

Austin AudioWorks

Audio Entropy – The Death of Music

Barry Thornton of Austin AudioWorks

Music is a most soulful experience. One of the finest that the human mind can have. It is based on our most primitive sensual response. Music is about rhythm and feeling. Your first sensual input, before anything else, was your Mother's heartbeat. And with that beat came the chemicals in her blood system, her feelings. The idea that you could process Mozart in the womb is very doubtful; that you did process the periodic and dependable 'thump-thump' is unquestionable. Maybe it was Mom's good feeling listening to Mozart that put endorphins in your blood and you felt good too.

After birth your senses developed to be the basis of your thought and thus your interaction with reality and the world. But the auditory sense stood out as the only truly 3-dimensional 360-degree sensory array we have. Your ears perceive the whole 4π -steradian space around your head and are supported by your eyes for keeping you alive.

The music we make is one of man's oldest, simplest, and most profound artifacts. It is one of the most complex; it is unique to us. In a way it defines us. In fact anthropologists have decided that making music is one of the factors that determine humanity or human like intelligence.

As a music listener it can be the most fanciful, the most magical, and certainly the most emotional of all our sensual inputs. To a recorded musical listener it is also the most illusionary of experiences you can have. Really good musical reproduction takes the illusion to the level of a mild hallucination. We are amazing; we can have a soulful experience from cold and hard electronics. As one of our reviewer critics has said, "I had an Eargasm" and that was delightful and one of the richest of human experiences.

Like all events, the music reproduction process is one of Entropy. Information is lost at each stage of the process deteriorating the audio stream and affecting its ability to stimulate the Eargasm in each of us. The critical listener's driving question focuses on the process. "How can I cut the losses?"

Sometimes the real problem is not what is lost, but what is added. This too is a form of entropy for entropy is about the loss of information and adding garbage that masks and distorts the information which reduces its veracity and usefulness.

So the trouble is that you can lose or gain information - either is a perversion of the truth of the original information. In audio this perversion sucks the life out of the music recording. The illusion falters; it isn't as much fun anymore.

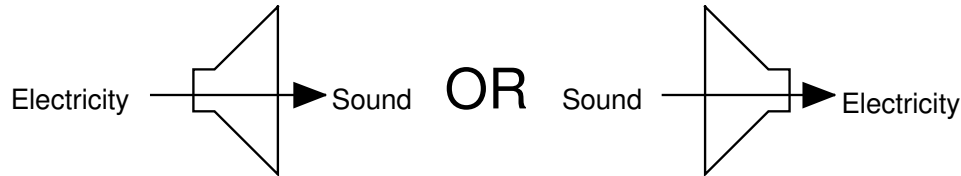
Science and Technology have done a great job of reducing the losses in the audio chain. We can build individual elements of the chain (storage, conversion¹, connectivity, processing, amplifiers, and conversion again by the speaker/headphone transducer) that individually work quite well but applied sequentially can get pretty bad. The good music system has a gestalt, it is more than just the sum of its parts, it has a character that titillates our minds.

1 Most music today stored electronically and the conversion is all-electronic, but in the case of mechanical storage, a record that is, the converter is a mechanical-to-electronic device and will be the subject of a later paper.

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Of all the steps in the musical equipment sequence the amplifier-to-transducer step is the most brutal. All other steps in the reproduction chain are electronics sending information from one electronic device to another, and are well-defined engineering skills. But the amplifier-to-transducer information transfer is much different and it is different for two reasons:

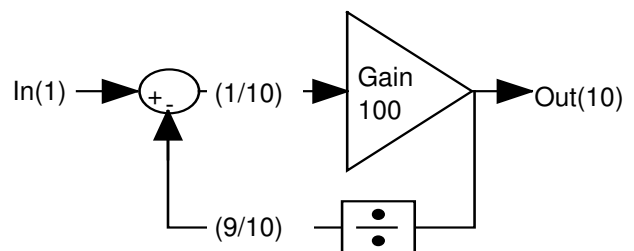
1 – The electro-mechanical process, the speaker or headphone, is a two-way event. Such devices both take in electrical power and convert it to mechanical (sound) power, and convert mechanical power to electricity. Every audio transducer, that is speaker or headphone, is also a microphone.



