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The Sound System: An Electro-Acoustic Interactive System

The consulting process must include background information to help the church make good long-term decisions that will enhance the worship of the congregation. The audio system must work in a large acoustic space; the two interact with each other. Thus the church must have a basic understanding of both the sound system and the physics of sound in a room. This document will attempt to provide this understanding in layperson's terminology. We encourage you to contact us with any questions that arise as you study this document. Our desire is to do as much as possible to be a ministry of technical support to your ministry.

System Discussion

Any discussion of the church sound system should commence with a look at the task of the sound system. Simply stated, the sound system must provide enhancement to the worship of the congregation by making it easy for the listener to hear the spoken word and music. This may seem to be a given, however, we have heard many systems over the years that would be better left turned off instead of on!

To accomplish this task we have three major goals for the system.

1. ***High speech intelligibility*** (it should be easy to understand each spoken word)
2. ***Natural sounding speech reproduction*** (the pastor should sound through the system just like he does face to face)
3. ***High quality music reproduction*** (music should have a high fidelity quality of sound)

The most important of these goals is usually high speech intelligibility, because talking is a major part of all worship services. We want these attributes evident at every seat in the sanctuary.

Speech Intelligibility

Fundamental to the church sound system is the level of speech intelligibility it can achieve. A simple definition of speech intelligibility is; 'the ease with which the listener can understand the talker's spoken words'. (Did he say CAT or RAT?) It is critical to understand that increasing intelligibility is not simply a matter of turning up the volume, or adding two or three more speakers here or there. **Good intelligibility is realized when the ratio of direct sound to reverberant sound is high.** Direct sound is the sound that travels directly from the speaker to the listener's ear. Reverberant sound is the rest of the sound that reflects off of surfaces before reaching the ear. This is why it's easier to understand when the talker is 8 feet in front of the listener than when the talker is 65 feet away. The sound system should acoustically transport the listener from 65 feet to about 8 feet. Put another way,

the talker will sound like he or she is about 8 feet away, even when the listener is actually 65 feet away.

Many factors affect intelligibility; some of these are:

- Reverberation characteristics of the room
- Ambient noise levels in the room (HVAC, congregation noise, outside noise)
- Distance from speaker to listeners
- The directivity of the speaker system

In most churches we cannot or don't need to make any changes in the first two points. Note though that the more reverberant a room is, the more difficult it will be to achieve a high direct to reverberant sound ratio. Also, the higher the ambient noise level is, the louder the sound system will need to be operated. This means then that a high direct to reverberant ratio (D/R) must be the result of careful sound system design.

Before we can quantify how well a system works, we must be able to measure intelligibility. A traditional sound system measurement is the speaker frequency response. This is still important, because a speaker system that does not have a reasonable high frequency response cannot reproduce the consonants of speech (or the higher fidelity of music). The traditional means of measuring intelligibility involved a group of people listening to word lists and indicating the words they thought they heard. This is still a valid method, however as you can imagine it is rather awkward to perform! More recent studies and computer developments have made it possible to measure parameters affecting intelligibility with a computer controlled digital signal analyzer. We use the Techron TEF 20 analyzer, developed from groundbreaking studies by the late Richard Hyser at the Jet Propulsion Laboratory, California.

We primarily use the %ALCONS method of measuring intelligibility. This means the 'percent articulation loss of the consonants of speech' or 'how many consonants get lost between the speaker and your ears'. This is what I referred to earlier with the cat and the rat. If you do not hear the consonants properly, you will not pick up many of the words you hear.

The professionally accepted standard for good intelligibility is a maximum %ALCONS of 15%. However our experience is that some elderly folks will start to complain with only 10% loss. Therefore we aim for a maximum loss of no more than 10% depending upon the specific situation. Often we achieve 5% to 8%. We can provide objective measurements to show our installed system meets or exceeds what we predict. Having the ability to perform objective intelligibility measurements protects both you the client and us if problems arise.

