JdB Sound Acoustics

Presents

KINGSTON ROAD UNITED CHURCH

SANCTUARY ACOUSTICS AND SOUND SYSTEM

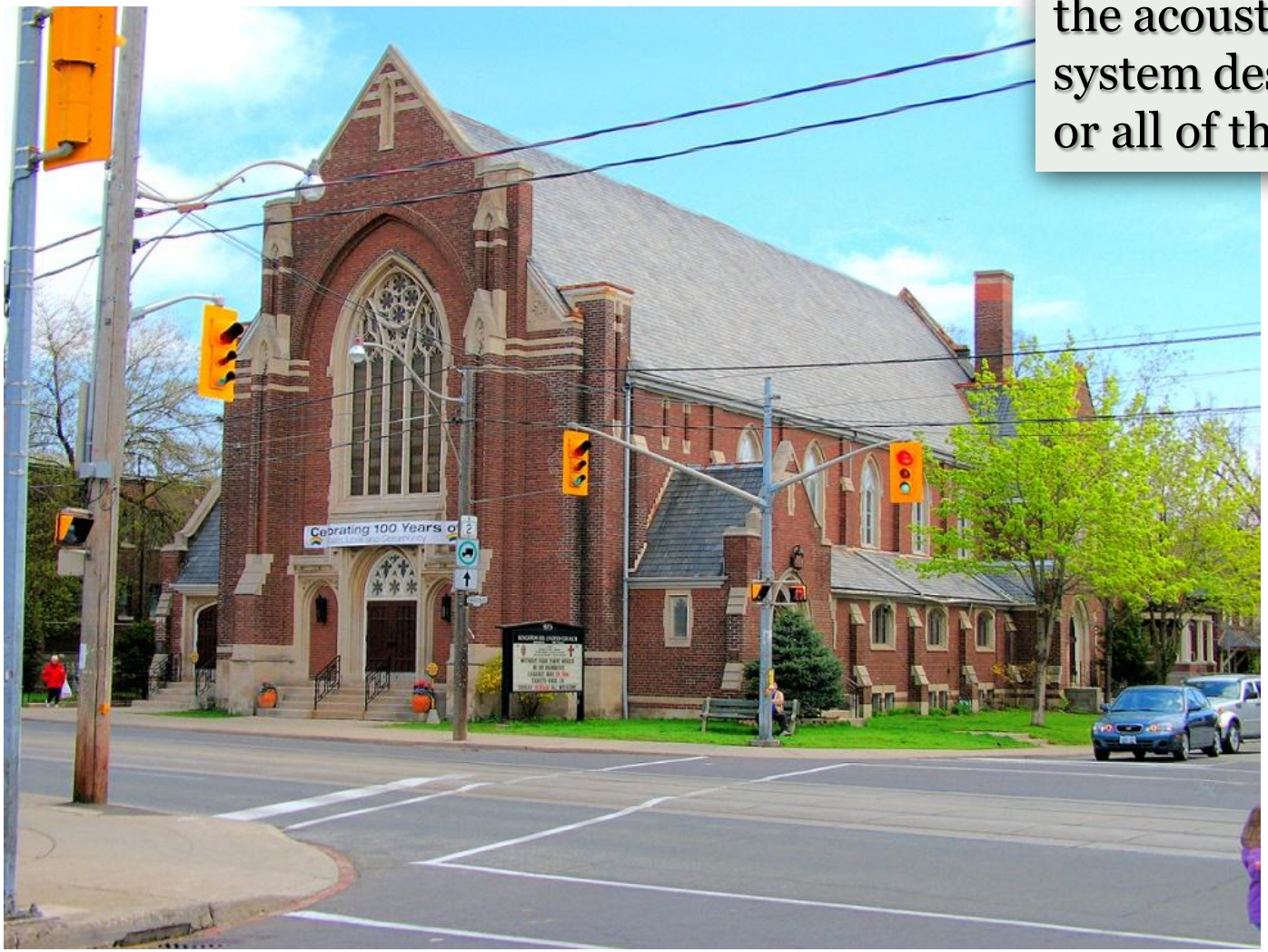
BY JOSEPH DE BUGLIO

2008

The Beginning

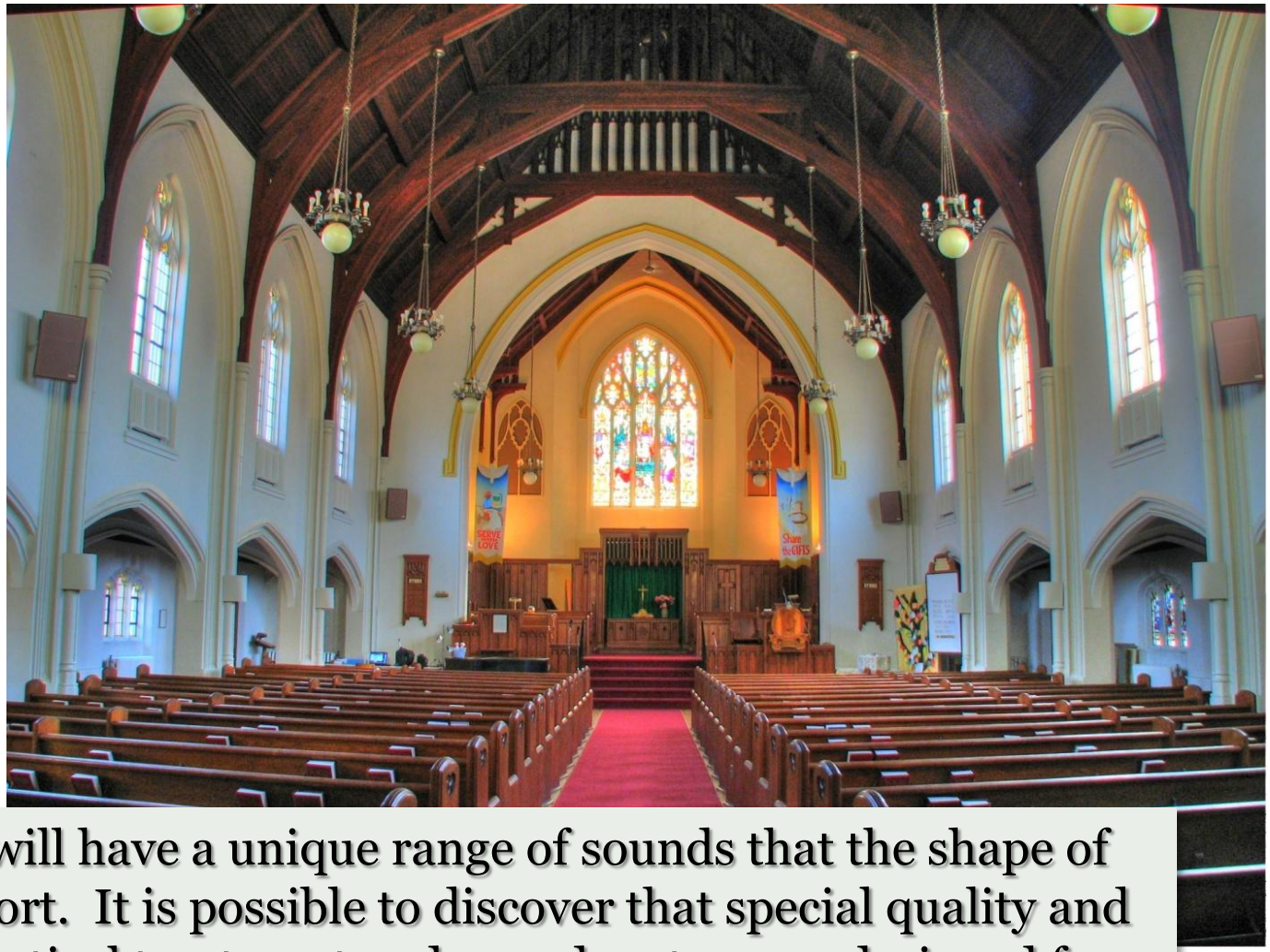
- Feb 2008, JdB Sound Acoustics was contacted to have the sound system upgraded.
- The Church had already tried several sound systems with little improvement from one system to the next.
- While the sound system was installed professionally, it was not designed correctly for the room.
- As often stated, most churches are put together with the best of intentions. That includes the design of the worship space, the acoustics and the sound system.

