How Does Good Sound Work?

By Douglas Jones

The message is important. But is the message getting across? In this first of three articles a sound expert helps you understand what helps and what hinders in terms of sound systems that reproduce accurate sound

It is interesting that the question of "what does quality sound like" should be asked at all. For one reason or another, relatively few people feel that they are able to identify quality sound.

This is often a dilemma for those of us in the sound system design field. On the one hand, we feel that churches clearly need quality sound systems. On the other hand, few people feel that they are able to tell what a quality sound system is. There are also quite a number of people who aren't sure that a quality sound system is really needed. After all, the telephone—a pretty low quality sound system (no offense to the phone company) —is successfully used every day.

Are these high priced consultants, designers, and sales people just trying to sell high-priced technology and hardware that really is not needed, to people who can't/won't appreciate it anyway? Well, in some cases, yes. In most cases, however, a system that is considerably better than the telephone is warranted. The church needs to be sure that the tools it is using to get the message across are not interfering with the message. What this means of course is that churches must have "high quality" sound systems and "good acoustics."

HOW OUR HEARING WORKS

Our job is made easier as more and more people learn to use their ears and are critical about sound. One way to begin to discriminate between good and bad sound is to develop some appreciation for the wonderful sense of hearing. Before we get into the question of quality sound, let's review how the auditory system works

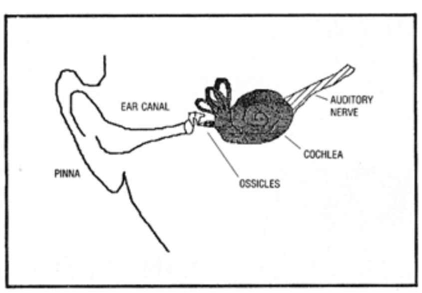


figure 1.

Sound Travels in Three Stages

The ear can basically be divided into three stages that correspond to the three physical structures comprising the mechanical part of the auditory system. (See Fig.1 and 2.)

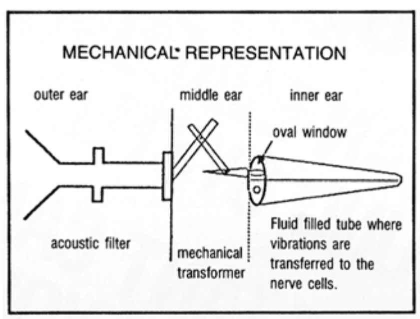


figure 2.

The Outer Ear. As sound enters the ear, the first thing it encounters in the outer ear is the *pinna.* The pinna is a most remarkable thing. Try this experiment. Close your eyes and with your arm outstretched in front of you, snap your fingers directly in front of you. Then swing your arm up over your head, snapping your fingers as you do it. Can you hear the sound of your snapping fingers move up in the air? Can you tell where the sound is coming from? The reason that you can is mostly because of the pinna! The pinna is actually a filter that superimposes a position-dependent "cue" on the incoming sound, a sort of unique signature for each position in space. The brain decodes this cue, and as a result you are able to tell with a great degree of accuracy where the sound is coming from.

The Middle Ear. Next the sound enters the *ear canal.* This is a tube that guides the sound and directs it to the middle ear, ending at the *eardrum* or tympanic membrane. On the other side of the eardrum are three tiny bones, the *ossicles,* They transport the vibrations from the eardrum to the oval window in the inner ear.

The eardrum and the ossicles form a very sophisticated transformer whose job is to transfer the energy of the moving air molecules to movement within a fluid. To get some appreciation for this task, imagine being in a swimming pool under water with someone standing on the side trying to talk to you. If you have ever tried this you will know that it is virtually impossible. The sound hits the water and 99.9% is reflected back into the air. Only one tenth of one percent of the sound actually makes it into the water. This is because there is an enormous difference in impedance between air and water. Vibrations simply don't transfer very well between the two. The amazing thing is that the eardrum and three special bones accomplish the transfer of energy from air to liquid with almost no loss at all.

The Inner Ear. In the inner ear, the cochlea, the real mystery starts. Vibrations that have been filtered by the pinna, funneled down the ear canal, made the transition from air to fluid, are now brought into contact with some very special nerve cells. These nerve cells send signals back to the brain that are turned into the sensation of sound.

