches learned to put up with the new problem because – either they spent so much money on fixing the echo that there isn't enough money to fix the standing waves, or the church board refuses to apply another acoustical treatment that will expose other problems. The same scenario happens when trying to make the reverberation shorter or less noisy. Most of the room fixes that come from the secular community always degrade the overall worship experience. It would be correct to say that the secular methods of managing church sound automatically sabotages church worship and creates a strong distrust of the whole acoustical profession.

the secular methods of managing church sound automatically sabotages church worship

The Bible Opened the Doors to church sound

In 1997, a minister was reading from 1 kings' chapter 6. Read these Bible verses before. However, this time, everything that I had been learning about church sound up to that point came together. Verse 29, it describes carvings of open flowers, cherubs, and palm trees. These carvings were to be on all the walls of the two large rooms in the house of God. In verse 32, it says that the carvings were to be on both sides of all the inner doors. Then, verses 34-35, describe the main entrance doors as having these same carvings on both sides. The house of God was to have carvings on all the walls. What was their purpose? The open flowers are related to life. The cherubs were signs of protection, but what was the purpose of the palm trees? The carvings of the palm trees seemed out of place.

From an aesthetic point of view, the carvings could be interpreted as giving churches permission to decorate the house of God as they see fit. At the same time, many churches have interpreted the carvings as being something that could cause people to think that God was allowing worship to false idols, which has resulted in many churches avoiding anything to be mounted on the walls. It seems that most churches practice an either-or approach to how the interior walls are to be finished. Church walls are mainly bare and flat. This makes churches of the right rectangle shape sound the worst, but it also makes these churches the simplest to upgrade to the Biblical standard. All other room shapes with flat walls can be greatly improved as well.

Setting the aesthetic issue aside, hearing that palm trees were allowed in the Holiest two rooms on the planet, it opened the possibility that there was a purpose for the shape other than aesthetics. Eager to find out if the palm tree shapes had any benefit in managing sound in existing churches, we went off to a construction company and bought dozens of eight-inch diameter cardboard construction tubes in eight- and twelve-foot lengths. After cutting them in half, we started to place them around the room where my home stereo was. After getting over that wow experience, we loaded up a van and started testing them in local churches. Permission was asked to use the worship spaces, and every church allowed us to do the before and after testing. No matter what the room shape or the acoustical condition of these churches, the changes were always an improvement and were always dramatic.

The Five Things we learned

There were five things we learned right away when using the half-round tubes. These changes were not subtle. Rather, these changes were dramatic and without second-guessing ourselves.

The first was that these tubes worked together as a system. As it said in the Bible, to have these carvings repeated on all the walls, not for some of them. That instruction from the Bible was not an option. In any place where we didn't put in sufficient half-round tubes, the resulting sound degraded the performance of the entire room.

Secondly, we also discovered that if the tubes were too far apart, they didn't do enough to contribute to the overall quality of worship.

The third thing we learned is that by changing the sizes, grouping them together, and changing the spacing, the room could be equalized at the same time as solving or preventing the other dominating acoustical issues.

[9] As written in the Owner's manual page 5, of the Audio Real Time Analyzer from Audio Controls. Model SA-3050A. The suggestion is to replace the room.

[10] This is based on the hundreds of churches that have crossed our path. Perhaps such fixes exist, and it is being kept as a secret.

The fourth thing was that mounting the tubes horizontally didn't help to improve the sound in the room. In fact, they do nothing when mounted horizontally in terms of worship space performance. In many instances, horizontally mounted tubes did not prevent flutter echoes or reduce standing waves sufficiently to be of any help. Yes, they did change how the room sounded, but the change wasn't enough to contribute to an improvement.

The fifth thing we noticed is that the treated room sounded larger, or rather – the sound of the room matched the size of the space we were in. This encourages us to naturally speak louder effortlessly.

Between the instruction of the Palm tree carvings and all the walls needing to be covered, the Bible's details are much too specific to be thought of as being decorative or symbolic. The palm tree, having no branches and growing vertically, provides the foundation for an acoustical treatment that is superior to every other method of managing sound in a large room. This acoustical system is perfectly suited for churches. No other acoustical system is as good or better. Why? It is because every other acoustical system or method makes the room good for either speech or music – not both. The Biblical system of sound management performs perfectly regardless of where a person is sitting or standing and for music or speech. Worship is supposed to be an equal opportunity experience for everyone. This acoustical system allows every person to participate in worship, no matter where a person is standing or sitting within the whole sanctuary. No concert hall in the world is famously known for such performance qualities.

Two types of concert halls

In fact, most concert halls are classified as being a "listeners" or a "performers" hall. The meaning of that is simple. For a performer's hall, the performers get good positive feedback support on stage so that they can hear themselves and others on stage. This brings on a better performing experience and no need to rely on technology to hear the other performers on stage. These are the concert halls where it is often heard that performers show greater enthusiasm for their performances. For a listener's hall, it is the audience that has the best experience, while the performers must totally rely on their professionalism or technology to follow through on their performances even though they can hardly hear each other. In such performance venues, it is common for performers to lip-sync parts of a show due to the limitations of the room. After several generations of in-ear-monitors, they have become so good that bad rooms are less of a limiting factor – except for live, acoustical performances of orchestras and choirs.

To our surprise and glee, we discovered that the results were always superior in churches with the right shape, volume, and ceiling height when fixed with the Biblical method of managing worship space sound. When compared, these rooms outperformed any concert or recital hall of the same size and volume when used as performance spaces. This method of managing sound also helps rooms of other shapes to perform at their highest potential as well. This method of managing sound in a church always makes a worship space sound better for every part of church worship, regardless of the room shape or dimensions. Any secular method of managing church sound always degrades the overall room performance and minor sound system improvements. No exceptions. (That said, there are a few secular acoustical products that have the potential to be almost as good, but they are too costly to be applied in sufficient quantities for any church to install. Because of their high costs, these products have few installations with sufficient products to know if they would be effective for a church.) At the same time, there has been no instance where the Biblical method of managing church sound made things worse.[11]

Performance comparison between concert halls, performance venues, and churches

The following is both measurable and subjective.

In the concert world, the Boston Symphony Hall and La Scala in Italy are considered the top performance spaces in the world. The Boston Hall is better suited for musical instruments, while La Scala is better suited for opera. In the secular world, these rooms would score in the high 90's, but as a worship space, they would score below 50% of their required performance level. The low score is for the simple reason that these rooms are not adequate for audience participation. Therefore, designing a church like either of these great performance halls, without the Biblical method to manage sound, such an endeavor would come up short for church worship.

Likewise, many people have been amazed at the sound quality of existing Greek and Roman outdoor theatres. It is true that such places have impressive sound effects of being able to hear at great distances when such places are empty. When these places are full, the sound is not good. Historically, it is recorded that for drama events, the performers wore masks with built-in cones to amplify their voices throughout the space. The Greeks and Romans well understood the limitation of these outdoor theatres and the recognition that analog cones or horns were needed to amplify a natural voice so that everyone could hear. As a worship space, these theatre designs fail to meet the needs of a basic church service. For this and other reasons, fan-shaped performance spaces score below 25% when compared

[11] There are examples where a church was given a complete acoustical design, but the installation was not completed. In those cases, the improvements were still better than any secular method would have done. Had those churches completed the installation, they would have realized a much higher level of performance.

to what Christians need and below 40% when using any kind of sound amplification system.

The biggest disappointment is that existing churches operate at 35% or lower of the worship spaces' potential performance when there is no acoustical system or the wrong acoustical system is applied. This level of performance is the same regardless if a sound system is used or not. Yes, a sound system does improve speech, but for people with any kind of hearing issues, often personal hearing assist systems are needed. When such systems are poorly adjusted or maintained, people will stop using them and will attend elsewhere or stop going to church.

When a worship space is treated with the Biblical acoustical system, it brings existing worship spaces up to a minimum of 70% for full-range performance. Depending on the room shape and dimensions, such as a rectangle, that level of performance can be well over 90%.

Nuts and Bolts

Being the kind of person who always wanted to know why I was dumbstruck that the secular community didn't know about this method of managing sound. Over the years, I have asked a few acoustical experts from around the world, and they were not aware of this method working as a means of managing sound in a large room. Some expert consultants were aware of the use

of Barrel Diffusers which have been used in sound studios and small venues, but because there are no mathematical formulas from which to predict the results, these projects were thought of as novelty installations. Acoustical engineers have a reputation of avoiding taking risks and would rather play it safe and have the fallback attitude that the math bears out the results, and if the project fails to live up to its promise, the blame is shifted elsewhere. For a new building, the blame can be shifted to the builder or Architect for any onsite changes without informing the acoustical consultant. For an existing building, the blame is shifted to the products recommended as often they have much more performance than the coefficient values from the Lab state. (Current testing methods of acoustical products understate real-world performance. As a result, most experts over-dampen their installations. For a shopping mall or convention hall, an over-dampened room is a good thing. For a performance space, it is problematic.)

There are some acoustical experts who understand the merit of a diffused room, but at the same time, they unanimously said they would never recommend this method as a system to manage sound. In fact, none of them look at acoustical treatments as a system and treat acoustical fixes the same way sound experts place speakers around a room as a point-and-shoot setup. These days, some experts classify full-range speakers as point-and-shoot speakers. That said, many performance halls use shallow barrel diffusers as spot treatment, just to manage a single standing wave or flutter echoes, and are mounted on walls as standalone fixtures – not as something that is part of a system.