In order to have hearing problems in a church, either the building design, the acoustics or the sound system design has to fail - or all of the above.



Once a church is built, there many things that you can do to bring the performance of the space up to acceptable levels for exciting worship. The shape of the shell of the worship space will determine the type of sound the church will have. Sort of like what makes the sound of musical instruments , just like a Trumpet is different from a Tuba and a Violin is different from a Cello.

The rectangle is the best sounding shape for a worship space. By changing the length and width ratio's, you can make the room more suited for Classical sounds or Modern Rock and Roll sounds. For Kingston Rd United Church, the space is ideally suited for classical sound, but with a change to the acoustical fix of the room, it will become a Hybrid space. It will be able to perform very well for classical performances but it will also do very well for most contemporary programs too.



Every large room will have a unique range of sounds that the shape of the shell will support. It is possible to discover that special quality and as long as the acoustical treatment and sound system are designed for those behaviors, you can have great results. From a warehouse worship space to the big mega churches, every Church Shape will have musical and speech qualities that are desirable and useable.

For this worship space, the room is Long and Narrow. This room will not do well for Christian Heavy Metal or Punk. However it would do well with a rousing performance of a Southern Gospel concert.

Myth:
Often Church Designers are mislead to believe that a sound system can somehow deliver clear speech and music with magic by increasing the sound system budget. This is a myth that is practiced every day in the church community.

Sound problems in a church come in layers.

This is a Modest Church, built in 1908.

Then, there is the sound system itself. The design of a church sound system is far more critical than the choice of speakers and equipment. Get the design right and modest equipment will do a great job. In most cases you can have to the best equipment in the world at any price and if you get the design of the sound system wrong, you will gain nothing except for hearing the problems in better fidelity.

Sound problems in a church come in layers.

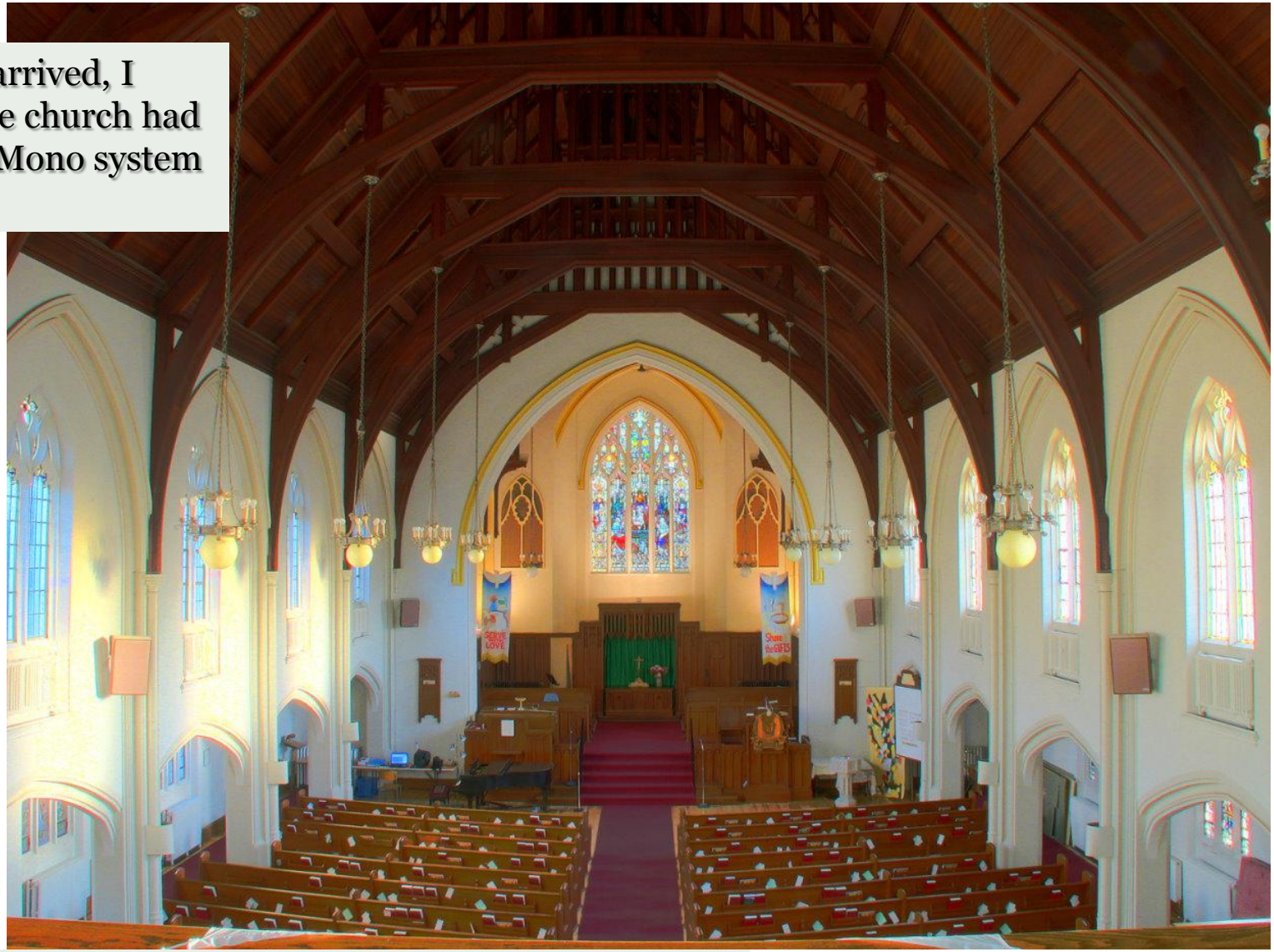
In the end, for a speech only system, even cheap equipment can meet the needs for people with hearing aids if the system is designed properly. That said, a properly designed sound system will limit the type of equipment you can use to meet your needs in a church. However, for each equipment type, there is a broad range of products to choose from in every budget category.

Sound problems in a church come in layers.