Consider what the ear is able to do. As far as frequency range is concerned, the average person can hear from around 20 hertz (cycles per second) to around 20,000 hertz. This is about 10 musical octaves. Compare this to the eye which is sensitive to wavelengths of light ranging from about 400 to 700 nanometers, not even one "octave." As far as loudness goes, the range of the ear is greater than 100 dB, able to experience the sound of rustling leaves and the roar of jet planes. The ear also has a built-in protection mechanism to protect it from sounds that are too loud. As a sensing device, the ear, like the eye, is just about as sensitive as any sensor could be for these specific forms of energy.

Perceiving the Sound

So far we have only looked at the mechanical aspects of the auditory system. The other part that needs to be considered is the processing or perceptual part. This is where some of the answers to the questions about quality are to be found.

The science that explores perception is known as psychophysics. ***Psychoacoustics*** is a branch of psychophysics which deals with how the auditory system perceives sound.

It is interesting to explore how God made each of our senses. One of the marvels of the sense of hearing is our ability to understand speech spoken by people with widely different accents and to understand speech in the presence of a fair amount of interference. The auditory system is designed to detect and process the content of the sound, and to identify the sounding object.

The ear tries first to identify the talker and what is being said, and to segregate the important sound from the unimportant. Then, aspects like how it is being said, what sort of environment it is being spoken in (a cathedral or a living room), and other things such as the location of the talker are considered. These processes are not necessarily all done in a sequence; rather it is more of a hierarchical structure.

GETTING THE WHOLE MESSAGE

One of the skills that a sound engineer has to learn is to listen to the *sound* in music, for example, and not so much to the words, tune, or rhythm. What this means, as far as sound systems go, is that the ear is quite forgiving. In really bad sound systems it still will try, and often succeed, in making out what is being said. You have to really distort and garble a voice before it becomes unrecognizable.

Just because you can recognize the content, however, doesn't mean that you got the entire message. For example, suppose your friend goes to the symphony, calls you on the phone, and holds up the phone for you to hear the music. Well, you might recognize Beethoven, but you wouldn't get the whole message!

Vision, on the other hand, is much more *spatially* oriented. It is important to see objects in relation to other objects. We really don't learn much about the content of something when we look at it. The important information is size, shape, form, texture, and position relative to us (Fig. 3). If a photographer were asked to take a photograph of your church and the building was out of focus and the colors were all wrong, you may still recognize It as a picture of your church. If, on the other hand, the spatial elements were distorted (say, the north wall was twice as high as it should be, and the south and west walls had traded positions), you probably would not recognize your church at all.

If you recorded the sound of a choir, you would probably loose the spatial relationships altogether. In fact, if you could transpose the position of the sound of the tenors with the altos, and the basses with the sopranos, the choir not only would be recognizable, many would not even know the difference. You would have to seriously distort the voices and make them "fuzzy" to render the choir unrecognizable.

The fact that the auditory system is ***most*** *sensitive* to *content* explains why the telephone works as well as it does, even though the sound is actually quite distorted and changed in the process. There are limits though. Have you ever noticed how much easier it is to understand your close friends over the phone than it is a stranger? The reason is that you know the voice of your friend. You know his inflections, his mannerisms.

The same thing happens in churches. If the listener is a regular church-goer and knows the context and the vocabulary, he will probably tolerate a bad sound system and get much of the message. A newcomer, however, will be frustrated. The more accurate a system is, the more of the sound will be transmitted and the more likely it will be that all will be able to understand.

Transferring the Subtle Elements

Most sound systems do faithfully reproduce the basic content of the sound. Where they break down is in transferring the more subtle elements of the sound which are still important for communicating the entire message. When this happens, the brain has to work harder to fill in the blanks; as a result, attention spans can be shorter and fatigue can set in early.

Think about our photo analogy. If the picture of the church was out of focus, and the colors were all wrong, you may recognize it as a picture of your church, but you would most likely identify that as a low quality photo. If you didn't know the building, the picture would be meaningless and possibly even annoying, even though the primary visual elements (the spatial ones) were intact. Now think what this would be like if it were a 30 minute slide show where all the slides were that way~

The same applies to church sound systems. Many church sound systems "distort" and change the pastor's voice and many folks don't even realize it, much less identify the system as a low quality one.