System Tonal Quality And Music Reproduction

Earlier I stated that I want the pastor to sound through the sound system about the same as he does face to face. Note that the telephone is intelligible, however it is not completely natural sounding because it has a limited frequency bandwidth. Natural sound relates to the tonal quality of the system, and given the quality of today's equipment, has to do more with how the system is adjusted than with the actual components themselves. Tonal quality relates to intelligibility because a voice that has been artificially boosted in the low (bass) frequencies will not be as clear to those with moderate hearing losses as it will be to younger people who have not yet lost any hearing ability. We do not want to make the pastor sound like a radio disc jockey; we want him or her to be easy to listen to.

Many churches today have services that involve recorded music playback (accompaniment tapes for soloists), live music (praise and worship band or a small orchestra), or both. Research has shown that people listen to music with a different portion of the brain than we do speech. This is one reason why a sound system optimized for speech reinforcement will not be judged very good for music re-

production, and visa versa. With the aid of electronics we can have one system that will perform well for both functions; this is discuss this later when we get to the equalizer.

To provide good music reproduction the sound system must have adequate power amplification available, as music will often be played at relatively loud volumes, even at 'rock and roll' levels for youth services. It must also have a sufficiently wide frequency response so that the bass and the higher treble ends of the frequency spectrum are adequately reproduced. In some situations sub woofer cabinets will be required to achieve the low frequency levels desired. For churches that do not have contemporary bands but do use recorded music at moderate volumes, full range speaker units without sub woofers will be sufficient.

We often use the term 'hifi like music reproduction' to convey these ideas about music through the sound system. This is because many people can relate to good quality high fidelity speakers in their living room. Please note though that this is where the similarity between a church sound system and your living room stereo ends!

The sound system is comprised of three parts; the speaker system, the input devices, and the control center. All three parts are important to the overall success of the system, however the speaker portion is the single most important part. We will look at it first.

Speaker System

The speaker system must perform two functions. It must convert the electrical energy from the power amplifier into acoustic energy, that is, sound. Then it must disperse this energy where we wish it to be, which of course is the congregation seating area. There are many inexpensive speakers that will perform these functions; the difficult thing is to do them *accurately* and in a *controlled fashion*. This is what separates a good speaker from an average speaker. In the long term you will be much more satisfied with a good speaker than a poor or even average one. Some important aspects of speaker performance are as follows.

- **Frequency response;** Ideally the speaker will be flat from about 50 Hz to about 16 kHz. In reality, good speakers are somewhat less than ruler flat, but as long as they don't have any abrupt response changes or large dips/peaks they will work fine. Sub woofer cabinets can extend the bass response down to the 25 Hz to 35 Hz area for added low frequency reproduction with music.
- **Dispersion;** The speaker must disperse its produced frequency response in a smooth consistent manner throughout its rated dispersion angle. For example many speakers have a specification of 90 degrees horizontal by 45 degrees vertical. This ideally means that if you sit anywhere within the 90 degree horizontal angle of the speaker you will hear the same volume at all frequencies. In reality there is usually a 6 dB tolerance, +/- 3 dB, which is acceptable. This phenomenon makes itself audible by the speaker producing its rated response directly in front of the speaker, but when you get off axis the high frequency volume falls off. This indicates poor dispersion control at high frequencies and is a characteristic of a poor speaker. Note that even very expensive well-engineered speakers will exhibit this problem to a limited extent. Also note that contrary to what some sound people think, you cannot compensate for poor dispersion with an equalizer.
- **Power Handling;** A speaker can fail from having too much power applied to it; the voice coil will overheat and burn out. You can also destroy a voice coil even when the applied power is within the handling capacity of the speaker; when the applied signal is significantly distorted. A good speaker will have an average, continuous, or RMS (root mean squared, a mathemati-

cal calculation) rating, and a peak rating. The continuous rating is the approximate power that can be applied over a long time period. The peak rating is the maximum power that can be safely applied for a very short time period, typically a few milliseconds. This would be the situation when fast signal peaks happen.