Getting Started

LOOKING AT THE WHOLE PICTURE

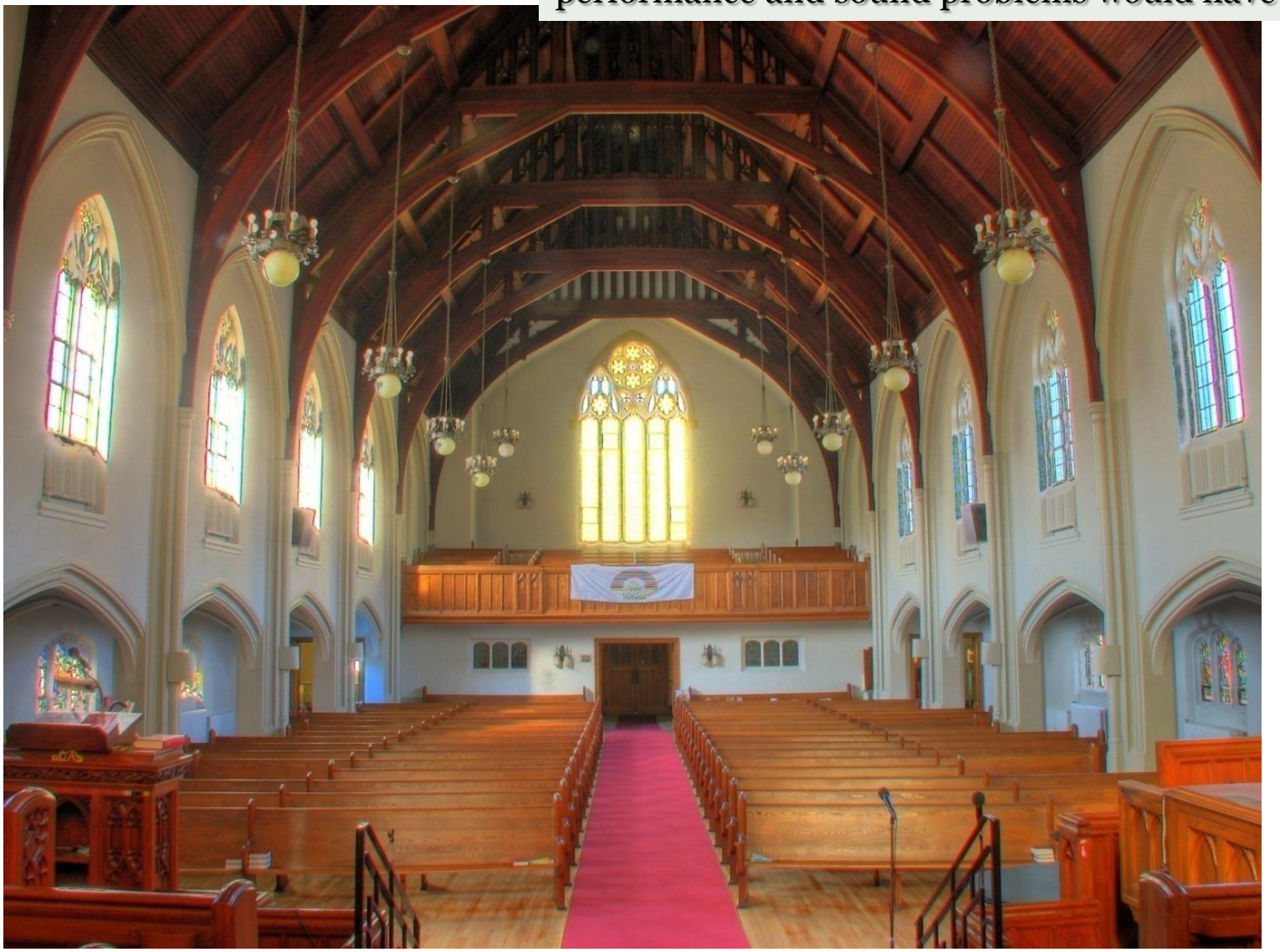
When I first arrived, I found that the church had a Left/Right Mono system up front.

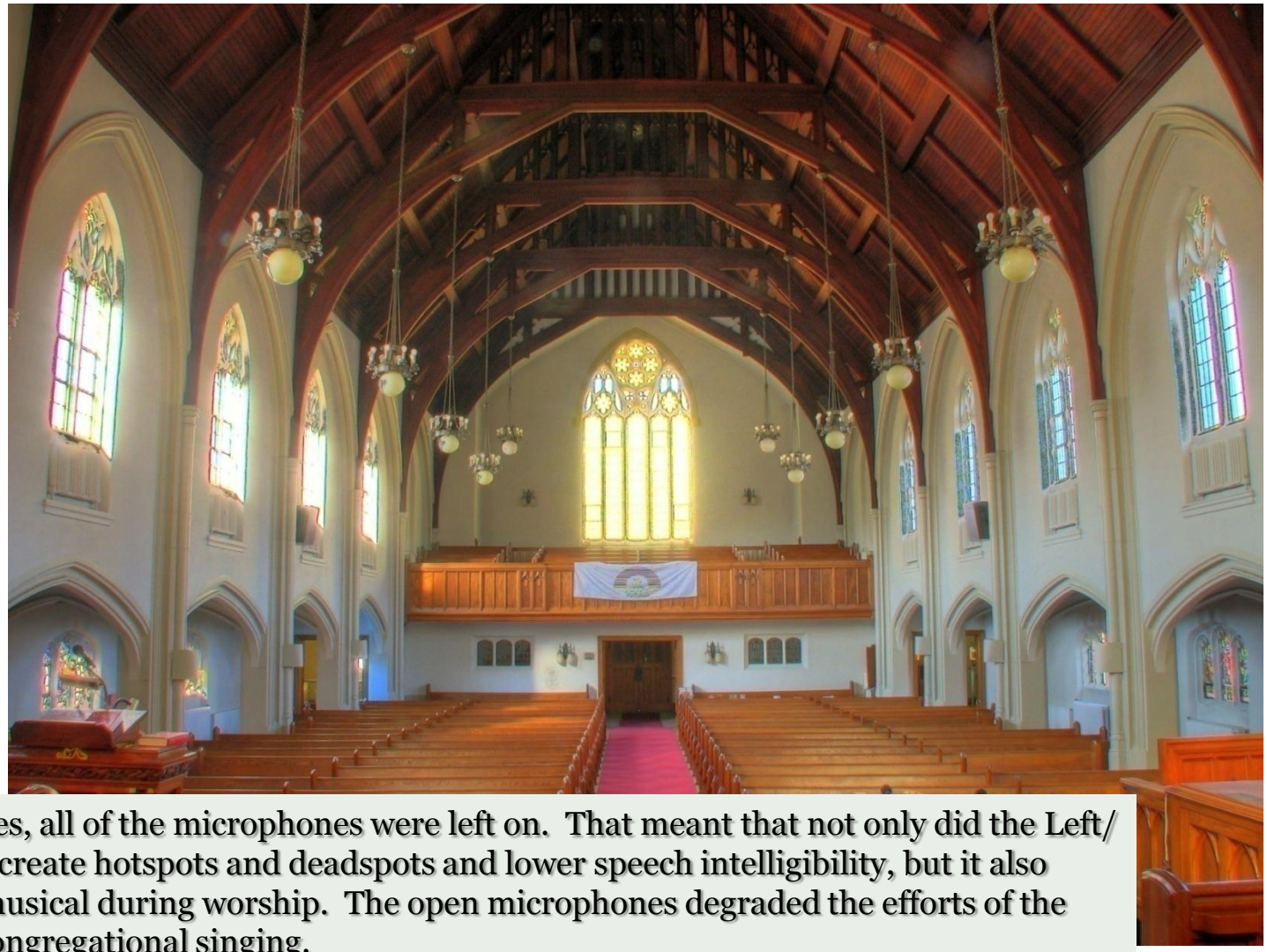


The system had a second set of speakers half way back. This was the 3rd system the church has owned over the years.

The Equipment Rack and mixer were at the front of the church behind the choir loft.

During worship services, there was no one to control the microphones. Even if they had an automated mixer, the performance and sound problems would have persisted.





During worship services, all of the microphones were left on. That meant that not only did the Left/ Right Speaker System create hotspots and deadspots and lower speech intelligibility, but it also degraded everything musical during worship. The open microphones degraded the efforts of the choir, the organ and congregational singing.

No one believed that the open mics were such a problem until it was suggested to do a worship system with the sound system off.

If your choir sounds great at rehearsal and poor during the worship service, it is most often because of the sound system, not the number of people filling the pews.

To compound the interference problems further, there was no delay on the second set of speakers. Adding a delay would have only meant that the number of deadspots and hotspots would be consistent to the same at the back as at the front. Again, this sound system was put together with the best of intentions.

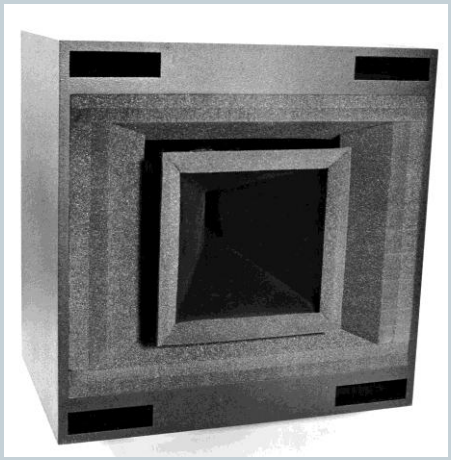
If you look closely, one of the most exciting details about the worship space is it bare flat walls. This room was a clean canvas to reveal the color of sound that this church had yet to experience since the church was first built.
While this room is slightly on the long side, most of the dimensions are within the ideal range of what a great recital hall or concert hall would be. As a result, just fixing the room for speech would also make it great for music and anything else the congregation would want from their church.