So far we have been concentrating on systems designed for speech. The problem is, of course, much worse if music is considered. Think back to our symphony example. How much of a performance is lost even when the most sophisticated recording techniques are used? How much of your musical productions are lost because of your sound system or acoustics?

TOOLS EQUAL TO THE TASK

Let's look at it in another way. It you had the most important message in the world to deliver and you had to choose between delivering it in person or over the phone, which would you choose? Well, the Church does have the most important message in the world, and we had better make sure that our tools are equal to the task. The Church should be using the best tools available to it to get the message across.

In talking about quality sound we need to make sure that we understand the difference between sound *reproduction*, and sound *production.*

Sound Reproduction

Sound reproduction should have accuracy as its primary concern. This is what most churches should employ for their public address systems every service.

Sound Production

Often large music P.A. systems, such as you would find at large concerts, are sound production systems. Many inexpensive or poorly designed systems must also be classified as "sound production systems," as what comes out of them bears little resemblance to what went in. This is not necessarily bad, and sometimes quite appropriate. Background music systems, really don't need to be very accurate. If the speakers add to the sound, usually that is OK.

Often performers want to sound bigger (and often better) than life. I learned this the hard way early in my career as a sound system designer. I was engaged to design a portable sound system for a singing group that was considering a cross-country tour. I was awarded the job because I stressed "quality sound," and strived to make the system as technically accurate and "pure" as the technology of the day could offer. Opening night, however, was a disaster. Oh, the system worked fine. It sounded just like the singers and everyone in the place could hear them. That's what a sound reproduction system should do. The problem was, they really needed something to make them sound better than life! They wanted something much closer to a sound production system.

High quality, accurate sound systems can easily be turned into "production" systems often by simply operating it differently or by adding special effects. We have found that in order to make something sound "better than life," you have to start with a system that will at least do as good as life. You can then modify the sound as needed.

QUALITY: THE DEGREE OF EXCELLENCE

So what is quality sound? The dictionary defines quality as “the degree of excellence of a thing.” Quality is a relative word. Words like “high” and “low” need to be used with it: Fidelity (as in “hiqh fidelity” or “hi-fi”) is a quantitative word. It really does not need words like “high” or “low” attached to it. A high quality sound system is a system that has fidelity. A low quality sound system is one that does not have fidelity. A system is either true or it isn’t.

Measuring Quality

We have seen that accuracy is synonymous with high quality, at least for sound reproduction systems. The real question is how is “quality” or “accuracy” measured? I-low is fidelity detected? This is a very difficult question and there have been many attempts at finding an answer.

The answer, in many cases, depends on whom you talk to. A mathematician, for instance, will tell you that all you need to know is the transfer characteristic of the system and you will know all there is to know about it. An engineer will get out his analyzer and give you curves and numbers. The audiophile will ask about the warmth, the clarity, the punch, the “air,” and the definition.

Actually, these are all pieces of the picture. We can measure many different aspects of a sound system, and the measurements can be useful to help us understand what is happening. Measuring and quantifying is what the science of acoustics is all about.

The problem with measuring is that some of the things we measure, the ear is relatively insensitive to. Conversely, the ear is sensitive to much that we don’t know how to measure yet. Measurement still can’t always predict quality sound, although there has been a lot of progress in the last few years. The bottom line is still not “how it measures,” but “what it sounds like.”

The science of psychoacoustics is beginning to provide us with some tools for subjectively evaluating sound. Evaluating the responses of many listeners in controlled situations helps us understand how physical changes in a sound system can change perception of the sound of that system

Learning to Listen!

So back to our question. You want to hear true, high-quality sound? The first step in identifying quality sound is to learn to listen! Spend time just listening to things. Try to be more aware of sounds. Next time you listen to your sound system, listen to the sounds, not the content. Is it a fidelity system? Should it be? What is being lost?