New ways to combine physics

What makes the Biblical method of managing sound so unique is that it employs 5 principles of physics at the same time. There is no mathematical formula that combines all these principles simultaneously. Furthermore, these laws of physics, when combined, are outside of the abilities of commonly known equations and simulation models to make any reasonable level of predictability. These are the 5 principles of physics – phase cancellation, scattering, low-frequency wave disruption, increasing the path of the sounds traveling distance, and air. The Biblical method of managing sound in a worship space combines these 5 laws of science together in one step.

Human engineering

When combining these principles of physics, they provide a solution to room acoustics that is 100% compatible with how the human ear works and the physiology of how the human body functions.

1. The ears are on the sides of our heads which helps us to localize sounds. That translates into the importance of being able to look at what we hear. This is important because as we age and our hearing declines, the first skill we subconsciously learn is to lip-read. When that option is not available, hearing aids are needed, or assistive listening is used. Room shape determines a lot of whether a person can lip read or not. When the room shape is too wide, reading lips is not an option.

2. While the dynamic range of our hearing on average is more than 60dB, when the signal to noise of the room is less than

20dB[12] between the reverberation and direct sound, clear speech is compromised. Most churches, with or without sound absorption on the walls, have a signal-to-noise ratio that is less than 18dB and a lower signal-to-noise ratio below 300 Hertz. A good signal to noise from 150 to 6,000 Hertz is critical for clear speech. The Biblical method of managing sound ensures a high signal-to-noise ratio. Most churches with this system have a signal-to-noise ratio between 20 to 30dB.

3. Most churches have too much storage of bass sounds or sound energy below 800 Hertz. This excess energy overpowers or masks the high-frequency sounds in speech and music. By default, this degrades speech intelligibility – regardless of the quality and technology used for amplified sound reinforcement. It is not that most churches have too much absorption; it is that there is little to no absorption below 800 Hertz. The half-round diffusers are ideally suited to absorb this frequency range through phase cancellation.

4. The most important frequencies that are needed for good speech intelligibility are between 2,000 to 5,000 Hertz. This method of sound management makes these frequencies louder by canceling the masking effects of the lower frequencies.

5. The better the signal-to-noise ratio, the more relaxed a person will be when hearing speech. The more a person is relaxed when listening, the better they are at remembering the message.

6. When the signal to noise is 20dB or greater, a person is less distracted when hearing speech. A person spends most of their time understanding what is being said rather than questioning what the person said in the first place. This improves diction, which is critical when listening to people with accents.

Simulation programs are a bust!

With such complexity, there is no uncomplicated way to quantify this system or simulate the result. Most simulation programs and other calculations only count the first reflection of sound and then makes assumptions of the travel of sound afterward within a room. Therefore, none of the simulation programs can predict an accurate outcome.[13] Now this opinion was based on using conventional acoustical products. For the Acoustical Society of America to openly state that existing acoustical modeling programs cannot be trusted to give a true and accurate representation of real-world results seem shocking, and no one seems to be surprised by this revelation. Yet the audio industry uses modeling programs to justify their design decisions. As a result, many customers are left with little to no course of action when it comes to forcing the designer and installation company for any compensation or recourse when a project fails to meet its objectives. These simulation programs are used as a shield in protecting the sound company and not the customer. Many churches have been stung with promises of great results, only to have little to show in the resulting outcome.

Secular Faith

The secular community has a lot of faith in their technology and simulation programs despite the consistent subpar results. That said, the idea of simulations is such that after repeating the process and refining it many times, eventually, there should be a good outcome. That plan hasn't been working very well. Besides, how can prediction models be accurate when the performance values of individual products and surfaces are incorrectly measured in the first place? Wallace Sabine, the father of modern-day acoustics, first did acoustical testing in a library[14] where the books' spines provided ample diffusion, from which he formulated an equation where he was able to make the absorption rates of some products predictable. However, modern labs test products in rooms that are reflective and flat. The evidence clearly supports the fact that regardless of the math equations used for room predictions or simulations, the absorption rates are higher than what is stated. As a result, everyone adds too much absorption into the spaces they are trying to design or fix. Likewise, when testing the acoustical values of a diffuser, the data has always shown how each product performs as a single item. There is no testing of how groupings of diffusers behave. Since diffusers are designed to be interactive, the prediction of the result is beyond what any computer modeling or math equations have been designed to calculate.

With all these shortfalls, those who design or attempt to upgrade performance space acoustics rely on personal experience more than book knowledge, simulations, or math (but they will never admit that fact.) When it comes to simulations, these "experts" know how to put on a great dog and pony show. At the same time, they also know that if the client were to follow the data used for the simulation, the room would come up short. Instead, the consultant reveals only the data and designs of what does work and cites proprietary trade

[12] The secular community accepts 10 to 15dB of signal to noise ratio which means many more people will need hearing assist if they can afford it.

[13] According to The Journal of the Acoustical Society of America, in the April 30, 2019, issue, in a peer reviewed paper, it says the following. "In the first-round robin on room acoustical simulation and auralization, the simulation results for six simple scenes and three complex rooms provided by six teams using five different acoustic simulation algorithms were compared against measured data with respect to physical and perceptual properties. The results demonstrate that most present simulation algorithms based on GA generate obvious model errors once the assumptions of an infinite reflective baffle are no longer met. Consequently, they are neither able to provide an exact pattern of early reflections, nor do they provide an exact prediction of room acoustic parameters outside a medium frequency range of 500 Hz–2 kHz." https://asa.scitation.org/doi/10.1121/1.5096178#_i33

[14] Wallace Sabines collection papers page 148

secrets for not disclosing how they get the results they claim to achieve in secular venues (but rarely achieve in a church). Some performance halls are famous for rooms with unique sound effects or rooms that are ideally suited to rely on expensive technology. When they make these spaces available for multipurpose use, the shortfalls are even greater.[15]

Secular experts say the right things

In researching this article, many writers, whether experts or

journalists say the right things that people want to hear. They cite the importance of eliminating hotspots and deadspots, and in the next sentence, they detail how critical even sound distribution is. They talk about these issues as being separate- when, in fact, they are the same. If there are no hotspots or deadspots, then the sound is evenly distributed.[16] Yet the rooms they write about often have hotspots and deadspots. Then writers also talk about Reverberation times (RT60). They mention the importance of keeping stage noise down. Then they mention the importance of balancing the performance of the worship space with the needs for TV and Video streaming. Other concerns are the performance of the sound system and how that sound system is supposed to carry the load to distribute sound evenly throughout the room. These days, many churches are trying to be so multipurpose that it seems that worship space performance takes a back seat to entertainment quality performance[17]. Again, these experts are saying the right things, but they are not delivering. How can you get the camel through the needle when you don't know what a camel looks like?

The one thing that is never read about is how the acoustics or sound system upgrade improved the worship experience for the congregation. There is no mention of signal to noise ratio of the worship space. There is no mention of the frequency response of the room. There is no mention of the free field distance[18] between two people talking without amplification within the room. There is no mention of speech intelligibility with or without the sound system. There is no mention of gain before feedback (an indicator of how many microphones can be on at the same time without feedback.) There is no mention of how to fix stage noise, short of giving everyone In-Ear Monitors (IEMs). Most importantly, it is never said how they improved congregational singing or how the number of people singing increased without the song leaders prompting.

The secular community is fixated on math, simulations, and technology. However, when it comes to church acoustics, their achievements always come up short in fulfilling the whole experience of worship, including preaching the Gospel. In the end, it takes more faith to follow what the secularly trained acoustical and audio experts, with their consistent shortfalls in results, than it does to follow what the Bible teaches, which works every time.

Biblical Faith

Using the Biblical method of managing sound also boils down to an exercise of faith. Why? Because there is no level of predictability by math or simulations, and yet, when applied, it consistently solves all the problems in one step when installed in existing buildings. What the Biblical method offers is a method of managing church sound to such detail that the results are always the same. The Biblical method of managing church sound always gets the highest levels of speech intelligibility, whether amplified or not. It gets the best gain before feedback. It eliminates all hotspots and deadspots, giving the room the best distribution of sound possible, both on stage and for every seat in the pews. It sounds the best for congregational singing and does the best job of encouraging the congregation to sing. The type of reverberation when the audience is singing has the most supportive and pleasing effect on fostering group unity. For many congregants, after a worship space is upgraded, they get the impression that the

[15] Yet the acoustics of a worship space that follows the biblical example is, a superior multipurpose performance space.

[16] Deadspots or hotspots are where the sound level changes from one position to another. The Biblical system of room acoustics from side to side is +/-1.5dB. Most churches have a score of +/- score of 3dB which is a technically a failure, but by the secular community standard, it is a pass. Hotspots and deadspots can be by frequency or an average sound level change. This should not be confused with comb-filtering.

[17] This is so wrong. Biblical acoustics creates a true multipurpose space and entertainment acoustics is a downgrade.

[18] This is the distance two people can speak- even with raised voices and still understand each other in a conversation. In many rooms, treated by the Biblical method, two people can converse over 100 feet apart. A poor room is considered a space where two people have trouble hearing each other beyond 25 feet, even with raised voices.

reverberation is longer[19], but in fact, this treatment keeps the same reverberation time, but because the frequency response of the room was changed, the high-frequency portion of the reverberation is now audible, which was being masked by the excess bass the room had before it was fixed.

For the 400-plus churches we have worked on, we have been able to document a consistent guideline that ensures the best results every time. We have turned all our experiences into a trusted recipe. Following the recipe works every time. The secular community has nothing like this. If the secular community has such a recipe, where is it? Such a recipe would make every large room venue a joy to perform in. This recipe works for both existing and new worship spaces. It can't be overstated enough that the rectangle is the best shape, but if the church insists on using secular shape designs, this recipe still outperforms anything the secular community can offer.