- **Mechanical Integrity;** You can also damage a speaker mechanically. For example, someone blowing on a microphone or dropping a mic on a hard floor will produce a signal with large amplitude (volume) at low frequencies. This will cause the woofer cone to travel to, and sometimes beyond, the limits of its excursion. This can result in woofer cone damage, or breaking of the voice coil leads.
- **Phase Response;** You may sometimes hear about the phase response of a speaker or speaker system. This is a difficult thing to understand, and we won't go into details here. Note though that ideally a speaker system will have a consistent smooth phase response. Phase is in a sense the other side of the frequency response coin, so if the frequency response is smooth, the phase response will also be smooth.
- **Driver Alignment;** Related to phase response is the time alignment of the speaker system. This refers to the frequency response of the speaker reaching your ear in the same phase relationship as it left the speaker. One of the big engineering efforts in the past few years has been in the time alignment of speakers, and we agree an aligned unit is more desirable, theoretically, than an unaligned unit. However, there is some disagreement as to how critical the alignment must be.

The design of the speaker system depends upon several factors;

- The shape and size of the sanctuary.
- The reverberation of the sanctuary.
- The sound system design goals that apply to your particular church (speech only; general music and speech; high level music and speech).
- The available budget

When we visit a church we measure the physical dimensions of the sanctuary and seating area, and take a reverberation measurement. We use these measurements in our computer design programs to determine what speaker system is most appropriate for your situation. We stated earlier that in most churches, a high direct to reverberant sound ratio must be the result of careful system design. The speaker system employed has the greatest impact on this high D/R ratio. Therefore, we will not use a speaker with little directivity control in a sanctuary that is large and reverberant, for it would disperse too much sound onto wall and ceiling surfaces, thereby, adding to the reverberant sound. We would also not use a highly directive speaker in a situation that called for a wide angle short throw speaker, as many of the listeners would be outside the coverage of the speaker. Our design programs assist us greatly in determining the most appropriate speaker to use, and in predicting the result that would be obtained.

In a speech only application in a reverberant room it is often most desirable to use a combination of high frequency horns with a bass speaker to provide a suitable direct to reverberant sound ratio. The horns operate from either 500 Hz or 800 Hz up depending on the driver employed, providing a high degree of directivity control, directing sound only to the areas required and keeping sound off of other areas such as ceiling and wall surfaces.

In general music and speech applications, such as is required in many newer small to medium sized sanctuaries, a full range speaker or speakers can provide a suitable directivity level.

Regardless of what type of speaker system is employed, we draw your attention once again to the importance of its *control* and *evenness of dispersion*. Remember we want everyone in the congregation to hear the rated response of the speaker system, not just those sitting in the center of the speaker's dispersion pattern.

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FOR HORIZON AUDIO SERVICES LTD

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Speaker Location

While a good quality speaker is important, critical to the success of the sound system is where the speaker(s) is located in the room. Usually, the best location is overhead up at or near the ceiling just in front of the pulpit area. This location offers a number of advantages, including;

- Excellent localization
- Ability to achieve a very even volume coverage from front to rear of seating area
- Eliminates destructive interference that results from multiple speaker locations
- Minimizes rear wall reflections travelling directly back to the platform

The physics involved in an overhead speaker system design is taught in many of today's electro acoustic textbooks.

Stereo? As music becomes increasingly prominent in more churches the question of having a stereo sound system comes up more often. This is partly because most of us have stereos in our homes, and because most electronic instruments today have stereo outputs. We are not opposed to a stereo sound system in the church when appropriate, however lay people must understand that in most churches a true stereo system is not feasible. In the living room one hears true stereo only when the listener is approximately equidistant from the speakers. In the sanctuary relatively few worshipers will be in this area. In fact in many churches the best location for a stereo effect will be the center aisle! Another reason most churches should not consider a stereo system is the cost: it requires double the speaker system; double the electronics; and considerably more installation and system set up time. Note it is not a question of fidelity; a central cluster (mono) system can sound just as hifi as a stereo system. We can virtually guarantee that no one greeting the pastor after a service will say they would have received more blessings if the sound system had been in stereo!

Another reason to have a central cluster speaker system, especially for speech only applications, is the fact that the human voice is not stereo, but mono. Speech is more intelligible through a central overhead system than through a stereo or split mono system. An important aspect of speech reinforcement is localization; the voice appears to be coming directly from the talker rather than the speaker system (the sound system draws your attention to the talker as opposed to the speaker). A stereo or split mono system cannot do this.