Next time someone talks to you face-to-face in a comfortable, quiet room, pay attention. That is the highest quality sound that you will hear. Direct, face-to-face communication is the standard by which anyone can judge the performance of a sound system. Does the sound in the pew sound like talking to the pastor face to face? Do all the nuances of his expressions come through? To the degree that it does so, it is a quality system. Current technology won’t let everyone in a large church experience sound as good as this, but with a combination of good acoustics and a carefully designed sound system, we can come pretty close.

Guidelines for Evaluating Quality

Here are some guidelines for evaluating an existing sound system and identifying whether or not it is a high quality sound system. Remember that you *must listen* to *the sound, not* just *the content.*

1. The sound should never sound distorted or fuzzy, no matter who uses the equipment or how it is set up. If it does sound fuzzy, something is wrong.

2. The system should always be free of spurious noises, crackles, rattles, hums, buzzes, etc.

3. It should sound the same everywhere in the room.

4. Your attention should be drawn to the talker, not to a loud speaker somewhere. This one may take some concentration to actually determine where the sound is perceived to come from. It is important that the perceived source of the sound be in roughly the same place as the talker. If it isn’t, a fair amount of mental confusion and therefore short attention span can occur.

5. You should hear each word once! Echoes produce confusion.

6. If you are considering new equipment, remember that the weakest links are the transducers (speakers and microphones). Choose these wisely. Spend time listening and comparing. Speakers sound different in different rooms. Listen to the equipment in as many different spaces as possible and hopefully in your own space. The equipment that is the most consistent is the best.

The Goal: Accurate Sound

To summarize, the ear is quite forgiving. It will do its best to understand even under non-ideal situations, and will often succeed. A lot of the meaning can be lost when the sound system forces the ear to fill in the blanks. We need high quality sound because quality sound is accurate sound. We need accurate sound because our message is so important. What does quality sound like? It sounds real. Your ears are the best judge.

How You Can Evaluate Your Church’s Sound System

By Douglas Jones

In this second article Doug Jones shows how you can determine how well your present sound system is working, or not working

There are a number of ways, using nothing more than your own ears, that you can evaluate your own sound system. This effort will help you make good choices about purchasing a new system, or fixing or updating your existing one.

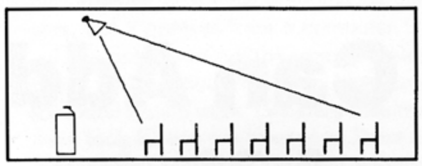
Remember that the function of a sound system is to reproduce at the listener’s ear the same sound that he or she would have heard standing close to the source. In order to meet this specification, all of the parameters such as frequency response, sound pressure level, intelligibility, gain before feedback, and distortion must be optimized.

In this article we will discuss the evaluation of systems that are primarily used for speech reinforcement. Systems that are used primarily for music reproduction are often more complex and have a somewhat different set of requirements. Most churches want a system that first of all delivers clear, intelligible speech.

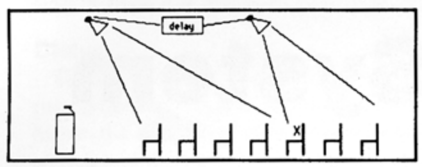
Types of Systems

First, let’s look at what kind of system you have in your church. There are three basic types of systems that can be used in most applications (see diagram on next page). The rule of thumb is to put as few speakers into a system as possible. The reason for this is not all economic. The ideal sound system would be an infinitely small point source that projected sound to only those parts of the audience where it is needed. Sound that is produced by a loudspeaker that is not directed to specific listeners, is not just wasted, it is actually harmful as it increases the apparent reverberation of the room. Another way to think of this is to consider a large group of people reading in unison. It is always more difficult to understand a large group of people reading at once, no matter how well trained they may be, than it is to understand one reader. Every time a speaker is added to a system, it is like adding one more reader to a room. Even though these

Single Cluster System

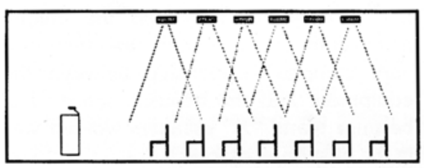


Multiple Cluster with Delay



In the multiple cluster with delay, the sound going to the second cluster is delayed so that the sound arrives at the chair "x" from both sources at the same time.

Distributed System



"readers" are all saying the same thing, the sound is coming to any given listener from many sources at once, increasing the confusion and decreasing the intelligibility significantly.