The church acoustics recipe covers all the areas of how any congregation in any style of worship needs room to respond to the whole time of worship. It covers by percentage the absorption, reflective, and diffusive ratio all worship spaces require. By making minor adjustments to how the diffusers are spaced in the room, they can be adjusted for room anomalies such as poor frequency response, low signal-to-noise ratios, and an improved reverberation time. Just as an FYI, in a room with a high signal-to-noise ratio of 25dB or higher, the reverberation times can be longer without giving up anything as long as the ceiling is high enough.

Church Sound and Acoustics Recipe

Absorption Ratio

- 30% of the total surface area of the room needs to be absorptive.
- For most churches, the carpet and padded seating are enough.
- For taller and higher-volume spaces, additional absorption, mounted high on the side of the walls, will be needed to meet that 30% rule.
    - In such cases, only 3 to 8% of the available wall space will need to be covered with extra absorption.

Reflection Ratio

- The total amount of untreated reflective surface space will be 52-55%
- There are to be no bare wall areas perpendicular to the stage/altar area greater than 49 sq. feet where the length to width of the exposed space is less than a 3:1 ratio, including windows.
- Reflective areas are combined with diffusive surfaces to maintain a balanced ratio.

Diffusion Ratio

- The average amount of diffusion from half rounds is 15 to 18% of the total wall space.
- The length of the tubes needs to be determined by the amplitude difference 512 Hertz and 2000 Hertz.
- For most churches up to 3000 seating, the ideal tube sizes needed are 8-, 12-, and 16-inch half rounds.
- The worship space can be equalized with tube spacing, groupings, and sizes combinations for the flat frequency response the room it is supposed to have, to correct any acoustical irregularities from improper worship space building practices the existing space already has.
- All the walls need diffusion, no exceptions.
- The half-round tubes don't work if they are mounted horizontally.

The Ideal Reverberation Time

- Reverberation for Church Worship should never be greater than 1.7 seconds between 300 – 3000 Hertz regardless of the size of the room.
- The reverberation from 512 Hertz should never be greater than 1.5 seconds.

Frequency Response of Worship Spaces

- The frequency response of the room should be:
    - +/- 6dB from 20 to 100 Hertz and
    - +/- 5dB from 100 to 4,000 Hertz and
    - +/-4dB from 4,000 to 8,000 Hertz and
    - 6dB per octave roll-off from 8,000-20,000.

Signal To Noise Ratio

- The ideal signal-to-noise ratio between the direct and reflected sounds is to be 20dB or greater.
- A preferred signal-to-noise ratio of 25dB or greater is ideal.

[19] In many traditional churches, the before and after acoustical change, the reverb time measured remained the same, but the musician notice that the reverb time became long. Both congregation and musician liked how the room changed. For some musician, it gave them a better space to advance their musical skills.

Half Rounds vs. Barrel Diffusers

Half-round diffusers are more efficient, which means less wall coverage. Generally, less than 18% of the total wall area. Barrel diffusers are much less efficient and require a broader 30% coverage of wall space. For this reason, the barrel diffusers are from floor to ceiling to get a similar level of performance. Unlike the half rounds that can tune the room in real time before installing them, the barrel diffusers need to be customized for every installation. This requires a highly detailed set of measurements of the room before any acoustical plan can be designed.

While any generic barrel diffuser installation will make any room sound better, a detailed plan can get an additional 15 to 30% more in overall room performance, which is typical of a generic half-round installation.

The results - good and bad

When a worship space performs to this standard, the room becomes a space that serves everyone. The room will have no special sound effects. The room will not have any unique sound qualities. The room will sound the way it looks, which is a rare quality. There will be no surprises in how the room behaves. The sound of the room will match its size. The overall performance of the room doesn't change with attendance size. The only change is that the reverberation gets slightly shorter as the room fills up. All other room performance requirements remain the same, regardless of attendance.

Few people are aware of this as most rooms sound smaller than they appear to be, and since few sanctuaries sound as big as they look, the small sound of a large space is accepted as normal to the layman and experts in sound and acoustics.

In a bad room, standing at the pulpit, or main speaking position, the strong early reflections are such that many pastors lower their voices. The sound person raises the volume of the sound system, and the pastor lowers their voice more. Eventually, the pastor learns how to force themselves to speak louder and trust the sound system to do all the work – often at a less-than-ideal standard.

In a Biblically treated room, the pastor will naturally speak louder, and amplifying their voice through the sound system will be more relaxed, effortless, and without deadspots or hotspots. Every seat will have the same quality of sound to listen to for both speech and music.

Since the room encourages the pastor to speak louder, the same effect happens to the congregation. When singing, not only does a person hear themselves as the room is supporting their efforts, but people will feel less alone when others join in because everyone can hear each other equally as well. If the congregation wants to sing in 4-part harmony, everyone will be able to hear the musical parts and join in according to their talent and vocal range. When a person speaks from any seat, everyone up to fifty feet will be able to understand them.[20]

Hearing and understanding the pastor without the sound system will be easy for the first 50 feet. Anyone speaking in the room to people at a distance will naturally speak louder- as people do when speaking to others outdoors.

The musicians will be able to experience considerably less interference from the room as the space will do a better job of supporting all their efforts.

Bad results – untreated or improperly treated room.

In bad rooms[21], musicians are fighting the acoustical effects that hinder their performances. The same acoustical effects that hinder congregational singing are the same barriers that force talented performers to work harder at their craft, and it discourages or slows the process of potentially new musicians from advancing their talent. It also makes new musicians much more nervous about performing in a church with bad acoustics when they can hear themselves. This is primarily because the signal-to-noise ratio throughout the room and especially on stage is so low that floor monitors cannot be used. It is also the number one reason for churches adding drum cages on stage. These same interference effects of the room also limit the performance of all sound systems – regardless of the system design, speaker quality, or technology[22].

Musical Instruments

It goes without saying that a rectangle-shaped room is always the best. While a 2 to 1-ratio of the length versus the width is ideal, the room can be up to 30% wider and still have great results. All other room shapes or orientations[23] for those rooms will have very good results as well. If worship space shapes and dimensions were musical instruments, everyone would want the violin. Without the Biblical acoustical system applied to them, even for the rectangle, it is equivalent to a broken violin, a broken trumpet, a broken clarinet and so on. Applying the Biblical method of managing sound will give each room shape a great-sounding trumpet, violin, tuba and so on. There is nothing wrong with having a great-sounding trumpet.

[20] People with hearing aids may need to be closer depending on how profound their hearing loss is. That said, when hearing amplified sound in a well-behaved room, the need for a separate hearing assist system becomes less critical for many. However, a hearing assist system is still important for those who have trouble hearing beyond 10 feet in an average living room, even with properly adjusted hearing aids.

[21] Under performing worship spaces because they are untreated or have the wrong acoustical treatment applied.

[22] When a properly designed sound system is installed in a church, before equalizing the system, the sound system will expose the acoustical problems the room has in a worship space that have no treatment or the wrong type of acoustical management system.

[23] There are many rectangular shaped sanctuaries that are used width wise, which by default have a lesser quality of worship space performance.

I've never had a church turn that down. Such a sanctuary space can have a great worship experience. That said, what is not possible, but always expected is to make a fan-shaped room sound like a violin. If a church board wants a violin, then they must start with a rectangle. God gave us that design, and as Christians, we should follow it.

Sound effect reverberation vs. True Reverberation

Another thing that we learned later about this method of managing church acoustics was that there are two distinctive forms of reverberation.

Sound Effect Reverberation

The first type – sound effect reverberation - is the kind of reverberation we have experienced in many existing large rooms. That form of reverberation is more of a sound effect. Any reverberation that is longer than 1.4 seconds is mostly noise. That noise can be so loud that it discourages many from singing[24] , and it fosters that feeling of being alone[25]. In most rooms where the reverberation is longer, much of the excess reverb is below 800 Hertz. The amount of this excess energy can be 15 to 30dB louder than the frequency of sounds between 2,000 to 10,000 Hertz. By studying the frequency response of a room, which is like looking at the reverberation in 1/6th octaves, the engineer can choose the best acoustical plan to fix the room. Unfortunately, the existing secular methods of managing the acoustics of a church are not efficient enough to correct the frequency response of a worship space. The Biblical method is very capable of fixing that effortlessly.

There are some churches that are known for their long reverberation times. In those rooms, it is never stated how great the congregational singing is. What people focus on is how great the pipe organ sounds. While it is a novel idea to have a great-sounding pipe organ for recitals and concerts, that sound effect does not support congregational singing as intended. Singing with a */great-sounding pipe organ is not the same as the congregation singing by itself and not needing such an instrument to lead the people.

If anything, any musical instrument used during worship should be something that accompanies congregational singing rather than leading the congregation. Having a person conducting the congregation is good. When the conductor is leading a musical team, and the team is drowning out the congregation, that is like saying that the congregation's contribution is not important. It minimizes the efforts of the congregation, and the congregation eventually becomes passive listeners.

Too much of the wrong type of reverberation and a lack of reverberation limits the participation of congregational singing.

There is at no time when a sound effect created by a room is good for Christian worship. There is one exception. When the signal-to-noise of a worship space acoustical sound is greater than 25dB, the length of the reverberation doesn't matter. When the signal-to-noise ratio is that high, the reverberation becomes complementary to the singing efforts of the congregation.

Many cathedrals only have a signal-to-noise ratio of 9 to 13dB. This is interesting because in these large spaces, the signal to noise from 100 to 500 Hertz may be only 10dB, and at 2,000 Hertz, the signal to noise can be above 15dB. In these cathedrals, children and female choir members sound good, and male choirs do not sound as good. People have learned to sing in the musical range where the room interferes with the choir the least – which is usually in the higher frequencies. Again, these sound effects are just that, an effect that does nothing to support true congregational singing.