Many businesses hire consultants. Sometimes they don't take the consultants advice. This happens all too often in the church community especially when you give a prescription that seems hard to swallow.

A Church is more likely to make a huge investment into audio technology than spending money that will change the look of their worship space.

The problem is, a church this size can spend $50,000 .00 or $200,000.00 on a new sound system and have only a marginal improvement over what they had before. Instead, this church spent a whole lot less and improved everything.

Pop Quiz




Question:
Which of these mid priced high quality speakers will do better in a side by side – equal volume live oral speech test at 40 ft.?

Answer:
All of these speakers will be within +/-1% of each other. It would be fair to say they are all the same in speech intelligibility.

Which has the best fidelity? For most it comes down to person taste.

Upgrading loudspeakers without changing the design of a sound system to the right design for the room – regardless of the acoustical condition of the space often equals no performance gain other than better fidelity and loudness. Fidelity and loudness have nothing to do with your ability in understanding speech. The three most important features of a sound system design are:

1. intelligibility
2. sound coverage
3. system gain

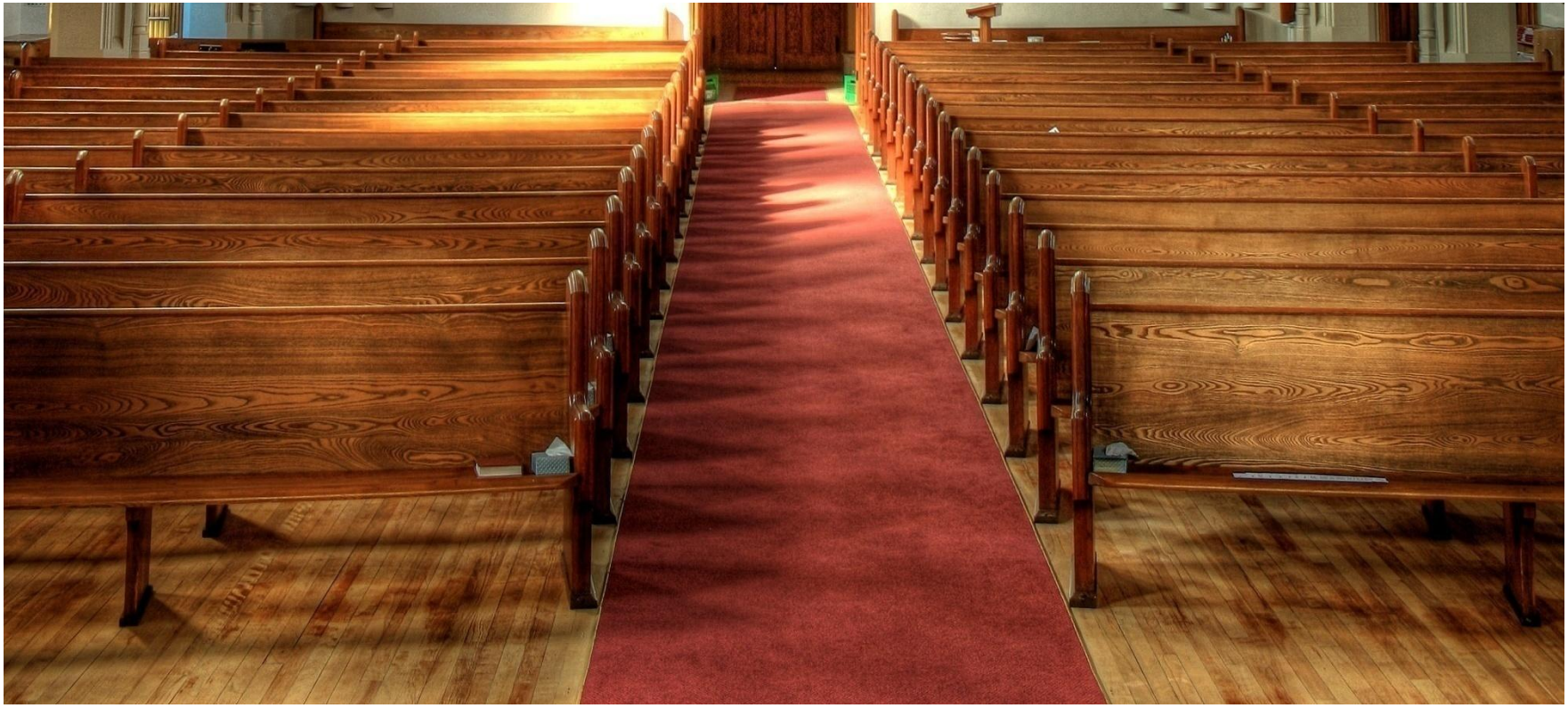
There are three main ways to control sound.