The best system for most churches is the single cluster system where one or more speakers are located at one point in the room, usually above the pulpit. Single cluster systems have the advantage of usually being the cheapest and most intelligible systems for most churches.

The next type is an electronically delayed, multiple cluster system. This is a system where there are groups of speakers covering the whole area, each delayed so that the sound presented to any listener sounds like it is coming from the true source. The major drawback to this type of system is expense. These systems are usually indicated where the room is too large or reverberant to cover from one point.

The third type is a distributed system where there are many small speakers distributed throughout the room. These systems are very difficult to install and often are the most expensive because they are labor intensive. They also represent the greatest compromise in sound quality. They should only be used when the architecture prohibits a cluster type, such as churches with very low ceilings, or in situations where there is no way to make a cluster look presentable.

Evaluating the Sound System

A simple test that you can perform reveals problems in both the sound system and the acoustics of the room. With the system off, have someone read from the pulpit. While the person is reading, go to the furthest seat in the room and listen. Sometimes the sound actually is loud enough but can't be easily understood. This is known as low intelligibility. The sound system, in this case, needs to improve intelligibility. Other times the sound could be understood well enough, if only it were a bit louder. In this case, the sound system must magnify the volume at the listener's ears.

Once the furthest seat in the room has been evaluated, walk around. Listen carefully to the quality of the sound. It should not change. If some areas are very different from others, this may be a sign of poor acoustics and may be difficult to fix with a sound system. Let's assume that the reader sounds about the same all over the room. Now find the furthest point in the room where the reader can be easily understood. Usually this is in the front part of the room. Make a note of this position.

Now turn the sound system on and repeat the listening test. Can the words be understood clearly in the furthest seat? Does it sound the same as it did at the position where it was easy to hear and understand? Does the reader sound the same all over the room? Does the sound still appear to come from the mouth of the reader, or does it sound like it is coming from a wall or the ceiling or from behind? If the answer to all of these questions is not "yes," then some help with the system or the acoustics may be needed.

Another good way to evaluate the system is to ask the listeners, by means of a survey form, what they think about the sound. Some good questions to ask are: "Do you ever have to strain to hear? Do you feel that there are places in the auditorium where the sound is better than others? If so where?" If a majority of people think there is a problem, then something should be done.

Finding Help

If you decide that your system needs improving it is best to bring in professionals to help. (1) Try to find someone who will design a sound system for you who does not also sell equipment. There are some very fine sales and design engineers around, but there are also some who think first about making the sale of equipment and secondly about how it will work in your setting. (2) Ask your designer to put in writing what the guarantees and the specifications of the *system* (not the individual equipment) are that he or she is recommending. It is very important to have performance specifications in the design.

One of the most important specifications is intelligibility. Intelligibility for music measures how precise the sound is to the listener. For speech this means being understandable. A great deal of research has been done in the last ten years showing that if the consonant sounds in speech are not clearly reproduced, the. ability to understand the spoken word is greatly impaired. A competent sound system engineer can predict with a high degree of accuracy what the intelligibility will be in a given system. It is measured in Articulation Loss of Consonants (AL-CONS), and 15% is considered the limit. (A smaller number is better.) This means that no more than 15% of the consonant sounds are "lost."

It is sad but true that many architects who design "auditoriums" often design beautiful spaces that have rather poor acoustics. If you are contemplating building a new church, make sure that the architect is paying attention to acoustics. Expensive sound systems can often be avoided if care is taken in the design phase of a building to insure good sound. The design phase is a good time to get an acoustician and/or a sound system designer involved.

In the next article (on page 194) we will explore further the different types of consultants that are available to you, and the reasons for those differences.

What a Consultant Can Add to the Evaluation of Your Church's Sound System

By Douglas Jones

In this third article Doug Jones discusses what a professional sound system consultant might do for you.

Now that you have **evaluated** your church's sound system, and hopefully understood the nature of the problems you face, how do you go about having your system **analyzed** and, if necessary, repaired?

CURRENT **CONTROVERSY**

Although you may not be aware of it, there is a controversy going on at the moment. The issue under discussion is the use of high tech computers both in the design and analysis of sound systems. Recently a number of papers and articles on this topic have appeared in professional journals and trade magazines.