The Physics of a Choir

When seeing the makeup of a choir, it often confuses me to see so few men and so many women. In a good room that properly supports congregational singing, it should be more men than women. However, that is not what we usually see. Here is why.

Most choirs perform in spaces where the frequency response stores energy below 1200 hertz and much more below 400 Hertz. This is where bass and lower mid-range sounds are so strong that they sound muddy if those frequencies are excited too much. Like most cathedrals and worship spaces, there is much less interference at higher frequencies. Therefore, choirs are forced to have more women singers than men singers. It doesn't take a lot of men to drown out the soprano singers. It is for this reason that most choir compositions must have more women and fewer men, especially those singing bass. Yet the most common complaint about most choirs is the lack of bass from the bass singers. Yes, for a recording, a choir can be mixed to sound great. However, while the live performance can be very loud, the articulate harmonies that should be heard are lost in a muddy blur of unintelligible words that crash into each other – especially if the men sing too loud.

Adding a high-quality, properly engineered sound system with top-notch sound engineers mixing may help in some rooms. However, going in this direction means that this is no longer an acoustical event. It is no longer a performance where everyone can hear the harmonies or hear where the sounds are coming from. Yes, the sound engineer can make the bass louder, but the words usually lack intelligibility because the room still gets in the way. At this point, the choir is being controlled by the sound engineer, and if the sound engineer is not supporting the

[24] This is not true in rooms where the signal to noise ratio is 20dB or higher between the reflected sounds and direct sounds in the room.

[25] Which is also created by excessive bass energy and standing waves.

gestures of the conductor, the choir stops sounding like an ensemble and sounds more mechanical. The responsibility of the sound engineer dramatically increases, and any missed cues or adjustments can undermine the whole performance.

The conductor and sound engineer must be like a team. During the rehearsal with the sound system on, the conductor becomes familiar with hearing the room and sound system together. The rehearsal was done without an audience in a room with poor frequency response[26]. What the conductor hears on stage is a very different performance than what the audience and the Front of House (FOH) sound engineers hear. When the room is full, the performance of the room changes. Often, the adjustments the sound engineer makes for the full room will change what the conductor and singers hear on stage. Depending on the training and confidence of the conductor and singers, some will flinch while others keep going for the sake of the performance. If the room is bad, everyone may not have heard the sound system changes, and the sound engineer either pushes the sound system to its maximum limits or the sound person pulls back, knowing that the sound system can compromise performance with unwanted and distracting feedback. In this situation, it will be the soundman who will get the tongue-lashing for the poor quality of the performance. Meanwhile, it is the unmanaged acoustics and poor frequency response of the room imposing itself on everything, and no sound system can perform around that. The truth is, it is the room that gets in the way, and blaming the sound engineer or music director doesn't solve anything.

In a worship space that has a flat frequency response and signal-to-noise ratio greater than 20dB, it takes more men's voices to keep up with the women. This, in turn, makes the 4-part harmonies and the chorusing of the whole choir much more dynamic and dramatic. Furthermore, in such a room, what the audience hears is the same as the sound on stage. In such a room, amplifying the choir is not needed except for soloists or duets. In the same room, the frequency response of the room doesn't change whether the room is full or empty. Only the length of the reverberation time changes, but not enough to take away from a live performance. In a rectangle room, hearing all 4 parts of the choir is possible for the whole audience area – or up to 4 feet from the outside walls. In all other shaped rooms, hearing the 4 parts of the choir is excellent in the middle 3rd of the seating area, and people can hear 3 parts of the choir in the rest of the seating area.

In a good room, according to the math, the frequency range and efficiency of the singing range of most singers, the makeup of the sopranos, altos, tenors, and bass singers should be as the following. For every two sopranos, there should be two altos, three tenors and four bass singers. Instead, what we often see is for every four sopranos, there are three altos, two tenors and one bass singer. The makeup of most choirs around the world is a reflection of the acoustical challenges most worship spaces present.

True reverberation

Reverberation that truly supports congregational singing is such that it is not heard until the room is excited sufficiently. When talking to someone 3 to 10 feet away and speaking around 50 to 60dB, there will be little to no reverberation during a conversation. In other words, the room sounds dull and boring. As the two people move further away from each other and they raise their voices to hear each other, then they will start hearing the room come alive and what they hear is clear speech with a supportive amount of reverberation to it. As the room gets larger and as the two people move further apart and naturally raise their voices, the ability to hear clear speech up to 80 feet in most cases is possible. In some larger churches, hearing clear unamplified speech up to 135 feet is possible. In one church, a custodian was able to follow the conversation of two women having a conversation 135 feet away, only interrupted by the noise of electric street cars on rails and trucks driving past the front of the church.

While some may think that this is no big deal, the real impressive part of this is the moment a person or a group of people start to sing. That is when the room comes alive. What is also impressive is that the singing can originate from anywhere within the worship space. But it gets even better. Once the sound of the people singing is louder than 70dB, everything the room does supports their efforts. As more people join in, the room continues to support their efforts as well. On top of that, the room gives the impression that the reverberation gets longer as more people start to sing.

What is happening here? How is that possible? Remember earlier about the 5 laws of physics being used at the same time? One of them is phase cancellation. Phase cancellation is when a single frequency intersects with another reflection of the same frequency out of phase. In audio, this concept can be demonstrated with two speakers playing a single tone. When the polarity of one speaker has a reversed connection to the amplifier, the sound drops or disappears. Often this drop can be from 10 to 60dB – depending on the quality and conditions of the two loudspeakers. When the polarity of one of the speakers is reversed, the sound of the one speaker will try to cancel the sound of the second speaker. This is known as "phase cancellation." The Biblical method of managing church sound uses half-round shapes to cause an interference pattern from the reflections off the flat portion of the wall. The rate of

[26] As most churches have a bass heavy frequency response and improperly managed acoustics, micing and mixing a choir properly for live sound is always and underwhelming experience.

cancellation can be up to 45dB. When you add in the other 4 principles of physics, the room remains stable, no matter how many people are in attendance.

*The 20dB Rule ***

Sound absorbers are limited to an absorption rate of 20dB, and the moment the sound exceeds 20dB from where the origins of the sound started, for speech that is usually around 55dB, at around 75dB, the room is beginning to be overloaded on the bass frequencies. An overloaded room sounds distorted, and it makes the listener uncomfortable. This over loading effect happens for both congregational singing and amplified sound. Therefore, even if a song leader were to get the congregation to sing acapella, as the volume of their singing gets over 75dB, it sounds forced and not very musical. Regardless, if a room is unmanaged acoustically or treated with the wrong method, the room overloads, and the signal-to-noise ratio drops as the program gets louder. As the program gets louder, everything sounds harsh and unpleasant.

On the other hand, in a properly diffused room using the half-round shapes used the proper way, the phase cancellation will keep the signal-to-noise ratio constant. True reverberation shows up for congregational singing, and it does not get in the way of hearing speech – even when speech is amplified. In step one, the phase cancellation helps to create a high signal-to-noise ratio, and in step two, the amount of phase cancellation remains at the same signal-to-noise ratio at any sound level. In other words, reverberation doesn't show up until it is needed, and it stays out of the way for other parts of church worship. This is what churches need, and this method of sound management is the only system that does that.

Another way of putting it is that the room gives a congregation what it needs when it needs it and nothing more and nothing less. Who knew that the Bible would be the source of such knowledge and know-how, giving the church the best solution to church sound, and the secular community refuses to even acknowledge that such control of room acoustics is possible?

Bad Room means attendance changes everything

For an unmanaged room, attendance has a huge impact on how a room sounds. As more people enter a space, their bodies will interfere and absorb more sound. For many churches, 100% attendance can be either good or bad – depending on the kind of acoustic anomalies the room has.

For most churches with unmanaged acoustics, a full house means poorer congregational singing, but the consolation is that the sound system will perform better. That gain in sound system performance is noticeable, but it is often short-lived if there is a lot of singing or the HVAC system cannot remove the added humidity created by the people being present in the room. Humidity has a bigger impact as the size of the room increases. If the church has a mixed displacement system and it is quiet, often, it doesn't remove humidity fast enough. If the HVAC system is noisy, it limits the performance of the sound system and how worship is celebrated as well. If the church has a vertical displacement system, it is designed to remove humidity as fast as people can make it from singing.

Most concert halls use vertical displacement HVAC systems. Solomon's Temple was designed to draw in cool air from the ground and allow the warmer air to escape from the small windows 40 feet in the air.

Regardless of ventilation capacity, a worship space that is acoustically unmanaged will change in sound quality as the room attendance changes. Those changes will impact every part of worship.

The Standard has been set for 3500 years

The authorship of the design of any building that is dedicated to God as a House of God should follow the example as God Himself detailed it in the Bible. The worship space is – in fact – a tool to preach the Gospel. It would be correct to say that the House of God that Jesus[27] designed through the hand of King David[28] was a tool for followers of God in the Old Testament and a tool for followers of Jesus[29] in the present New Testament.

However, any building that follows any other design and is dedicated as a house of worship to "god" –can be anything. Such a building can be for the worship of anything or any to any "god." In a way, anything designed outside the scriptures could be considered an abomination[30]. Blunt as that sounds, a House of God is supposed to be for God's followers. Any other design of a place to worship is not something that God wants for us. Regardless, God is gracious in allowing man to choose where and what we worship in, and for centuries, He has been patient with us. He was patient with the Hebrews before the House of God, which became a pagan temple, was destroyed. The people of Israel were cast into bondage until they repented of their ways and learned to love God as Abraham and Noah did before there were the Ten Commandments and were allowed to return to their land. God loves those who love Him through the saving grace of Jesus's sacrifice as the perfect lamb for our salvation. Upon accepting Jesus as our savior, we become transformed through the Holy Spirit, who helps us to testify Jesus in our daily walk for the rest of our lives.

