HORIZON AUDIO SERVICES LTD.

Evaluating And Comparing Speakers

I remember, many years ago now, the first time I purchased a pair of speakers. They were big; at least 18" tall, and they had a 12" woofer. Best of all they were *expensive*; I think about $150.00 for the pair; and that was at wholesale! Well I used those speakers on my stereo for a few years, but as time went by I became less satisfied with them. Somehow they didn't sound quite as good. Finally I began to shop around, visiting several hi-fi stores and doing lots of listening. I finally settled on a new pair that I thought sounded very pleasing. They happened to be the first series of Interface A from *Electro-Voice*. Listening to the Interface speaker beside the old speaker, I began to hear a number of differences, and began to learn what separates an inexpensive speaker from a better quality speaker.

As years went by and I became more involved with sound, first as the 'sound person' for a contemporary gospel band in my home church, and then as a small recording studio operator, I purchased more hi-fi speakers made by *Electro-Voice*. The last pair was their top of the hi-fi line, the Interface D model, which I eventually used in our recording studio control room as the main monitors. Today those same speakers still sound good in my living room! About 17 years ago as *Horizon Audio* developed, we needed a dealership for a good quality line of speakers, and we became an *Electro-Voice* contractor dealer. However, that's not the focus of this discussion.

There are two points that I learned over time as I listened to speakers. The first point is that *listening is a learned skill*, which explains why I became dissatisfied with that first pair of speakers. I realized over time that I could hear defects in the speakers and in some records (the old vinyl discs and eight track tapes!). The second point I learned was that *speakers are designed for specific uses*. The engineers who design and construct speaker systems have to make various compromises as they work to achieve their most important design goals. This is why a good hi-fi speaker will not work well as a sound reinforcement speaker, or why a near field monitor will not work as well for home hi-fi use as a hi-fi speaker will. We must use the proper tool for the task at hand.

The reader of this discussion will know that *Horizon Audio* specializes in the design and installation of high quality sound systems for speech reinforcement and music reproduction in church auditoria. This is a specialized area of the general sound market. It's different from the music store market or the commercial sound market, or the production market. The speakers we use in our market area are in good measure designed specifically for this market. I want to explain the major aspects of speaker design that make a good quality speaker, and that make a speaker suitable to our uses.

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The speaker system is the single most important part of a sound system. Even if you have million dollar electronics, if the speaker system is poor, your system will sound poor. The speaker system has two important tasks to perform in a church sanctuary or auditorium. First of all it must take the electrical voltage produced by the power amplifier and convert it into acoustic energy; sound. This energy conversion is a difficult task to perform accurately. The second task is to disperse this acoustic energy in a controlled fashion to the listeners' ears. This may sound easy, however, how this is done is very much dependent on the acoustic characteristics of the listening space. Remember that this listening space is the sanctuary, not a living room or studio.

There is one word that perhaps sums up what we look for in a good speaker. That word is *accuracy***.** For us, accuracy is this: what comes out of the speaker to our ears is exactly what goes into the speaker. We don't want the speaker to change the incoming signal waveform in any manner. Furthermore, we want to have that accuracy anywhere inside a specific angle in front of the speaker, not just when we are directly in front of (on axis of) the speaker. There are *four* elements to accuracy to look at.

Frequency Response

Everybody has seen the familiar graphs with a line that represents the frequency response of a speaker. Some companies advertise a response of 20 Hz to 20 KHz, which may seem great, however, they fail to mention the tolerance of the measurement. Is it + or - 3 dB, or +5 -10 dB? Remember also that virtually no one can hear down to 20 Hz or up to 20 KHz.

The ideal frequency response would be a ruler flat line, so it follows that the closer a speaker is to that ideal, the better it is. Note that in some cases a manufacturer will deliberately cause bumps or raised portions in the response. Some hi-fi speakers for example, have a raised bass response to compensate for lower listening levels in the typical living room. For our purposes though, we want as flat a response as possible.

Erratic bumps and dips in the response will be the cause of particular audible results that have various emotional subjective names. For example, a peak in the middle voice range will cause a nasal or honky sound. A bump in the 100 Hz to 250 Hz area will cause a boomy and/or muddy sound. Peaks in the 5 KHz to 10 KHz range will cause a sizzling sibilant sound. For most applications if the speaker exhibits a response that is within +/-3 to 5 dB from about 50 Hz to about 15 Hz with no erratic changes in between, it can be considered as a fine speaker.