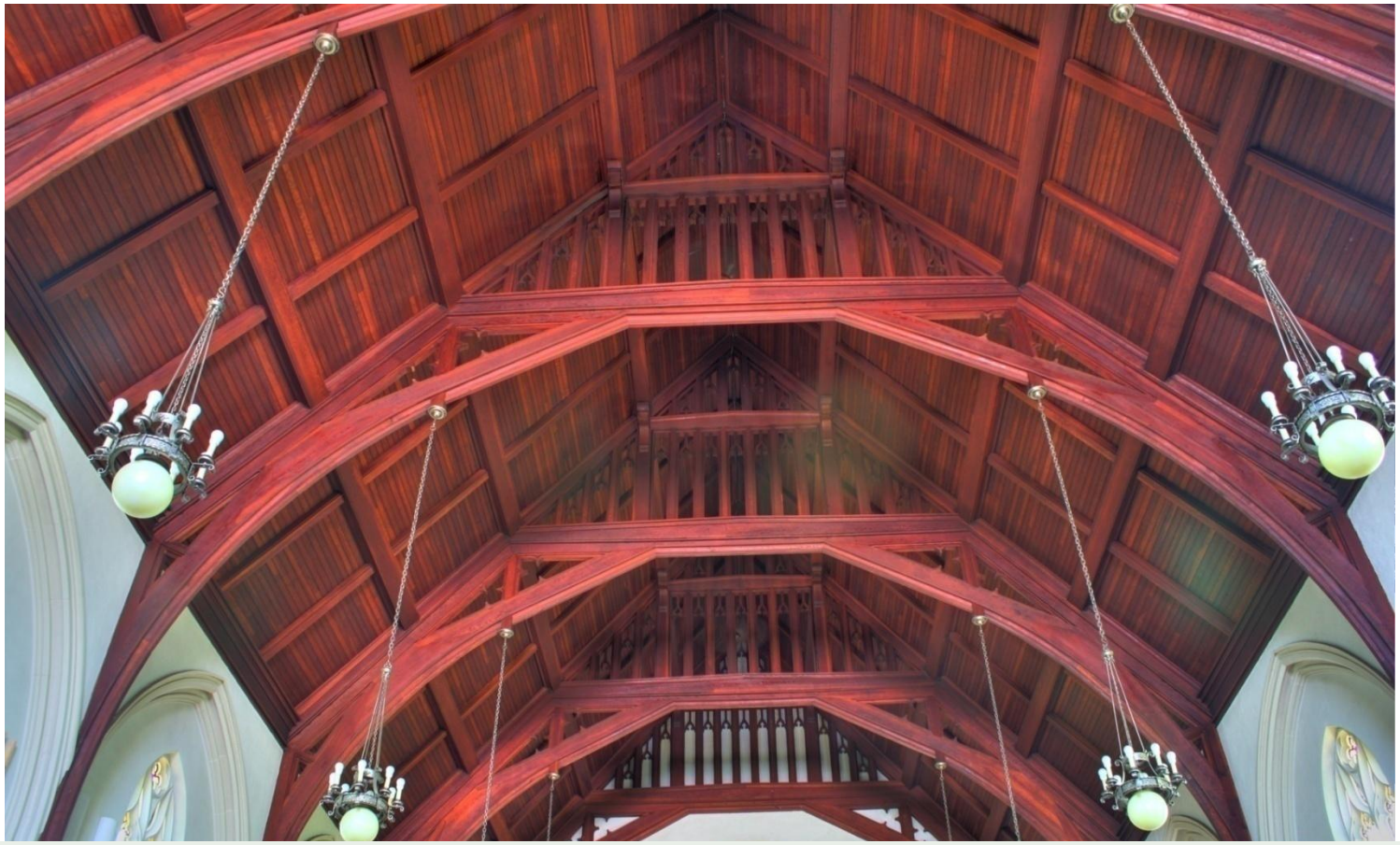
Absorption

Diffusion

Combination System

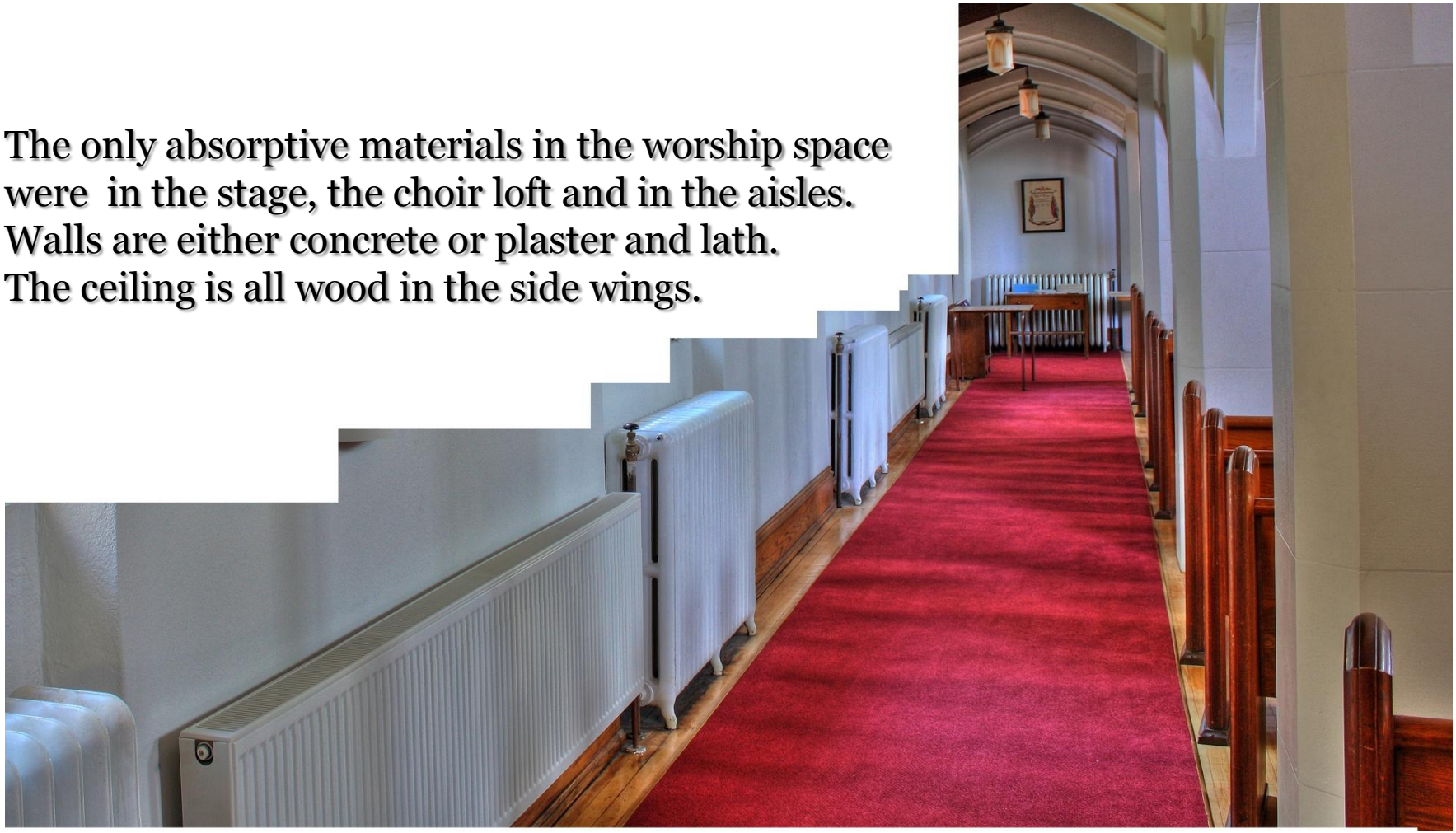
For this project a combination system would be needed. Part of what made that determination was how the space was finished. In this case, the bare floors and no seat padding meant the room would need some absorption, but not much.



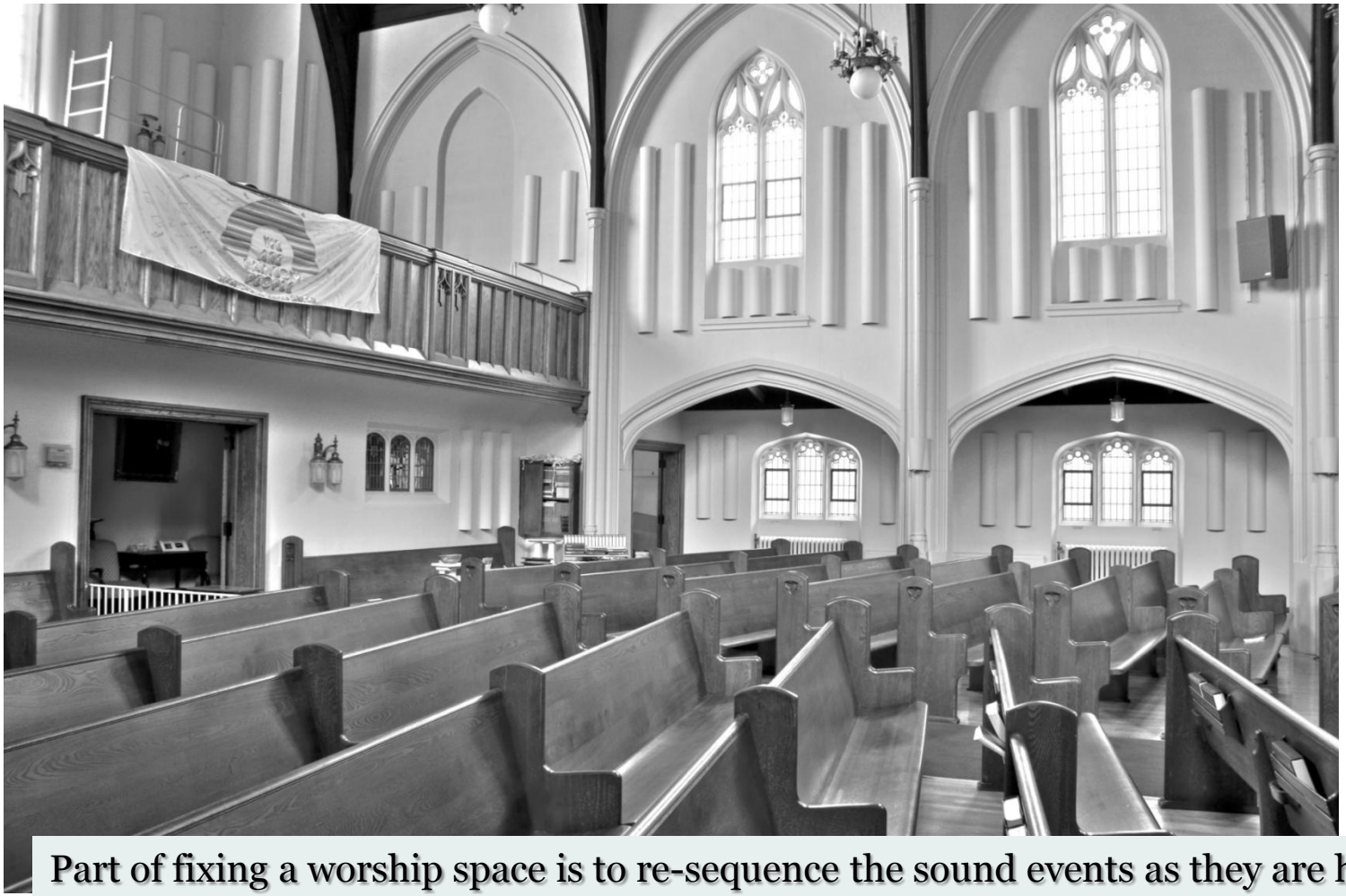


When starting a project like this, the hardest part of a church this high to assess to is the ceiling. As it turns out, when you have a ceiling like this, there is nothing you need to do except to enjoy what it is already doing for you. This ceiling works great. The more obstacles, the better. Sure, all of the other acoustical problems were preventing the ceiling from doing its job but that will soon change. By nature, Cathedral ceilings are natural bass traps. In this case the large windows nicely radiate the excess energy out of the room at the back of the church, although a round window would have been better.