A house of worship is not a salvation issue, but it does reflect our relationship with God. As the road to Jesus becomes narrower in these modern times, the tools to find the narrow

[27] John 1:1-3, Colossians 1:16-17
[28] 1 Chronicles 28:19
[29] Matthew 5:17
[30] Considering that Solomon's temple became an abomination before it was destroyed.

gate[31] becomes more specific and harder to find. In a bad room, it becomes easy for false teachers and corrupted messages to prosper and flourish like a plague. In a good room, it becomes harder to get away with false teaching and easier to expose corrupted ministers.

Everyone knows the old saying of how the Titanic was designed and built by professionals and engineers sunk it. Noah – who was an amateur woodworker, built an Ark and saved the animals and his family. Noah got his instructions from God. Shouldn't we use the same example when it comes to church design and acoustics? God designed all the details of His House that King David drew and for Solomon to build. We have proof of what God designed through David's works. Why do Christians still reject what the Bible teaches for houses of worship? Christians have had over a million churches designed and engineered by everyone else, and the results don't speak for themselves. Following what the Bible teaches works. It isn't much of a stretch to say that God guarantees it.

Concerts, recitals, and performance halls all have one thing in common. They all are designed and used as spaces where the audience is static. The only contribution expected from the audience is their support of the performance through clapping and cheering. On that note, clapping and cheering are louder on the stage in fan-shaped rooms[32]. Perhaps that is why many new performance spaces are designed in a fan shape layout. The focus is on the person, their ego, and self-esteem, and not the message. This is also why so many churches add drum booths for the drums. The drum booth screams of a room with unmanaged acoustics and/or the room shape are not suited for church worship.

That said, all the best-sounding concert halls for acoustical performances are rectangles. The concert hall is designed to give the audience a memorable live sound experience. People who can afford it often return to hear the same concert performance from different locations within the hall to have multiple experiences of the same show. The same show, but different every time. If it was like that in a church, the space would be deemed a failure if the sound was different from seat to seat.

For amplified concert venues, the room shape becomes irrelevant, and the room is dampened down so much that everything has to be amplified. In these venues, it is not about the listening experience. Rather it is about bragging rights. It's about getting people worked up and being caught up in the moment. It seems to be about bringing people to an emotional high and at the threshold of mass hysteria where if a leading person wanted to get people to do something harmful to others, there is a good chance that people will leave the event so charged up that they might do something stupid. Sort of like how people riot after a sports event. Fortunately, that is not the outcome of most events, as soon afterward, people settle down and treasure those memories until the next event.

[31] Matthew 7:12-14

[32] This is from my own experiences of room testing. There is no empirical data to support this claim.

Order of Worship

The order of worship has been molded over time. Outside of the Catholic and Orthodox churches, the Reformed and Protestant churches, the order of worship was as follows from the 15th to 19th century. In studying the scriptures, there emerges a clear order of how worship should be conducted. There is no single part of the Bible that gives a clear and direct order of worship, but there is a pattern. Beginning in the Old Testament and then later by following the life of Jesus and His disciples, we see an order of importance in worship.

1. Reading of Scripture

1.1. Jesus began His ministry with the reading of the Scriptures. (Luke 4:16-22) And he came to Nazareth, where he had been brought up: and, as his custom was, he went into the synagogue on the sabbath day, and stood up for to read. And there was delivered unto him the book of the prophet Esaias. And when he had opened the book, he found the place where it was written, The Spirit of the Lord is upon me, because he hath anointed me to preach the Gospel to the poor; he hath sent me to heal the brokenhearted, to preach deliverance to the captives, and recovering of sight to the blind, to set at liberty them that are bruised, to preach the acceptable year of the Lord. And he closed the book, and he gave it again to the minister, and sat down. And the eyes of all of them that were in the synagogue were fastened on him. And he began to say unto them, this day is this scripture fulfilled in your ears. And all bare him witness and wondered at the gracious words which proceeded out of his mouth. And they said, Is not this Joseph's son?

1.2. While this is the only time it mentions that Jesus read the scripture in a synagogue before speaking or teaching, Jesus often began with a quote of the scriptures – which He wrote – before engaging with the priest and Pharisees.

1.3. In the Old Testament, the Israelites read the scriptures day and night until all of the scrolls were read when they returned from their captivity in Babylon. Nehemiah 8:1-8

2. Preaching and Sermons

2.1. Jesus began preaching after reading or quoting scriptures.

2.2. This was a consistent pattern of how Jesus interacted with gatherings of people.

3. Questions and Answers (optional)

3.1. Jesus would answer questions from the disciples and the religious leaders after His sermons and teachings.

3.2. A Q & A, is also a great way for a pastor to learn the needs of the whole congregation rather than learning the needs of a few and thinking that it is what the whole congregation needs.

3.3. The Q & A, helps people to think for themselves rather than being told what people should know. This helps people to study the Bible for themselves rather than being taught what to think.

3.4. This gets more people to engage within the church community, bringing people closer together rather than being seat warmers.

4. Prayer

4.1. Following His teaching, he would pray – often alone.

4.2. The Lord 's Prayer[33] is about respect, knowing your sinful nature, confessing it to God, and asking God for forgiveness and to guide us in our daily walk.

***5. Celebration of communion** (for the services that include communion)*

5.1. As in the last Supper.

6. Congregational singing

6.1. Jesus and His disciples sung hymns after the last supper.

6.1.1. Matthew 26:30 & Mark 14:26

This was the order of worship for hundreds of years. It upholds the Biblical teaching that the Word of God will draw His lost sheep to Him and not from anything man does of his own accord. This was true for hundreds of years.

The order of worship changed during the period between 1825 to 1835. A preacher by the name of Charles Finney changed the order of worship to change worship into a recruitment campaign – which was labeled evangelism. The following is a quote from a biography of Charles Finney.

"Finney found the newly emerging pop culture as the perfect tool for creating exciting experiences because it was immediate, and it stimulated excitement. Finney urged those writing and leading music in his meetings to look to the advertisers of the day for inspiration[34]. This new way of thinking affected not only the content and style of worship and music, but it transformed the view of the church and its worship. Music for church services was chosen based on whatever would create an exciting atmosphere for unbelievers or believers. Liturgy within corporate worship eventually began to mimic that of an evangelistic meeting, with an altar call replacing the Lord's Table as the climax of the service. Finney's revivalist measures

[33] Matthew 6:9-13

[34] https://religiousaffections.org/articles/articles-on-worship/roots-of-evangelical-worship-charles-g-finney/#identifier_5_24924

marked a decided break with the Judeo-Christian worship tradition."

Charles Finney, within a 10-year period, secularized Christian worship. Before Finney, it was politicians who popularized the concept of starting events with music before giving their speeches. In fact, historically, in going back to Greek History, where religious idols were worshiped, the events would begin with music and dancing. Later, Romans played music to entice the crowds to cheer louder when slaughtering the Christians in the arenas. There is no place in the Bible where any form of worship began with music. However, there are events that end in music as a celebration of God after worshiping God in learning, rituals, or ceremony. Sure, David danced in the street to music when moving the Ark of the Covenant, but that was not a time of worship.

Since the 1830s, one could justifiably say that Charles Finney was instrumental in hijacking true Christian worship and corrupting it by introducing secular marketing and entertainment style of music at the beginning of worship and ending it with altar calls after guilting the listeners to a false conversion. This man was so clever in his schemes that it created a flood of hype, which packed churches full of people in record numbers that it was mistakenly viewed by all other churches as a massive revival. His false teaching of scriptures, and falsely leading people into believing that a person gets a free pass into heaven by just saying a simple prayer of repentance.

In an article entitled "The Legacy of Charles Finney," Michael Horton[35] traces how Finney rejected original sin, a substitutionary atonement, the supernatural character of the new birth, and justification by grace alone through faith alone. Horton concludes that Finney "is not only an enemy of evangelical Protestantism, but of historic Christianity of the broadest sort." Finney also believed that once a person accepts Christ as their savior, all future sins are already forgiven. Therefore, continuing in a sinful life and not being transformed didn't count against you. This strengthened the concepts of "backsliders," "rededication of your life," and "self-justification" as the normal way of Christian living. This opened the door for the notion that the work of the Holy Spirit gave Christians access to signs, wonders, and healing. This is a false concept of the Holy Spirit. Jesus clearly stated that the purpose of the comforter was to testify Jesus (John 15:26) and to transform those who are Born Again, as Jesus described to Nicodemus in John 3:1-21.

Since the radical change in church worship – which was in part driven by worship spaces that could not support congregational singing, Finney flipped the order of evangelical outreach by beginning meetings with an entertaining version of hymnal music before the sermon, and at the same time, he watered down the Gospel. He introduced millions of people to a simpler, non-Biblical form of Christian living. His form of outreach implied a free pass into heaven and an instant false conversion into Christianity[36] which was more appealing to the worldly community. To this day, less than 10% of people who respond to alter calls live transformed lives and 10 years later, often the falling away rate is closer to 99%. Or another way of putting it, only 1% of people responding to alter calls live as Christians[37] [38] [39] for the rest of their lives.

Charles Finney

At the end of his life, Finney rejected the fruits of his altar calls. He said, "I was often instrumental in bringing Christians under great conviction and into a state of temporary repentance and faith. But falling short of urging them up to a point where they would become so acquainted with Christ as to abide in him, they would of course soon relax to their former state.[40]"

Wow! Really? Did the founder of altar calls turn his back on his own "invention"? And could we have we worked out the kinks yet from the first model?