In situations where your church is still on the drawing board stage, you may wish to have the architect design the sanctuary such that it can support (now or in the future) what is referred to as an L-C-R system; a left center right system. This is the preferred type of system in many concert and performing arts halls. In this type of system music is reproduced through the left and right speaker systems, while voice comes through the center speaker. This type of system requires, among other features, a specialized mixer that has three main outputs instead of two to facilitate L-C-R panning. Note that Horizon Audio can provide sanctuary acoustic design consulting to your building committee and architect.

Monitor Speakers

Another speaker system is the monitor system. This system consists of either sloped-front floor monitor speakers, mini or floor powered speakers, or a combination of both. The monitor is used by musicians to monitor themselves and other musicians. Singers using accompaniment tapes or CDs also use a monitor. Monitors are vital to musicians! Floor monitor speakers come in a wide range of prices, and it is often tempting to go for a cheap unit, as only a few people use it. However, those few people are carrying out an important task in the church. We know from experiences as musicians that a good monitor can be a great help.

The issue of evenness of sound dispersion is particularly important with monitors because the users are usually very close to them. More than any other, this is the characteristic that improves as the price goes up. Our experience is that about \$500.00 is the minimum where you can begin to realize all around long term good value in a monitor. Intermediate quality models can cost up to about \$900.00. We don't sell very many at this price, however, the churches that have purchased them would never go back to less expensive models.

Powered monitors contain their own power amplifier, therefore, can be fed directly from an auxiliary output of the mixing console. These units are useful for giving a drummer or keyboard player their own individual monitor mix. Mini powered units are small enough to sit on the top of a keyboard or a microphone stand.

Some powered mini monitors are good not only for monitoring purposes, but because they have an XLR balanced input, can supply phantom power to a condenser microphone; it can be used in a small room as a mini self contained sound system. Plug in a mic and start talking! It works well for seniors meetings in small rooms.

This concludes our discussion on the speaker system.

System Input Devices

The second most important part of the sound system is what we call the system input devices. An input device is anything you plug into the sound system that produces a signal. The most common input device is the microphone, and the most important microphone is usually the pulpit or lectern mic, although today the wireless lavalier system often gets used more than the pulpit mic. The microphone is essentially the opposite of the speaker. The mic picks up acoustic energy - sound - and converts it to electrical energy. The mic has a pick up pattern that can be thought of as the opposite of the speaker's dispersion pattern. As with speakers, mics can be tailored in their application by good design and careful manufacturing, but this means the good mic will not be the lowest priced unit.

The pulpit/lectern mic must exhibit special qualities because it is often spoken to from a distance of 12" to 20" with a normal volume talker. Today, we have condenser type models designed specifically for pulpit or lectern use, featuring a long working distance, high sensitivity, low noise, and slim design. The word 'condenser' refers to the means by which the microphone converts sound to an electrical signal voltage.

Most major microphone manufacturers, such as Electro-Voice, Audio Technica and Shure, offer this type of microphone. They should be installed with shock mount devices to mechanically isolate the microphone from the lectern. Provided other aspects of the sound system performance are reasonable, these mics will allow good results up to 24" from the mic. Of course the system will only reproduce what one puts into it, so if the talker is soft spoken, you will not get this much working distance. Typically, we can get good gain before feedback with working distances of 12" to 20" with the

average speaking pastor. Note that you will not get these results using the typical good quality vocal mic on a pulpit.

Another important microphone is the vocal or solo mic. Used by soloists and worship team singers, this type of microphone can be hand held or stand mounted, and should be used closer to the mouth, as it is designed to be less sensitive, therefore, able to handle higher sound levels. This type of microphone is called a 'dynamic', and does not have as long a working distance as a condenser type mic.

Other types of microphones include instrument condenser and miniature suspension condenser units. Because of the condenser's high sensitivity it is very effective in picking up small groups such as a chorus or drama actors on stage, etc. Instrument condensers are also good for pick up of the piano, acoustic guitar, flute and so on.

The miniature suspension model is a special condenser that can suspend via a very fine cable in front of the choir. Although rather expensive, the advantages of a suspension model include the ability to locate it in an ideal location for good pickup, the fact that it is always in position and ready to use, and the small size, which makes it almost unnoticeable. Most suspension models are available in black or white. Some churches use these units for recording only purposes, and will often have one looking back at the congregation as well as the choir.