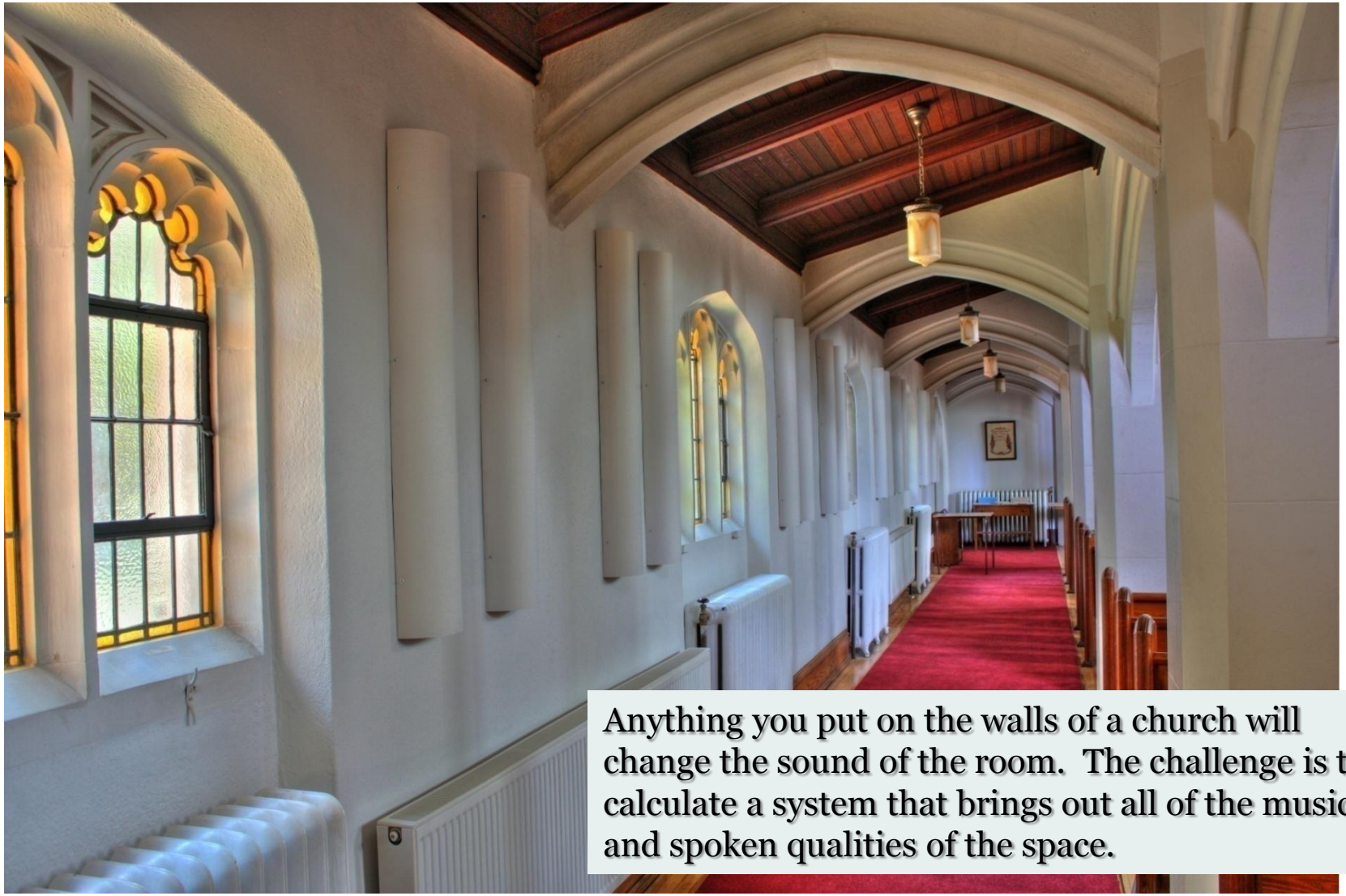
The only absorptive materials in the worship space were in the stage, the choir loft and in the aisles.
Walls are either concrete or plaster and lath.
The ceiling is all wood in the side wings.



This is how the church now looks after the acoustical change. Custom ordered barrel diffusers were used to provide the changes needed in this space. There are various sizes used. Each diffuser size and combination of placement targets specific acoustical events.