(Side Note: Now I do understand that this could be taken at the risk of making the logical fallacy known as genetic fallacy. This fallacy is a line of reasoning that concludes that if there is a defect in the origin of a thing or claim, then that should be used to discredit the claim or thing. In other words, someone might argue, "Just because the founder of altar calls realized that HIS altar calls were ineffective, that does not have to mean that all altar calls done by any person after him are also ineffective." This is similar to the ad hominem fallacy that would reason that if Charles was ineffective then anything he did was effective.)

One of his contemporaries (a man who worked alongside him in ministry) said, "During 10 years, hundreds and perhaps thousands were annually reported to be converted on all hands. But now it is admitted that Finney's real converts are comparatively few. It is declared even by himself that the great body of them are a disgrace to religion. As a consequence of

[35] https://www.thegospelcoalition.org/blogs/evangelical-history/the-conversion-of-charles-finney/

[36] Reacting to "Finneyism," R.L. Dabney commented: We have come to coolly accept the fact that 45 out of 50, or even a higher ratio, will eventually apostatize.

[37] In his book Today's Evangelism, Ernest C. Reisinger said of one outreach event, "It lasted eight days, and there were sixty-eight supposed conversions." A month later, not one of the "converts" could be found.

[38] A pastor in Boulder, Colorado, sent a team to Russia in 1991 and obtained 2,500 decisions. The next year, the team found only thirty continuing in their faith. That's a retention rate of 1.2 percent.

[39] In November 1970, a number of churches combined for a convention in Fort Worth, Texas, and secured 30,000 decisions. Six months later, the follow-up committee could only find thirty continuing in their faith.

[40] https://writeousrhema.wordpress.com/2014/11/18/is-there-a-high-recidivismturnover-rate-with-the-altar-call/

these defections, Practical evils, great terrible and innumerable are in various quarters rushing in on the church."

Personal Comment

It is my belief that Charles Finney was a product of a person driven to solve a problem within the church community, not knowing that he was looking for a method to get people to have a greater response in responding to the Gospel in an acoustically defective[41] worship space. By his own testimony of his own conversion, being freed from sin gave him the license to use his feelings as a way to justify introducing secularism into the church as an act of serving God. Finney was convinced that good intentions would trump anything sinful as long it was in the act of serving God. This opened the door to an avalanche of false teachers and teaching within large segments of the church community.

More fun facts

Gregorian chants, boy choirs, and church choirs are all historically influenced as a method of dealing with bad room acoustics.

Gregorian chants were a way of pitching the voice to a frequency range that excited the room to transmit a clear sound throughout the room and to pace the reading of scriptures according to the intervals of return of the late reflections in the reverberation of the worship space. At first, it was all a single person's effort, but in some churches, where the acoustics were less hostile, it led to a group of cantors standing close to each other to read the scriptures in a rhythmic, musical pattern. Some Orthodox churches still practice this form of worship to this day.

In the early church of the 8th to 15th centuries, it was customary for young altar boys to repeat what the priest said because the voice of a young boy was higher pitched, like a female's voice. In those days, it was well known that female voices carried further in the acoustical hostile worship spaces. It was also customary for females to be silent during worship. It fell upon young boys to play the role of being a human megaphone or an analog PA system before there was such a thing. This led to boys' choirs.

The earliest church choirs were all boys. Later, in the protestant movement, in smaller buildings, adult choirs became possible due to the shorter reverberation times. This paved the way when women were allowed on the same platform as church leaders during worship. According to who is writing church history, there is one expert that attributes the year of 1716 as the first time a woman was allowed to sing in a choir at the back of a church. It is not known when choir lofts were moved to the front of some churches, but this is when women were allowed to sit with men in the choir loft at the front of the church, where the male church leaders also sat. It wasn't until the 1830s that the choir began church worship. It was in this setup that this became an early form of a worship team, used primarily to encourage the congregation to sing before the sermon, but later morphed as an early form of Christian entertainment. Choral concerts that were apart from a worship service were a trend for a while, but that faded soon, as the acoustics of most churches could not support the choir – let alone congregational singing.

The acoustical conditions of most churches have led to highly amplified programs where the main goal is to get more people singing. This plan also fails in getting people to sing, as the acoustics of the room keep getting in the way. Many churches are now providing an all-out entertainment music program that resembles secular rock concerts, hoping to entice and pacify the congregation with highly choreographed entertainment, with simple, repeating verses and choruses, in hopes that this will be enough to keep people coming back, even though the audience can't contribute to group worship. Getting people high on endorphins and dopamine is not what the Bible teaches. That is purely an induced form of addictive behavior. It is no different than pagan idol worship, where the acoustical performance of a worship space doesn't matter. For some high-profile church leaders, it is the experience that matters. When people are chasing after an experience, the message doesn't matter.

The expression of being united in song and prayer is just that. It is a group activity. Whenever there is a mention of Christians gathering for worship, it paints a picture where everyone can participate. When the acoustics gets in the way, it limits that kind of activity, and at the same time, it gives room for a corrupted message to creep its way into the church.

A Warning to All

Often stated, with this acoustical system, 80% of the installation realizes about a 20% improvement. The last 20% of the installation realizes an 80% improvement. The thing is, when some people hear that 20% improvement, they stop as it does make a huge improvement compared to before. Often, they are so blown away that they can't imagine an additional 80% improvement. That last 80% of improvement is not as dramatic, but it is realized by the added sound system performance and by those who play musical instruments within the worship space. It is realized by the choir, the organist, pianist, and it makes it much easier for the congregation to sing in harmony, regardless of whether they are singing to musical instruments or acapella.

A Church building is neither a concert hall nor an entertainment venue – although many new churches are being designed and

[41] It would be fair to say that any house of worship that falls short of what the Bible describes as to how a house of worship should perform as being defective.

acoustically managed in that way. Church worship is a group activity where everyone can participate at whatever level they are comfortable with. Church worship is not a spectator sports event. The acoustics described in the Bible is nothing like that. There is no other standard that comes close to what the Bible teaches.

Therefore, no concert hall can be considered as good as a worship space. Concert halls serve the masters of entertainment. A house of worship cannot serve two masters. God's house is a house of worship, and it cannot, or ever should be, a place of entertainment. Therefore, a worship space must be better than any entertainment facility or concert hall. The thing is, if a house of worship that has been acoustically treated is used in this way, it would be an outstanding place for secular events. If it was suggested that this ability for a room came from the Bible, no one would believe it, and to them, it would seem like magic.

There are those who say that a house of God or a house of prayer is just a building and that we should not be worshiping the building. This is true. When Christians gather for the specific task of their obedience of fellowship and worship, the building does become a House of God. That is when the performance of the worship space matters. This is not to say that the building can't be used for anything else. All the scriptures record that anything secular done in the house of God is condemned. Idols, idol worship, worshiping people, false teaching, and secular entertainment, which often suggest improper relationships, are all things that are not accepted by God in His house.

The Bible gives us everything we need to know how to design, build, and manage the performance of a house of worship – a House of God. There was a time when God asked for an unblemished sheep for the blood sacrifice. At first, it was done out of love for God, but over time, it became a ritual. A house of God that is unblemished and pure is the best defense from the wolves in sheep's clothing and to help grow the Christians' love for God as a community. A community can't remain strong if the house they meet in has an acoustical performance that gets in the way of people being able to contribute to the worship. Satan has been using acoustics to divide the church for centuries, and we now know how to stop it or at least slow down the rise of false teachers and ministries/cults.

Do you believe in Miracles?

Finally, there is one other thing that makes all this so unique. The house of God, designed by David and built by Solomon, was constructed over 3,500 years ago. The language of acoustics as it is used today began around the 1400th century. The terms we use today didn't exist when the house of God was designed in 1,500BC. Yet, this method of managing sound surpasses every aspect of existing churches used for worship. How is that possible?

As mentioned earlier, the evidence shows that there are 5 principles of physics being used at the same time when using half-round shapes in groupings of more than 4 units. The half rounds are 2 to 4 times more efficient than any other method of sound management, and the pattern of their installation can be adjusted to equalize the room at the same time as fixing all the other problems. Furthermore, it is the only acoustical system that improves the room to the highest level of worship - congregational singing – a vital part of a Christian church service. No secular method of acoustical management can do that.

Every acoustical system will make a change, but in most cases, the change is to absorb a portion of the hearing spectrum – mostly the high-frequency sounds while doing nothing in the lower frequencies where all of the sound energy is. The excess energy masks the highs, degrading the room's overall performance in terms of Christian Worship. This level of sound degradation for worship makes the room better suited for entertainment.

When it comes to simulations, the secular methods don't work. The secular methods of sound management are based on a false premise of how the data is collected in the first place. Furthermore, none of the simulation programs can predict how the half-round shapes work. Yet, when the half-round shapes are compared to all other acoustical systems, nothing out there is close to the performance of the half-round systems as described in the Bible. What is known today is from trial-and-error real-world field testing and documentation. This system not only solves all the acoustical problems identified but also improves the room's performance. There has been no instance where this system made the room worse.

Here is an acoustical system using physics in a complex manner, so far advanced that the secular community can't match it without replicating it. This is a system designed 3500 years ago and detailed in the Bible. If Solomon's temple didn't exist, then this acoustical system, which works every time, would not have been detailed in the Bible. Think about that!

From a historical point of view, this acoustical system proves the existence of Solomon's Temple. It proves that King David and Solomon existed. The keeping of these details within the Bible is another strong argument for the inspired Word of God and the sufficiency of scriptures. Furthermore, since science cannot predict the results, every existing installation of this system in a church has been an act of faith. An act of faith that is the core of how Christians become followers of Christ. It takes an act of faith to accept Christ as the savior who sacrificed himself to atone for our sins. It is an act of faith that when we understand and accept His death and resurrection and that we

become adopted[42] children of God, receiving the Holy Spirit at the same time, this total understanding seals our relationship with God. Becoming a Born-Again Christian is a miracle brought on by faith.