Wireless Microphone Systems; Another input device is the wireless microphone system. These units have become very popular in recent years because of the freedom of movement they permit. More and more churches are also using them for drama presentations. There is a wide range of wireless available today. Even today's cheap systems are far better than expensive systems were 15 years ago. The difference in price today is reflected in the quality of the radio frequency transmission and reception chain, and the frequency band it works in. Up until recently most systems were in the VHF band from 174 to 215 MHz. This is the band occupied by television channels 7 to 13. Because no area has two adjacent TV stations, we are always safe in using a vacant channel for our wireless. This holds true until you get into the metropolitan areas, where there is so much RF activity in commercial bands that intermodulation of various frequencies together begin to cause problems in the VHF band. This is where the quality of a system begins to show its stuff! A more expensive system will have a receiver that is more highly selective (sensitive to its own transmitter), quieter, and so on.

We are in the middle of a general migration of wireless into the UHF band today. Systems using the 650 to 750 MHz area are becoming cost effective now. This is part of the spectrum used by commercial UHF television stations. The UHF band generally does not contain nearly as much man made RF noise as the VHF band. A feature of many of these systems is that they are programmable. A system can be tuned by the user to any of as many as 100 channels in a portion of the band. This allows the system to be tuned away from someone else's wireless, or from localized interference. The range the 100 channels covers may not always be wide enough to get away from general interference, however, this feature is very handy, and we recommend programmable UHF systems be purchased by all who are purchasing for the longer term. These systems are in the \$1,500.00 to \$2,500.00 range.

One other factor to consider in multi wireless systems is the antennae. Each receiver has two antennae; four systems, therefore, would sport a cluster of 8 antennae, or as we sometimes say, the antenna farm. When three or more systems are in regular use we recommend consideration be given to an antenna distribution unit, where two antennae will service four or up to eight receivers depending on the brand and model. A distribution unit can cost almost as much as a wireless system, but it allows the antenna to be installed on a wall or somewhere up high and out of the way, and also allows your receivers to be installed together in the cabinet where the operator can see them and they don't have to be spaced out to allow room for multiple antennae. We should also note that when several antennae are in close proximity to each other they would not exhibit the same omni directional reception pattern they do when alone.

A wireless microphone system can be easily added any time. We also find that they are a good donation item for an individual church member to donate. It's something they can recognize as a package and take 'ownership' in, rather than thinking 'I donated half a speaker'! This also holds true for items such as vocal microphones, tape/CD decks, and wireless hearing enhancement systems.

Another input device is the cassette deck when used for playback; of course it can record from the system as well. Many churches are now including Compact Disc players in their sound systems. Consumer decks can be interfaced with the sound system, but often are not as rugged as professional A/V decks from companies such as Marantz, Denon or Tascam. These companies also offer a combination deck; a unit that contains one tape deck and one CD player in a single chassis.

The last input device we will discuss is the direct injection unit, a small box that can interface a variety of devices into the system. Such devices include electronic keyboard, guitar, audio output of a VCR or film projector, and so on.

This concludes the discussion on system input devices.

System Control Center

The third part of the system is the control center, the heart of the system. It has three parts; the mixer, the equalizer, and the power amplifier. Economy or portable systems will often feature combination mixer/equalizer/amplifiers, however, in permanent systems separate components are necessary for long-term good performance. We usually do not recommend commercial mixer/amplifiers for church use, as they offer only limited flexibility.

Mixer

The mixer is the unit that accepts the various input signals from the microphones etc. and mixes them into one or more output signals. These signals are available as line level outputs to feed the main speaker system via the equalizer and amplifier sections, a tape deck for recording, and other processing equipment.

The mixer portion should exhibit good performance in at least two key areas; voltage gain and signal to noise ratio. If voltage gain is poor, you will find yourself in the situation where the mixer is turned up near full and you still can't get enough volume. This happens specifically when a soft talking person wants to have the microphone a long distance from their mouth. People not used to speaking in front of a congregation tend to do this. (This is one reason why we use a very sensitive microphone on a lectern.) If signal to noise ratio is poor, you will hear the mixer noise as a constant hiss from the speakers, especially when the mixer is set to high gain settings.