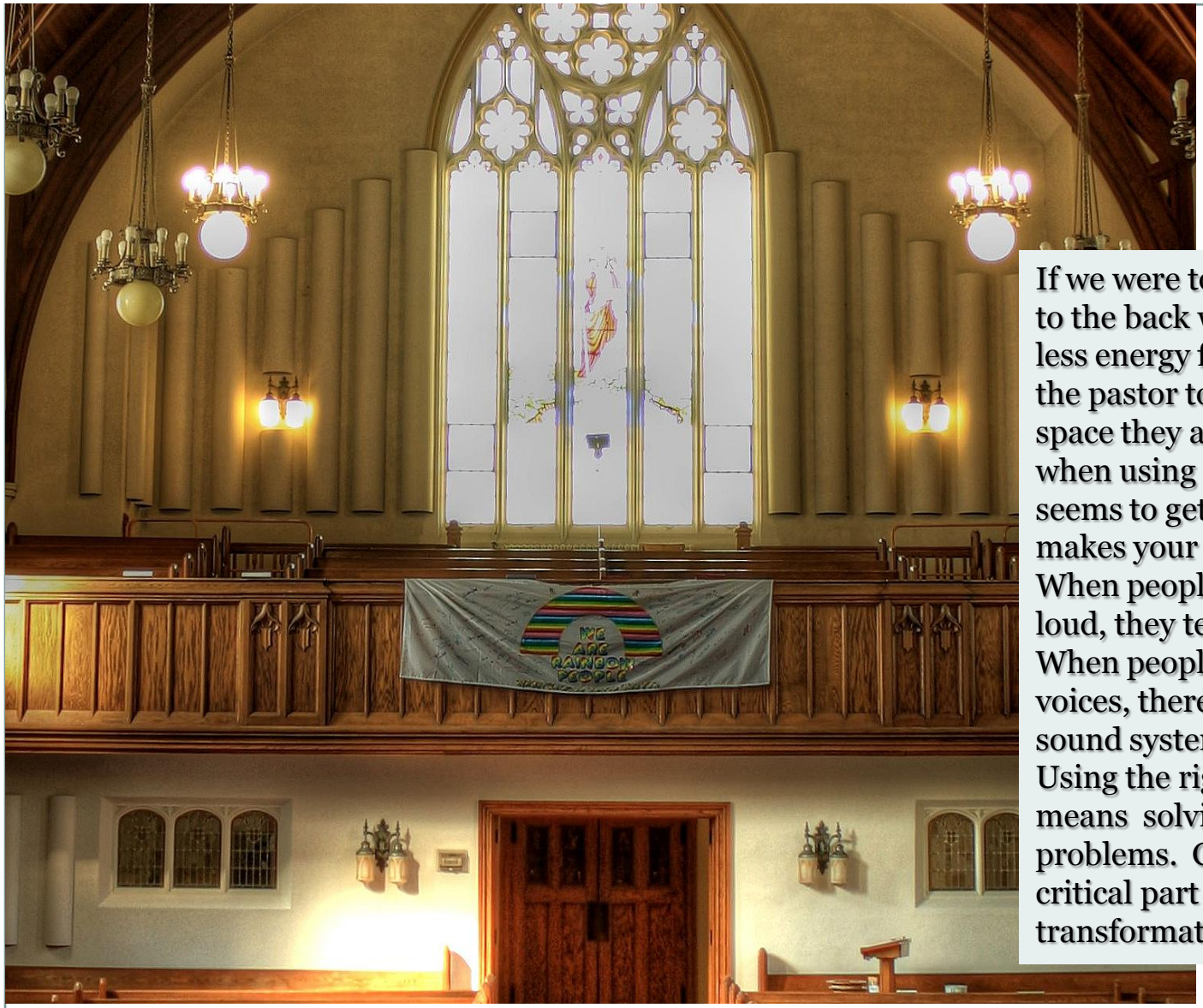


Part of fixing a worship space is to re-sequence the sound events as they are happening. This is needed for speech, music, congregational singing, the choir and the organ. Oh, this is also needed to get the most out of a church sound system too.
The patterns here looks symmetrical but it is not. The spacing between the diffusers change. Knowing the sizes and how much this spacing changes is the difference between creating new problems or achieving your goals.



Anything you put on the walls of a church will change the sound of the room. The challenge is to calculate a system that brings out all of the musical and spoken qualities of the space.

For this room the diffusers at the back helped speech, music, musicians, the organist, the pianist, the choir director and children performances.

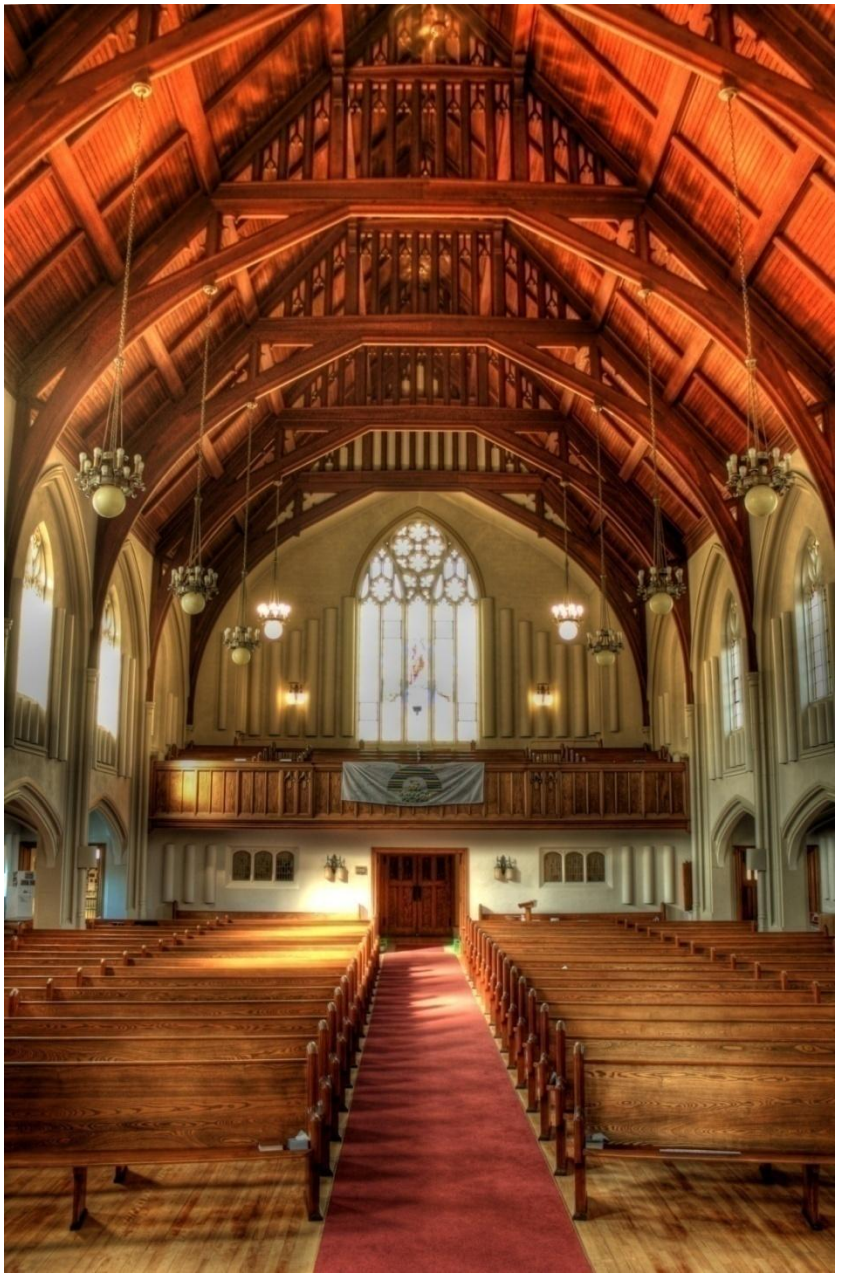


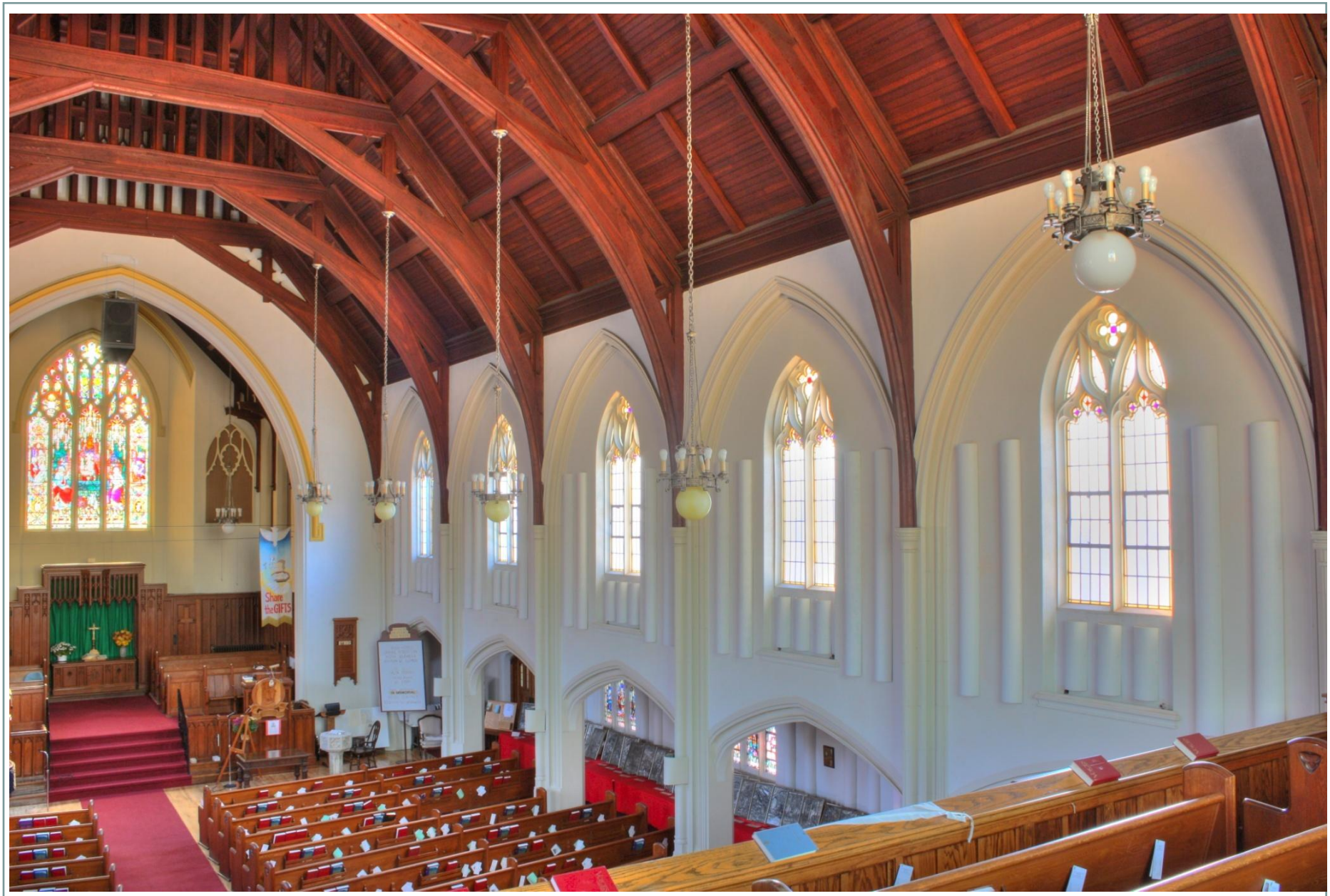
If we were to have applied absorption to the back wall, then there would be less energy for the performers and the pastor to better judge the size of space they are speaking into. Often when using absorbers, bass energy seems to get louder which in turn makes your voice seem louder. When people hear themselves too loud, they tend to lower their voices. When people are lowering their voices, there comes a point where the sound system can't do anything. Using the right acoustical treatments means solving other sound system problems. Good planning is another critical part to a successful church transformation.