2 - Amplifiers employ FEEDBACK to operate well, and in the audio world the definition of “operate well” is to measure well, specifically low distortion.

Feedback is about taking some of the output of the amplifier and feeding it back into the input, but out of phase (electronically inverted) and thus subtracting it from the input. In theory, any of the non-linearity (distortion) from the amplifier is also subtracted and you are left with the original signal. If you want the output bigger than the input (gain) you feed a little less back and the amplifier makes up for it by putting out more signals. The cost is that some of the distortion gets through too.

It works like this, feed a volt in and the amplifier’s open loop gain is 100 and you would get 100 volts out, but you want 10 volts out so you cut down the signal to the amplifier, in this case you want 1/10 of a volt (times 100 gives you 10 volts out). You divide the output to 90% (0.9 volts) and subtract that from the input. In this way you close the loop and get the gain you want regardless of the changes in gain in the amplifier.



Is distortion an audio demon? Well, yes - in a way.

People have modified an amplifier by adding a control that changes the input and feedback at the same time. In effect they changed the distortion and not the output level. Listening to such amplifiers has shown that the group consensus didn't notice anything until it got up toward 5% THD. And the advertiser agonize over .01% THD differences. So much for THD - it is a good sign post for the designer if they know what it means. Otherwise it is very mythological, get below 1% and you begin to argue about angels on the tip of a pin. Get down below 0.05% and it is for poets and philosophers, or as my old friend Po would say, it becomes Urination Olympics between products. One may think it's a big deal but it is really little in the big picture. Personally, I like to get down to triple digits but I know

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it is because of my male hormones as a designer, it's more academic than anything else. Making a power amplifier 'sound' better is not about the THD, the Noise, or the power ability. Clearly anyone can make an amplifier with low THD and noise, with lots of power. Still sounds like, in the words of Dave Fletcher of SOTA, "Hammered Sh*t". The music has entropied, it has lost its soul.

So what is it that causes the most Audio Entropy?

As suggested earlier the relationship between the amplifier and transducer is a very good place to look. At that juncture more damage is done to the audio signal than anywhere else in the chain. And the reason is, you got it, FEEDBACK.

Remember that earlier part about feedback? Signals from the output sent back into the input? Works fine on a white board. As a physicist and audio nut that has always bothered me. It seems that Feedback provided control, but not total control, only mostly control. Boy, that sounds fishy!

Consider this. It takes time for a signal to go through an amplifier, a few picoseconds for each transistor, so in temporal terms the output is behind the input. So whatever occurs in the output is the result of two signals that are not exactly temporally coherent. Because both signals are temporally stable, the effect varies with frequency.

Now I agree that in the audio band this phenomena as we have described is insignificant and I agree it cannot contribute to the Entropy of the Audio Musical Soulfulness Factor. A 100 Pico-Second error in a 1000 Hz tone is .00001 % or 0.0003 degrees error, totally insignificant! Nobody alive today or ever can hear that.

But philosophically that amplifier is unstable and the instability is frequency/time dependent. With this in mind, let's consider another characteristic of the Feedback Amplifier. If an energy change occurs at the output of the amplifier, Feedback will return it to the input, amplify it out of phase, and send it to the output again. In a way it is a very fast echo. We note that this phenomenon produces what is called Damping and is immensely useful in taming errant woofers.

But in headphones and speakers, the frequency dependent qualities of the transducer store (hold in time) and then return energy back to the output amplifier possibly milliseconds later. Feedback that causes the amplifier to react to this energy by creating new energy that was not part of the audio signal. The energy adds confusion to a complex passage of audio, it "muddies the waters", it alters the timbre and detail, and the soundscape suffers, the Audio Entropy increases.

Disconnect the feedback from the transducer and the problem goes away. Drive the transducer from either a pure voltage (unlimited current) or pure current (unlimited voltage) source, without the effects of feedback, and you avoid the 'odious' sonic barrier of traditional amplification.

So that is what we are doing; gain without feedback, treat the transducer respectfully and don't let its problems back up the line.

We did in our latest design, and we have "Eargasms" as the result. So much for all the talk, you'll have to hear what it does to your music. We invite you to critique our philosophy and actions with your ears and soul. Let us share with you the sensual rewards of your efforts.