The Human Ear vs. The Computer

There are a growing number of people who feel the ear is the only valid tool for the evaluation of a sound system. These peopie would, for the most part, do away with computers as analysis tools because a microphone plugged into a computer is not the same as a pair of ears attached to a working brain. And, of course, they are right. There are no computers that can perceive sound. Only a living being can do that. Machines can measure various attributes of sound, but cannot directly say much about the way a person will respond.

Let's bring this a little closer to home. Assume you wanted to know what a certain apple tastes like. Naturally, you can measure it with a tape measure and find out how big it is. You can also weigh it and find out how heavy it is. You could examine the color and decide it looks great. But knowing the apple is three inches across and weighs 10 ounces will not tell you much about how it tastes. If someone else tastes it and tells you it's good, you're somewhat better off than just knowing the size and weight. But, of course, you still may not agree with their taste in apples. To be absolutely satisfied, you simply have to take a bite and decide for yourself.

On the other side of the issue are those who would say our apple analysis was simply incomplete, and what we really needed was a more thorough investigation. These are the people you see at audio conventions carrying around their latest measurement of something or other, eager to show it to whoever they can. In our apple analysis, they would feel compelled to measure the fructose content, the pH factor and several others. In short, do a complete chemical analysis. Armed with this data they can safely say the apple would taste good. Of course, this approach assumes enough research had been conducted to show how people want apples to taste. This approach also assumes the people making the measurements know how to interpret the data they're collecting. In short, there has to be a balance between these two approaches to achieve the highest level of overall sound quality.

In audio, a good balance between the two approaches is also the key. Clearly there are very good points on both sides of the issue. What's really important about this controversy however, is how it affects you, the actual user. And, in reality, that is determined by your understanding of what to look for, and what—or whom—to avoid.

Avoid the Extremes

When building a new church avoid the people who come in and try to design and install a sound system without the use of any evaluation other than their ears. Chances are they will be wasting your time and money. In most sound systems—and this is especially true with the unique architecture found in churches—there is a very complex relationship between the equipment and the acoustic space. Just because brand "X" speakers worked well in the First Baptist Church down the street, there are no guarantees how brand "X" will perform in your space. And you deserve to know with a good deal of certainty how a system will perform before you spend your money.

By contrast, there are people who spend hours, sometimes days (usually at your expense) measuring and analyzing every possible parameter, only to end up with loads of paper and figures which to you may mean very little or nothing at all. And even though your room may have been analyzed extensively, you still don't know how the system is going to sound.

A similar problem also exists in the area of troubleshooting an existing sound system. If you have a system that is not working right and you want to have someone look into why, the last thing you need is to have someone make a guess about the reason only to be proven wrong. Over-analysis can be wasteful, and unless the operator of the equipment knows how to interpret the results of the analysis, you may be no better off than before the measurements were made.

FINDING A BALANCE

At this point you may think the situation is totally bleak. It isn't, really. Let me share what my attitude is and then demonstrate what I feel is a balanced approach to the question of using high-tech tools in sound system work. I believe tools should be used when they are needed and appropriate, but the final judge of the performance of a system should be your ears, not a printout from a computer,

Let's look at some of the recent developments in the various tools now being used for sound system work. Generally speaking, these tools fall into two categories. There are the tools that help in the design of a system, and there are tools which help analyze the system once it is installed.

Design

Design tools are often programs which run on general purpose microcomputers to help in the selection of components for your church and then predict the kind of results you can expect. Beware!! In many cases these "design programs' are really sales tools intended to catch the eye of the potential buyer and to sell a specific brand of audio equipment, rather than set forth true design parameters. Also you should realize that programs are only as good as the people who wrote the software. Remember "GIGO" (Garbage In, Garbage Out!). My experience Is that many of the design programs do not help in the selection of equipment, but simply predict how the equipment you have chosen will perform. This is like telling a computer carefully selected things about our apple and then having it make a prediction about the taste.