Part of the layout of an acoustical plan is from using a map of the Energy Time Curve(ETC) reflections. These reflections are based on energy and frequency. This map can be created from on site measurements or from computer modeling. There is excellent correlation between the two methods.

There was some absorption added to the room. All of it is hidden. Yet where it is hidden, it is also the most effective.

By changing the path and energy levels of the offending frequencies, you create a unformed dispersion of sound throughout the room. This allows a person in the Balcony to understand the conversation of two people in the choir loft when the room is empty. An empty room is considered the worst condition for speech communication.





Each section of the side wall targets different frequencies and amount of sound diffusion.

The sound system for this worship space is lifted from the pages of human anatomy. The mechanics of the human communication system (human ear) is such that we are designed to look at what we hear.

With the ears on the sides of our head we can determine distance, location and even speed of an object such as a car that is moving towards or away from us. When sound arrives to both of our ears at the same time, there is no sense of direction except for whether the sound is behind or ahead of us. A single speaker or group of speakers centrally located over the stage causes us to look at what we are hearing – even when the pulpit is off to one side.

With a single sound source in the room, there is no chance to create deadspots or hotspots unless the acoustical treatment is not done. Without the acoustical treatment, the standing waves would create sound level changes throughout the room, and no sound system design can overcome such a room condition. Standing waves happening between parallel walls and when multiple walls can store energy in the central area of a room. All room shapes will have standing waves.

For this project a pair of Tannoy Speakers were used. Above is the new VQ100 full range speaker. Under the main box is the Tannoy VQ-DF speaker. This is the only speaker used for the 85 ft. from the speaker to the back wall.


TANNOY
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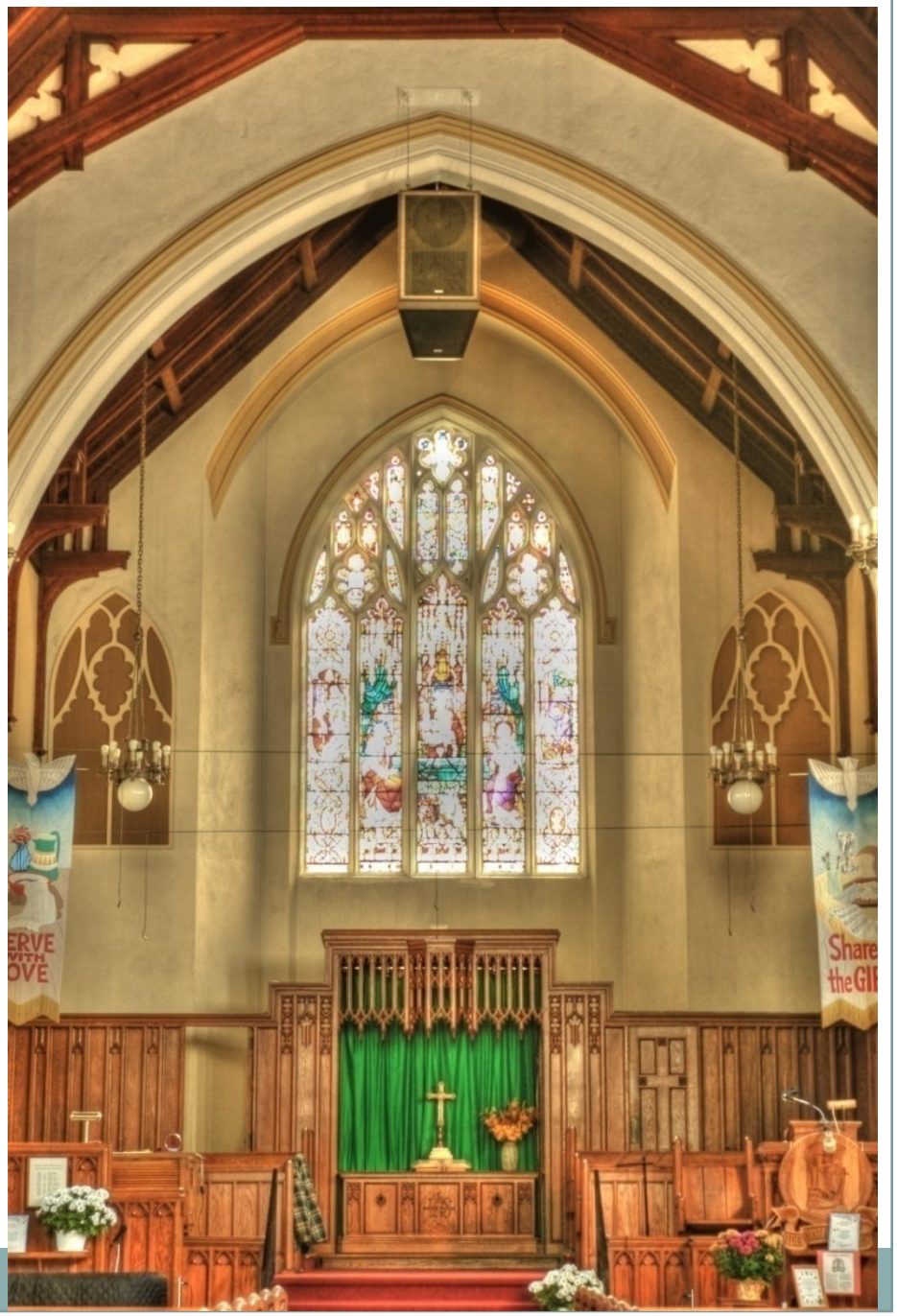
The sound level at the back of the sound system is down -4dB but the clarity more than makes up for the signal loss. The audio industry generally accepts a sound level coverage of +/-3dB. In those terms, this room is +/-4dB with or without the sound system turned on.

In this room, if the power is off, or if the microphone or wireless mic should fail, the minister should be able to carry on with a slightly raised voice and complete the sermon and the hearing conditions for people who can have normal conversations at 10 ft will not change. Sure, the volume will be lower but the clarity will be the same.



For this project, the churches full time custodian planned and installed the diffusers. He arranged for volunteer help. The cost of the room fix was less than $4,000.00.

Here are the numbers:

Speech Intelligibility at 40 ft changed from 74% to 94%.

The RT60 changed from 1.9 seconds to 1.5 seconds

The working distance for the lectern mic went for 6 inches to 32 inches with the room 40% occupied.
Cost of the sound system installed – Less than $25,000.

Many of the churches that have gone through such a transformation grow an average of 10 to 20% a year after such a change. Only time will tell if this transformation will have the same impact.

Consulting for the Acoustics and Sound System Design were provided by JdB Sound Acoustics

Sound System installed by Westbury International, Toronto, Ontario, Canada.