It is important and sometimes critical that the mixer exhibit good RFI (radio frequency interference) rejection capability, which is usually but not always a function of price. If your church happens to be in an area of high radio frequency field strengths, this can sometimes cause interference in the sound system. There are numerous actions that can be taken to minimize or eliminate RF, however, it is usually best in the long term if the offending equipment is upgraded to a better quality model, which will also give you better performance in other areas as well.

There is a wide range of mixers available, starting with small 6 or 8 mic inputs plus 2 line input economy models, to 12 and 16 input economy models, to 12 to 32 input intermediate class models, and even higher. For most churches, prices range from about \$850.00 up to about \$3,500.00 (for the intermediate class 24 channel model). Good manufacturers include Soundcraft with their Spirit Folio and Live lines, Allen & Heath with their MixWizard and GL series lines, and Crest. We will recommend models that offer the best combination of features, performance, price and value for your particular situation.

Equalization

The second part of the control center is the equalizer. This is perhaps the most widely misunderstood part of the entire sound system. It is critical to the success of the entire sound system that equalizers are of either the 1/3 octave or even better, the parametric type. Our experience has shown that octave or 2/3 octave units do not provide precise enough control of feedback etc. to be of appropriate benefit to the church sound system. In our own work in providing temporary systems for events we will use parametric equalizers, which have controls allowing us to zero right in on an offending frequency and control the bandwidth of each band. However, most churches do not have sufficient budget to include a parametric unit in the system. Therefore, we generally use 1/3 octave graphic units, except when the digital models are chosen.

We recommend two types of units. The first is what I call the traditional manual type of unit. Essentially it has a mini slider volume control (fader) for each band. These units come in a variety of price classes, however, we usually only use economy and middle of the road quality manual units. Note that the equalization curve we end up with on a manual unit must be a compromise between the various uses of the sound system. This is not a great problem in a speech only system unless there are significant differences between the pulpit mic and the wireless mic. In music/speech systems we recommend manual equalizers only if the budget is tight.

Sony, Electro-Voice and Yamaha offer single and dual channel one-third octave economy units. Ashly's MQX series are better intermediate quality models.

The second type of equalizer is the digital processing type. An excellent example of this is the Ashly Protea series, which offer several advantages over traditional manual equalizers.

- v ***Multi memory capability;*** many memory settings can be stored and recalled. A simple rotary switch can provide up to 10 selections. This allows us to tailor each memory for a specific system use. Memory #1 will optimize the system equalization for the pastor with the wireless lavalier mic, adjusting for specific feedback frequencies and pastor's tonal qualities. Memory #2 will do the same for the pulpit microphone. Memory #3 optimizes the system for recorded music; someone singing with accompaniment tapes or CDs. Memory #4 will adjust the system for live music; the worship and praise band. Other memories can be set up for other functions. This is a powerful tool for the system operator, yet very simple to use once set up.
- v ***Precise Parametric equalization;*** traditional manual units are called graphic equalizers. Their filter bands have a fixed frequency (on one third octave centers) and a fixed filter width, called the Q of the filter. The only thing that can be adjusted is the boost or cut amount of the filter (amplitude). Parametric equalizers provide user control of all three functions, thus allowing the skilled technician much more precise control of the sound. Ashly Protea models provide 12 parametric bands per channel for a powerful equalization tool.
- v ***Other Built In Functions;*** these models also include a compression/limiting circuit on both the inputs and the outputs of each channel. These can be adjusted to provide moderate compression of the signal, or serious limiting to provide protection from overdriving of the system.
- v ***Digital Economy;*** these units, given all the functions they perform, are considerably less expensive than what you would pay if one tried to do all these functions with separate pieces of analogue equipment. Digital models are available in two or four channel versions. The two-channel version costs only about 50% more than a two-channel intermediate quality analogue model. Note that many sound contractors shy away from using parametric equalizers because they are difficult to adjust. It requires a skilled technician using sophisticated analyzers to obtain a precise set up. If a company attempts to turn you away from parametric units, you should carefully evaluate exactly how competent that company really is.

In economy systems where we use powered mixers we will usually include one single channel manual equalizer to patch into the mixer amplifier so we can still achieve good system equalization.