Dispersion Characteristic

The next important aspect of a good speaker is its dispersion. It's fine to hear the flat response when you are sitting directly in front of the speaker, but what is the response when you are 30 degrees off axis? What is the response 45 degrees off axis? You even want to know what its response is beside or behind the speaker, as this can have a major affect on the system gain before feedback. This is one aspect where it is important to know what the speaker was designed for. The hifi engineer doesn't need to be as careful here, as most listeners in a living room will be within a few degrees of on axis all the time. However, when the speaker is going to be used

to cover a wide area in an auditorium, the engineer needs to be very careful about dispersion control.

The speaker's dispersion needs to be constant over its rated coverage angle to keep the listener 35 degrees off axis as happy as the on axis listener. This becomes more difficult to achieve as the frequency increases. Typically, the dispersion angle will decrease as frequency increases. Good even high frequency dispersion can make a major difference in the price of a speaker compared to another that may be identical in other respects.

It is important to note here that you must choose a model that has a high frequency dispersion characteristic suitable to your particular room, both in room dimensions and room reverberation. This is why in some churches we will use a speaker with a good wide-angle tweeter, and in other rooms will use a speaker with a high frequency compression driver and narrow angle horn, which limits dispersion to a particular angle.

I noted that a speaker's *off axis* dispersion was also important. Some speakers will 'throw' their sound over a wide unpredictable area, and this can cause feedback control problems. I recall one session my associates and I were having at my church. We had two speakers side by side at the front of the platform. One person was talking at the pulpit which was beside and a little behind the speakers. We were swinging the pulpit mic from speaker to speaker as the talking continued. The talker could tell immediately when we switched to one specific speaker, as he could suddenly hear much more lower mid range. This speaker had a problem in its dispersion control! It is interesting to note that this particular speaker was about *three times* the cost of the other speaker, which did not have the problem!

Efficiency

Now that we have our frequency response and dispersion control worked out, we need to ensure the speaker will give us a reasonable volume. We want the speaker to efficiently convert the electrical power from the amplifier into sound power. This becomes increasingly important as the desired maximum volume level increases. It's critical if you want to do rock and roll! (Or if your background noise levels are high.)

Speakers from years past tended to be rather inefficient, consequently people had to use large amplifiers and drive them hard to get the higher volume levels. One of the major advances in speakers has been the dramatic increase in efficiency ratings, while still maintaining good sound quality.
Efficiency is quantified by looking at the sensitivity rating of a speaker. The standard today is to measure the output volume of the speaker on axis at one meter, with an input power of one watt. Common sensitivities for music speakers are in the area of 97 to 103 dB. High power units can be as high as the 115 dB area. If high volume capacity is important, these numbers can be critical, because a speaker rated at 97 dB would require twice the input power as another rated at 100 dB to achieve the same volume level to the audience. In other words, to raise the volume heard by 3 dB, you must double the input power to the speaker. That can use up that high power amplifier quickly! (In our market area, high volume is not the most desired feature of a system, so most of the speakers we use are in the 93 to 100 dB range.)

It is also important to consider what frequency band the manufacturer is using to achieve their sensitivity rating. Is it one frequency, a narrow band, or a wide band of frequencies? One of the companies we use rates the speaker over a range of 300 Hz to 2 KHz, which is where the majority of energy is contained in music material. This specification may result in a lower number, but it will be more accurate for real world use.

One should also realize that speaker efficiency would decrease as frequency decreases. This is why music systems often employ extra bass units or sub woofers. One development of late has been to achieve more low frequency sound out of compact woofer systems.

Power Handling Capacity

Power handling capacity is one area where the numbers game is played a great deal. There are two elements to power handling; long-term average power, and short-term peak power. The *long term average power rating* is a measure of how much power the speaker will handle over the long term. One company we deal with rates their speakers based on an eight-hour time span. *Short-term peak power* is a rating of how much the speaker will handle in the short term; in the area of milliseconds.

Long-term power tests the speaker's ability to handle high currents in the speaker voice coil, and in the speaker's ability to dissipate the heat produced from the high current. *Short-term power* tests the speaker's mechanical integrity; the ability of the woofer cone surround and spider to hold the cone in place and the ability of the high frequency diaphragm to resist shattering.