Completing the inside of any existing church with the same shapes used in God's House is a living miracle Christians can experience today by exercising a similar act of faith. The first act of faith is a salvation issue, and it can never be taken lightly. After all, it is about a person's eternity. This second act of faith is secondary. It is a living testimony to the word of God, providing a safe place where His Children can experience a full range of worship in a time where the costumes and disguises of false teachers and antichrists are so good that if it were possible, they would deceive[43] , even the elect.

Finally, consider this. Psalms 28:7, The LORD is my strength and my shield; My heart trusts in Him, and I am helped; Therefore, my heart exalts, and with my song, I shall thank Him.

Psalms 33:20, Our soul waits for the LORD; He is our help and our shield.

Ephesians 6:13-17, Therefore, take up the full armor of God, so that you will be able to resist in the evil day, and having done everything, to stand firm. Stand firm therefore, HAVING GIRDED YOUR LOINS WITH TRUTH, and HAVING PUT ON THE BREASTPLATE OF RIGHTEOUSNESS, and having shod YOUR FEET WITH THE PREPARATION OF THE GOSPEL OF PEACE; in addition to all, taking up the shield of faith with which you will be able to extinguish all the flaming arrows of the evil one. And take THE HELMET OF SALVATION, and the sword of the Spirit, which is the word of God.

Bringing any house of worship up to the Biblical standard is like doing everything to stand firm and adding a shield to the building and its members. It is like adding a layer that makes it harder for false teachers and bogus worship styles to gain a foothold within the Body of Christ. Following the Biblical standards for acoustics will not keep the false teachers out, but it will do a better job of exposing them. It will also do a better job of bringing the Children of Christ closer together and be the light that this world truly needs today.

Nerd Section

[42] Ephesians 1:4-6

[43] Mark 13:21-23, 1 Corinthians 15:33, 2 Corinthians 11:3, James 1:26

2D vs. 3D Acoustics

The acoustical methods used by the secular community in designing new spaces or fixing existing spaces resemble a "point-and-shot" and "let us see what will happen" attitude and methodology rather than a clear plan to a solution that fixes or avoids problems permanently.

The secular community has only two tools they turn to - absorption and diffusion. Absorption is used for mid and high-frequency control, while diffusion is used for echoes. You never see their acoustical plan as a system. Instead, these items are put together as a mashup of hope and faith that math and common sense will work. When such a system works, it is a miracle. When it does not, someone else comes in and tries to fix it the next time the customer can afford to tackle the acoustics issue. Often the second acoustical upgrade turns into a series of trade-offs. In the end, there is no significant improvement, and it increases the distrust of the profession.

The Biblical method of managing church sound is a complete system that follows a specific plan. There is no guesswork about the plan or the outcome. It is a system that works every time. The plan follows a specific recipe as outlined in the Bible. This Biblical recipe has been tested and confirmed in hundreds of churches. The secular community has nothing like this; if there is, it hasn't been made public, and no facility employs such a system. The secular community has no recipe that has proven to be repeatable.

Perhaps one way to look at the differences is in the secular methods of managing sound. They use a mashup of 2D elements and hope to get a result that satisfies the customer. The Biblical method of managing sound is that it is a system that not only fixes the problems you could hear before the room was fixed, but it solves all of the other problems masked by the problems you were unable to hear. The Biblical method of managing sound is 3D, as it controls all of the elements of sound at the same time.

Sound is complex, and it uses and is affected by several laws of physics at all times. Sound has length (frequency or Hertz), strength (decibels or dB), and velocity (speed). Sound is also affected by humidity and temperature. Humidity changes the speed of sound, and temperature shifts the frequency of the sounds.

It is Mind-baffling how the secular world is stuck on using a two-dimensional approach to managing sound in large rooms when it is a three-dimensional problem. The secular methods are not repeatable, as each acoustical plan has to be customized, and every design is untested. That makes the secular method of managing sound an experiment, and every church they try to fix is like a petri dish in a lab. You put the samples in and wait to see what the results are. Most times, it is not what the church was expecting or wanted.

The biblical method of managing church sound is a three-dimensional system that takes advantage of all physics principles in one simple and easy-to-understand step. While there is no method of predicting the Biblical technique as the secular community understands sound, it takes more faith to trust the secular method of fixing the sound of a church than the Biblical method. Why? The Biblical method of managing sound is repeatable and works in any shaped room. Follow the recipe, and the results will be as God promised. Not because of anything supernatural or as a miracle, God shows us how to use physics as it is meant to be used.

The following chart shows the difference between 2D vs. 3D acoustical treatments.

2D vs. 3D acoustical treatment Chart

Acoustical issue	Secular (2D)	Biblical (3D)
Standing waves	- **Absorption** can only shift the frequency of the standing waves. - Absorption cannot manage the remaining bass energy, which masks the high-frequency sounds which degrade speech clarity. - Always reduces reverberation time. - Always degrades congregational singing. - An added cost - **Diffusion** only disrupts the stored energy. - To make panels for lower frequency control, the treatments become exceptionally large and intrusive within the space. - Maximum overall energy reduction is 6dB. - degrades the performance of the sound system within the area of the standing wave - An added cost	- Combines absorption and diffusion in a single step. - Frequency selective. - Wide or narrow frequency range of control. - Up to 40dB of overall energy reduction. - Disrupts all frequencies down to 20 Hertz. - Provides maximum speech and music clarity. - Enhances congregational singing. - Does not affect the reverberation time unless it is needed. - It enhances the performance of the sound system. - Part of the system - No added cost
Echoes and flutter echoes	- **Absorption** - is not recommended. - It only masks the problem by allowing excess bass energy to conceal the echo, not get rid of it. - always affects reverberation time - degrades sound system performance. - **Diffusion** only redirects the sound energy into another area in the room which often degrades speech intelligibility. - has a slight degradation of overall sound system performance.	- complete elimination. - Frequency selective. - Can reduce reverberation if needed. - Enhance the performance of the sound system.
Frequency Response	- **Absorption** always absorbs more high frequency than what was planned, and the remaining bass energy cannot be managed effectively by any other method. - Limited control up to 6dB from 500 to 1,500 Hertz - excessive control over 15dB from 3,000 to 20,000 Hertz. - **Diffusion** has a limited effect on the frequency of the room. - cannot affect enough change to improve the sound system's performance.	- tunable - frequency range from 50 to 20,000 Hertz. - by changing the spacing, sizes, and placement combination, the system can be tailored to offset any room anomalies that affect a room's frequency response. - Each wall can be adjusted for any frequency. - passive equalization can be up to 40dB. -enhances the sound system performance. - There is no additional cost to passively tuning a room.
Passive Equalization	- Not an option	- See Frequency Response
Distortion below 1000 Hertz	**- Absorption and or diffusion** - Pipe organ – no assistance - Piano – no assistance - Drums – no assistance - Sound system - no assistance - Subwoofers – no assistance	- Reduces all distortion up to 30dB from all sound sources. - improves sound system performance - The sound system can often be 15 to 25dB louder without offending people.

Room Noise	**- Absorption and or diffusion** - No meaningful assistance	- HVAC noise -10 to -20dB - Road noise -6 to -12dB - ambient audience noise -10dB. - increase the loudness of the fire alarm up to 10dB.
Corner bass buildup	- requires massive bass traps. - Limited to only 20dB of control - most churches have excess bass energy that exceeds 30dB.	- Not needed, as the wall system prevents any bass buildup before the sound can follow the walls into corners.
Congregational Singing	- **Absorption** always degrades congregational singing. - **Diffusion** does nothing to help congregational singing unless it is part of a system – which is never part of a secular acoustical plan. - There is no secular method to enhance congregational singing. - Sound System cannot improve congregational singing. - (Electronic reverb systems do work. They require high Maintenance costs and skilled people to set them up.)	- Always improves congregational singing. - The only limiting factor is the shape and dimension of the room. (- i.e., a room with a 30-foot ceiling will realize a significant improvement over a room with only a 12-foot high ceiling.)
Signal To Noise Ratio	- **Absorption** – Above 4000 Hertz up to 6dB - From 1,000 to 4,000 Hertz, no improvement. - From 20 to 1000 Hertz – lowers the s/n. - **Diffusion** – no meaningful improvement	- controllable from 18 to 25dB.
Speech Intelligibility	- **Absorption** – degrades unamplified speech - can improve amplified speech as long as people speak into the microphone correctly. - The more absorption in the room, the lower people speak, as the room gives the impression that it is doing all the work when it is not. - **Diffusion** – minor improvements.	- Always improves speech clarity and quality. - Encourages people to speak louder. -When people speak louder, it reduces or eliminates sound system feedback.
Sound System Performance	- **Absorption** tends to make the sound system less stable and more prone to feedback. - Degrades or shifts sound system limitations. - Diffusion – offers little to no improvement to sound system performance.	- Enhances everything a sound system is supposed to do.
Service Life	- Absorption – 20-25 years - Cleaning, replacing cloth cover, replacing absorbers due to deterioration of overall performance - Diffusion – can be unlimited	- Unlimited. - lasts for the lifetime of the building. - can be painted or cleaned as often as needed. - does not degrade in performance over time.
DIY Minimum Cost per sq foot of floor space Of equal performance	$2.50 per sq foot.	$0.40 per sq foot.
Commercially made products Minimum Cost per sq foot of floor space Of equal performance	$9.50 per sq foot.	$3.20 per sq foot.

Terms and Definitions.