Amplification

The final portion of the control center is the amplification function. Often the first question we hear asks how much power is in the amplifier. In reality, amplifier power is not that important. (Speaker sensitivity is more important.) Most good amplifiers have more than enough power to serve the typical church system. The smallest unit we generally use can deliver about 140 watts into an 8-ohm load over the entire audio spectrum with no more than .1% total harmonic distortion. Don't be fooled by companies who claim their amplifier can produce several hundred watts without providing the conditions on the specification.

Amplifier power is not the only consideration. As you may guess, one can purchase an economy two-channel unit for well under \$1,000.00 or pay as much as about \$2,000.00 for the same power output. What you get as price goes up is heavier duty physical construction; built in protection circuits (to guard against short circuits, high temperature, highly inductive speaker loads, over driving the input, and so on); greater headroom; ability to work into very low impedance loads; greater reliability; easier servicing; and better sound. For church systems, we recommend economy and intermediate priced units. Going to expensive professional models will not translate into better hearing for your congregation.

Telex Communications with their Electro-Voice brand line, offer a couple moderately priced good quality models. QSC and Crest are other manufacturers with extensive model line-ups.

Other Considerations

We have discussed all three portions of the electro-acoustic system, but even if you have a system that is well engineered, comprising good quality equipment, if it is not installed and set up properly you will still have problems.

Control Center Location

We recommend the control center be located somewhere at the rear of the sanctuary. Ideally, we suggest on the main floor, but sometimes a balcony location is more desirable. The goal here is that the operator be able to hear what the rest of the congregation is hearing and thus be able to accurately adjust the sound without disturbing the congregation worship.

Often we recommend a custom-made wood finished furniture grade cabinet. Other times a raised booth is constructed with half walls and long countertop inside. Whether a cabinet or booth is used is often determined by what type of worship service you have and its style of music. More contemporary churches will more often use a booth that will accommodate two or more people. Remember when sizing a cabinet or booth to allow space for a larger mixer in the future, a computer for the video data projection display, and the possibility of a lighting console.

Warranties

It is important to consider the warranties offered by manufacturers and the contractor when evaluating prices and services offered. Many professional manufacturers are moving toward longer warranties. Eastern Acoustic Works, for example, offers at least five years on all their professional speakers. Music store lines tend to have shorter warranties.

Ensure your chosen contractor offers serious back up support. In our installations we guarantee that if your system breaks down and is not usable, provided you inform us by noon of the Thursday, we will have the system up and running for the Sunday morning service. We provide no charge loan

equipment and no charge for the service call if the defective item is still under the manufacturer's warranty time period. We recommend that churches think long term; saving a few dollars now on equipment could easily cost you much more in service charges later on.

Installation

A well-crafted installation will not only present a high quality appearance, but will save you money in the long term when servicing is required. Part of a good installation is proper documentation showing installed equipment, serial numbers, manufacturer's manuals, and system block and wiring diagrams. Be sure this is not overlooked. We occasionally see that one way a cut-rate contractor can provide a lower price than a professional is in performing a sub standard installation.

System Set Up

We cannot emphasize too much the value in a carefully equalized audio system. It can make an average sounding system sparkle with improved intelligibility and music quality. One secret with equalization adjustment is patience; the technician must not be in a hurry! In systems employing one-third octave graphic equalizers a real time analyzer with minimum 1/3 octave display is a necessity. In fact, a 1/6 or 1/12 octave analyzer is even more helpful. If the system employs digital parametric equalization the technician must have a higher knowledge and experience level and a computer based digital signal analyzer for best results. Even more patience and time is necessary for parametric units, but the results are worth the wait.

Conclusion

We hope this document will prove very helpful as you plan for your sound system improvement project. We cannot over emphasize the value in thinking long term. Having been in the church sound system business for almost 20 years we have seen churches that, as we put it, are afflicted with 'lowest price syndrome'. This most often means the church saves money in the short term, but spends more in the long term, often having to endure sub standard performance in the mean time.

We at Horizon Audio will be pleased to consult with you further, and if you wish, to provide you with a high quality audio system when you are ready to proceed. May the Lord bless you in your efforts!