It is important to determine how the manufacturer is rating the power handling capacity. It must be a realistic rating using more than a single sine wave. It is best to use a signal that contains a wide range of frequencies, as music does, and contains peak to average level ratios similar to music material. This will provide the most accurate idea of how much power the speaker can handle. When you see phrases such as 'music power', 'peak power', or even 'RMS' (root mean squared - a mathematical formula), beware, and look for more details on how they rated the speaker.

Concerning the maximum volume a speaker will give you; power-handling capacity really goes hand in hand with efficiency. If a manufacturer comes out with a new model that will handle twice as much power as the competing model, but forgot to tell you it's 3 dB less efficient, you won't get any more maximum volume out of it than you will from the competition. The only one to benefit in this case would be the power amplifier manufacturer!

These are the four most important elements of accuracy. If your chosen speaker measures up well in these areas, you have made a good choice. There is one other element you may also hear about.

Phase Response & Driver Alignment

Phase is in a sense the other side of the frequency response coin. Phase refers to time; for example does the speaker produce the low frequency information in the same time relationship to

the high frequency information as the input signal was? This relates partly to driver placement, or alignment, and partly to the group delay characteristic of the individual drivers in the speaker. Some manufacturers today are placing considerable importance on ensuring their low and high frequency elements are lined up properly so the time relationship will be accurate. A speaker that exhibits a smooth frequency response will necessarily have an accompanying smooth phase response. In an un-aligned speaker, the low frequency information will usually arrive at your ear before the high frequency information.

I know that there are several very fine speakers available that are not aligned in time. I believe though that, *all else being equal***,** a speaker that is aligned will sound better than one that is not.

Comparing Speakers

The foregoing discussions will help you know what to look for when comparing specification sheets. Sometimes you will also listen to competing models. The following points will be helpful.

- It is important to listen under identical conditions for an accurate comparison. First of all, it is difficult to judge speakers when one is in a church on one side of town, and the other is in a dealer showroom on the other side of town. If you wish to seriously consider the two speakers, try to get them in the same location side by side.
- Ideally you should do your listening outside, as this eliminates the effects of room reverberation. However, it's not the most convenient, especially if the neighbours are nearby! Inside, put the speakers side by side on a table about ear height. This will give you easy on axis (both horizontally and vertically) listening, and will minimize the effects of the floor boundary in emphasizing the bass response.
- Try to use a reasonably large acoustically dead room so you can be at least 20 feet away and still be within the critical distance of the speaker in the room.
- To listen to the vertical dispersion performance, turn the speakers on their sides. This is easier than having a tall stepladder in the room, although that would work as well.
- Listen to all speakers at the same volume, using a meter if available, to set the volume. This is important because some speakers will sound different at loud levels than they will at low levels. More importantly, the frequency response of your ear varies dramatically depending upon the sound pressure level.
- Listen to a wide variety of material; speech and music that you are already familiar with. Also listen to noise through the speakers. Noise will easily reveal how much the dispersion collapses as frequency increases. There are good test CDs available for testing purposes.
- Save the high volume listening to near the end of your session, as your ears will experience temporary threshold shift, which is a temporary reduction in the sensitivity of your ears; this is a safety mechanism built into our ear-brain computer system!
- Don't be too concerned about one model being a two-way system and another being a three-way system. A good two-way system will always be better than a poorer three-way system.
- Last but not least, don't be unduly swayed by the price. Although a good general rule is that you get what you pay for, I know that a few speakers I have listened to and rejected cost several times what other models I have accepted have cost. Price is not always a

good indicator. This phenomenon occurs mostly in the very high priced systems, where a single cabinet can cost over $3,000.00.

Conclusion

I emphasize that it is not a good idea to choose a speaker system for a sanctuary or auditorium based only on the speaker. The room acoustics, size and dimensions must be considered in the selection process. A reverberant room will necessarily require a speaker system with very controlled dispersion in order to achieve a good intelligibility level for speech and clarity for music in the room. The first step in designing a speaker system is to characterize the room it will be used in. There is no such thing as one speaker that is great for all situations, contrary to what some manufactures would like you to believe!

I hope this discussion has helped you in learning what to look for in a good speaker, and how to make comparisons. I don't recommend trying to save a few dollars on the speaker system unless the budget is very limited. You will have to live with the speaker system for many years, and it will have a major impact on the ministry in the church. If you have other questions I didn't answer here, please feel free to call me with our toll free number. ***Thank you!***

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