Analysis

In the other category are the analyzers. These are machines designed to be brought into rooms and used for measuring various aspects of existing sound systems, or acoustics. These analyzers range from very simple and inexpensive "real time analyzers" to very expensive computer-based machines using advanced measurement techniques. Generally speaking, the more advanced the analyzer, the more difficult it is to use, and the data it yields may be more difficult to interpret. It may be wise to ask prospective consultants what sort of training they have with their complicated machine before turning them loose in your sanctuary!

One of the more recent developments in the field of computer-based analyzers is the Time Energy Frequency (TEF) analyzer built by Techron in Elkhart, Indiana. The TEF uses a measurement technique called Time Delay Spectrometry (TDS), developed by Richard Heyser, which allows the user to see how the sound behaves over time. For example, the user can "zoom in" on the sound as it leaves the loud speaker, and ignore the effect of the room. The user can then "zoom out" and begin to see the effect the room has on the sound. This is especially useful in troubleshooting problems that arise with existing systems. Sometimes it is difficult to tell by ear if a problem is the fault of the system or of the acoustics. TDS accomplishes this by effectively separating the system from the acoustics. Armed with this information, a consultant can come up with a solution that gets at the cause of the problem rather than simply treating the symptoms. Generally It is better to treat acoustic problems acoustically and electronic problems electronically. This may sound very basic, but the careful separation of these two elements will result in superior sound quality. It may be of interest that the so called "Real Time Analyzer," which can be a very useful device when used properly, really has nothing to do with time at all. The word "time" in the name refers to the fact that the measurement happens immediately or in "real time." It takes a good deal more sophistication—such as TDS technology—to measure how sound behaves over time.

Toward Accurate Solutions

The use of an example detailing how I used TDS on a recent job will further clarify this important aspect. I was asked to go to an auditorium to look at a sound system which was not operating properly. The users felt there was "not enough gain before feedback." This simply means they could not turn up the microphone very loud before the system started to howl. If! had merely gone in and listened to the room, I would have attributed the problem to a nonlinearity in the system and prescribed an equalizer (or, in this case, a better equalizer, since they already had one).

An equalizer, in case this terminology is new to you, is basically a filter, or tone control, which electronically removes part of the signal in the same way a tone control does on your stereo. Since feedback usually happens at one frequency, or pitch, an equalizer is often used to remove or reduce that one pitch from the signal that is sent to the loudspeaker. Most of the time this works out fine. Of course the equalizer doesn't know the actual difference between music and feedback, so it simply removes or reduces whatever pitch it's told to. As a result, it will effectively reduce feedback, however, it will also change the way your system sounds.

By using TDS, however, I was able to "see" the cause of the feedback and prescribe a better solution that cost far less. When I measured the sound at the lecturn I discovered there was a very strong reflection bouncing off one of the beams in the ceiling and coming right back into the microphone. Most of you have probably had the experience of walking in front of a loudspeaker while talking into a mike, and having the speaker start to howl. In this case, the reflection from off the overhead beam was just like having a loudspeaker pointing right at the microphone. The solution was to use the machine to isolate the exact area of the reflection and cover it with a few square feet of fiberglass. This single modification dramatically reduced the feedback *without* changing the way the system sounded and *without* having to purchase new equipment. The analyzer proved to be essential for effectively and economically solving the problem.

FINDING YOUR WAY

In summary, here are three major points you should watch:

1. Avoid both extremes in sound system analysis: the ones who would just listen and the ones who would just measure.

2. Beware of buying or modifying a system *only* on the basis of a computer display or printout. Listening to other systems the consultant has worked with, and checking out references is a much more reliable way of choosing someone.

3. Don't be afraid to ask questions: Is he or she keeping up with the latest developments? What improvements should I expect in my sound system? I have found that most consultants who use better and more advanced systems, such as the TEF, are also the ones involved in some sort of continuing education.

By now you must be asking yourself, "If I do all this will it really make a difference in my sound system?" The answer is, "yes, it will." But please remember—there are more diagnostic devices being offered and more people getting into the sound business than ever before. Technology is improving rapidly, and to the inexperienced buyer it can all be very confusing. Always insist upon references and check them out thoroughly. Your best protection is to become an informed consumer.

Douglas Jones is the president of Electro Acoustic Systems, Inc., Evanston, Illinois, and has consulted internationally for classical recording studios, concert halls, and churches.