Standing waves

Standing waves are often defined as excess stored energy between parallel walls. Most often, standing waves are below 1000 Hertz. The excess stored energy can be over 20dB louder when compared to frequencies at 3000 Hertz. However, standing waves can occur anywhere where excess energy cannot escape a room. Standing waves occur in any room shape. These standing waves often go undocumented as the excessive bass masks them in the room.

Echoes and flutter echoes

An echo is a distinctive reflection that includes full words or syllables. Echoes always interfere with hearing speech and music. A flutter echo is a short reflection that sounds like a ping or ricochet. This also included repeated pings that can repeat several times a second. Flutter echoes rarely interfere with hearing speech but can be a problem for drummers if heard from the drummer's position.

Frequency Response

Like loudspeakers, rooms have a frequency response. While many describe the performance of a room with a simple picture of reverberation time, this description is only a small part of a room's performance. Some experts even look at reverberation in octave or 1/3rd octave bandwidths. This is a step in the right direction, but it only describes the decay time at a given frequency, not how much energy each frequency has. Many times the strength or loudness of a frequency does not represent the length a frequency reverberates. For example, many times, a room can have a long reverb time of around 400 Hertz, but the energy strength is louder at 250 Hertz. Limiting room testing to reverberation time often fails to identify the larger picture. When experimenting with half-round shapes, these details about room acoustics were exposed as the room's frequency response could be changed in real-time.

Passive Equalization

Half-round shapes can be spaced, grouped, and sized to reduce a room's excessive energy it naturally creates. The amount of reduction has been up to 40dB or the equivalent to 2 Sabines (coefficiency of 2) and as narrow as half an octave. The most common sizes are 8, 12, and 16-inch half rounds, and grouping of 2, 3, and 4 of the half rounds can simulate larger diffusers without having to make larger and more expensive custom-made panels. These adjustments can be made on-site or by following what was learned from other projects with the same problems.

Distortion below 1000 Hertz

Distortion is the unintended alteration of sound between the source and the listener. It is excessive sound energy that has been changed when exceeding the dynamic range of a device, such as an electronic system and/or through a microphone or loudspeaker in the same signal path. Distortion in loudspeakers can also be caused by stored room energy acting as a resistor on the surface of any woofer-style speaker, including bass and subwoofer drivers. Pipe organs, brass instruments, and drums will distort when the room imposes itself on the musicians' efforts to perform. Distortion is also created by the performer whole attempts to play their musical instruments louder when they can't hear themselves. It is not uncommon to hear drummers, whole pound the drums harder or brass players whole say when they blow harder, the sound isn't getting louder. When performers can't hear themselves, they cannot hear their musical instruments distorting.

Room Noise

Room noise can be anything from children crying, a person's hearing aid feeding back, traffic noise, airplane or train noise, HVAC system, or ceiling fan noise. When using the half-round shapes as detailed in the recipe, those noises are reduced by 10dB or more without compromising the signal-to-noise ratio.

Corner bass buildup

Sound travels along walls. You may have heard the term "Room Nodes." This is when a range of frequencies has followed the wall into a corner, and depending on the average wavelength, the added energy boost from the corner piles up at the middle and quarter points along the walls. With a typical Sound Pressure Meter, a person can measure these buildup points. Often these buildup points are frequencies below 800 Hertz. With the Biblical method of

managing sound, the system prevents the buildup of any bass energy along the walls. Since there is no buildup of bass energy along the walls, there is no excess bass energy in the corners. Therefore, there is no need for corner bass traps. All other forms of acoustical sound management often require bass traps. Most churches never use bass traps due to their high cost and low-performance levels.

Signal To Noise Ratio

In church acoustics, the signal-to-noise ratio should be 20dB for acoustical sound and 25dB for the sound system for the best speech intelligibility and music clarity. The ratio is the difference between the direct average sound levels a person hears in relationship to the average sound levels of the reflections. In a typical church with no acoustical management, the average signal-to-noise of the room is between 6 to 12dB. When fixing a room with absorptions, the signal-to-noise ratio often increases in the high frequencies and decreases in the low frequencies (below 800 Hertz.) The final outcome of such attempts to tame a worship space is that the signal-to-noise ratio either remains the same or it is decreased. However, when the performance of the sound system is limited, amplified speech can improve the signal-to-noise ratio by an additional 3 to 6dB. This can be done by rolling off the bass to all microphone inputs and reducing the bass output of the sound system. When using the Biblical method of managing sound, the sound system's performance doesn't have to be limited.

Speech Intelligibility

Speech intelligibility is the understanding, not just hearing, of the meaning of common words within the vocabulary of most people. In many worship spaces where there is no acoustical management, complete words can be changed from what the minister says to what a person hears. This degradation of speech can be universal, by location, and when a person moves their head an inch or two when shifting their weight from one foot to the other. Other factors, such as dictions, the context of certain words, microphone placement and performance, sound system design and performance, loudness, and the adjustment of the sound system, all contribute the whether the words spoken by the minister have been changed by the time the person hears it. Speech intelligibility can be measured in several ways. The two most common are the oral or aural speech test, originally from Bell Telephone, and electronic measurement. Both methods are good, but the room has to be tested with and without the sound system on. Otherwise, you cannot tell if it is just the room, the sound system, or both that are causing the degradation of clear speech.

Sound System Performance

All loudspeakers and microphones are transducers of one type or another. All loudspeakers and microphones are tested and marketed as having a good level of performance. When you place a microphone or loudspeaker into a confined room, the frequency response of these two items changes. Confined rooms limit their performance. The room imposes itself and alters its ability to perform as intended. In a recording studio, the first thing that is often done is to change the space or add acoustical devices to get the best sound possible. After that, the person's voice is equalized to get the desired result. In a church, 99% of the time, the whole sound system is equalized in an attempt to restore the original frequency response of the transducers. The sound system can also be tuned to reduce the stronger interfering frequencies the room naturally amplifies. In any room that is absent a complete acoustical system, the sound system is always limited, degraded, and compromised. This level of sound system limitation is often 50 to 75%, regardless of sound system design and the quality of the hardware.

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Conclusion

1. The Bible is an accurate book on history.
2. It was Jesus who placed His hand upon King David to design all[44] of the patterns and details of God's House. All the details – not some of the details.
3. God combined several laws of physics that the secular community doesn't understand. These laws were brought together, when the details of the palm tree carvings on the walls[45] of Gods house were made.
4. The work of the Holy Spirit is evident, considering how this detail of Solomon's Temple could have been easily left out of the Bible without changing the overall story of the scriptures. Yet, this detail remained in the Bible, not as a decoration, but as a functional purpose. What more evidence does anyone need when using the phrase – the inspired Word of God?
5. When Jesus said he came to fulfill the law[46], could the understanding of what the palm trees be part of the ongoing fulfillment of the Scriptures in the 21st century?
6. Is it a coincidence that as mass media, the internet, and TV exposes more people to false teachers, the need for better houses of worship has been revealed to us in this troubling time?
7. Is it a coincidence that churches that have already installed this form of acoustical treatment have congregations that are doing better than churches that continue with their acoustical limitations?
8. Is it a coincidence that this method of managing church sound is affordable for any church and that it offers no commercial advantage to the secular community?
9. Is the science so complex and unfamiliar to the secular community that they seem indifferent or have no interest in learning more about this system?
10. Is this an example of the secular community being so wise by their own standards that they are blind to the truth?
11. Could it be that the secular community doesn't understand the true nature of Christian worship, and in their eyes, acoustics and audio are based on the needs of entertainment and spectacle-type performances? This worldview is how they also read the scriptures. When Christians read descriptions of worship, it means much more, but the unbelievers are blind to it. Therefore, those trained up in the secular methods of managing church sound and use those methods in the churches they try to help, are holding back the church community from true worship.
12. Is following the Bibles teaching on acoustics a test of faith only a Christian can exercise?
13. With such a lack of physical evidence of Solomon's Temple, does this acoustical system prove that the temple was real?
14. If it does, does it also support all the writings of the Old Testament as true, as those writings were recorded at the same time?
15. (Much of the Old Testament up to the books of the Kings, were written while the Israelites were held captive for 70 years in Babylon.)
16. Does this support the Genesis account of the beginning of man?
17. Here is one thing that can be tested from the Bible that any church can do, and it works every time. There is no other test in the Bible that is based on science and works 100%. This is what secularly trained experts in sound and acoustics do not understand.
18. Many wealth and prosperity preachers preach on Malachi 3:10 and the "name it and claim it" principle, which only seems to work for them. Why is that?
19. The Bible records History. In that, history is science.
20. That science confirms the existence of God, King David, King Solomon, the Israelite captivity in Babylon, Jesus, and the Holy Spirit.
21. The performance of the half-round shapes, as detailed in the Bible, happens according to the Will of God, not the cleverness or the will of man.
22. It takes the adopted sons and daughters of God to take God's plans and will for His Children to understand God's teaching, act upon that knowledge in faith, and show the world that God is in control, not man.
23. Church worship styles and Church design should not be an emulation of the church trying to out-compete the secular world.
24. Worship and Church design should reflect the exclusivity of God and the followers of Christ. Both the worship space and worship should stand apart from the world.
25. The Biblical method of managing church sound and acoustics is far more capable and advanced than

[44] 1 Chronicles 28:19
[45] 1 Kings 6:29
[46] Matthew 5:17-19

anything the secular community can provide at any price.

26. Furthermore, the Biblical method of managing church acoustics is significantly lower in cost.
27. New churches could cost less or have more space following God's plan.
28. Concert and Entertainment style buildings fail to meet church needs. So why do so many churches still design, build and manage their sound according to secular standards, which we know is a failure in the first place?