Knowing Where to Start

My father once told me “Know your facts and then stick to them.” This simple phrase of advice could be taken at face value, but when you look deep into its meaning it carries important points. Larger ideals of “Know your strengths” and “Know your weaknesses” are summed up in this original phrase, as the fundamental aspect of “facts” is the question of “true” knowledge. What do we *actually* know, and what is it that we *think* we know? In some cases it would be better to phrase this as what we are *sure* we know, but actually do not.

Scientists in ancient Greece were so sure that Aristotle was right about his fundamental “rules” of the physical world that they used them as the base of a pyramid on which to build greater knowledge. Hundreds of years of the finest minds were wasted because of a simple flaw in reason. When Aristotle proved to be a great philosopher (a philosopher is often a scientist who got everything wrong), not a great scientist. Generations of work were invalid because they did not know what they *actually knew*. Today we see great minds forgetting that Einstein’s Theory of Relativity is called a *theory* for a reason.

Well...What Do You Know...

It is much easier to accept current practices, wrap our arms around them and take comfort in their security. Doing so, however, is not intellectually honest. In the realm of loudspeaker design we know a specific way to measure their performance providing us with the security of numbers and graphs which are easily grasped. We have found, however, absolutely no correlation between these charts and actual performance. They are the equivalent of measuring the tire pressure on your car and using the ideal that “My car is 32 psi” to attempt to apply some conclusion of performance. You must question the premise of any system where the ideal frequency response curve is a straight line. Products exist in abundance that measure “badly” but perform well. Two DACs measure exactly the same and sound totally different. Clearly, information and designs must stand on their own, but you must possess the confidence of your convictions. You must know what you know.

So, what as a loudspeaker designer do you know? You know that circumstances affect the performance of virtually every aspect of loudspeakers. The room it is placed in, the system that drives it, the wire used and the passive components all are capable of altering their characteristics through interaction. On the surface this presents an insurmountable problem. It does tell us something we *know*. *We know that the fewer total pieces interfaced the more consistent and accurate will be our outcome and performance*. This is the KISS, Keep it Simple Stupid school of design.

Those playing Devil’s advocate can sight great sounding amplifiers stuffed with so many parts you cannot tell what color the PC board is. History has shown that as designers mature they refine (as in make better) their circuits through simplification. I would postulate that any great sounding complex design can be even greater sounding when properly simplified. I said postulate because I *believe* this.

The Elvis School of Medicine

One day Elvis Presley came to his doctor with a headache. His doctor gave him codeine which got rid of the headache. That night Elvis called his doctor and said "I have to go on stage but I am so groggy." His doctor gave him an upper. After the show Elvis called his doctor and said "I can't go to sleep." His doctor gave him a sleeping pill. In the morning they had trouble waking Elvis up so he took the pill that helped him not be groggy. After three months Elvis was taking 40 pills a day. If the doctor had given Elvis an Aspirin, a pill that was less effective at getting rid of headaches, but had virtually no side effects, Elvis may still be alive today (except for those fried banana sandwiches).

What the heck does this have to do with design, you ask? In the case of Elvis, and design, if the side effects are not controllable then it does not matter how effective a design process is. An "inferior" circuit that has weaknesses that can be addressed will perform better than a "perfect circuit" that has a fatal flaw. If it takes 32 components to cross over a tweeter, then a light should go off that something is terribly wrong. Complex error correction circuits, by their very definition mean that there are a lot of errors, or *one really big one*! When I am presented with this scenario the temptation is to keep on going because the original premise was so *cool*, but eventually it must be realized that until a scenario and design can be formulated that conducts this new idea in a mature and simplistic manner, it will not be successful. It does not mean that you have to abandon it, *but you must never make your customers pay for your R&D.*

Solder joints, while convenient and necessary, sound bad. I have constructed circuits that are identical but for single joints and multiple solder joints, and the fewer solder joints the better it sounds. I, therefore, *believe* that solder joints cause sonic degradation and *know* that each solder joint adds greater chances of breakage, failure and inferior design. A circuit with two hundred and two solder joints has two hundred more chances of solder joint failure than a circuit with two joints.

The Function of a Loudspeaker Enclosure

The function of an enclosure in a dynamic driver system is to absorb the rear wave of the driver while not causing any sonic degradation to the front wave. It can also serve to bolster the low end response of the system by adding resonance, well "controlled" resonance. The enclosure must function like the heat sink on an amplifier, which draws heat away from the transistors and dissipates it. In our enclosure, it is the rear wave energy that must be drawn away from our driver so it may me dissipated. Heat cannot be drawn away from the transistors if the material used is inert to temperature. We use aluminum because it absorbs heat and dissipates it effectively. If we used cotton balls as heat sinks, which are incapable of absorbing and dissipating heat, our transistors would burn up. We would have a poorly designed heat sink, because it would be incapable of serving its function.

How then do we accept that we must build enclosures out of rigid, inert materials that are incapable of absorbing or dissipating energy? This is exactly the opposite of the enclosure's function. *"Stuff it with foam*, that will solve the problem." Anechoic chambers use 12 foot wedges. Enclosures that accept 12 foot wedges of foam are not acceptable especially when we realize that the enclosure would still need to be the size of a gymnasium. Perhaps sometime in the future a foam will be developed that is capable of absorbing this much energy in a small space, but until this day, I *know* that current enclosure design does not function to properly serve its purpose. Common excuses include the mantra that "if we allow the cabinet to vibrate, it will make sound of its own." This will only occur if the cabinet is not properly designed to only dissipate energy on the *inside* of the enclosure. These two concepts are treated as parallel issues, when they are in fact separate and distinct engineering criteria. You *can* design a high loss enclosure that effectively "kills" sound projected into it, while not letting any of the internal energy be re-radiated by the outside cabinet walls. I think I have just re-stated the definition of an enclosure...

If we examine what was just discussed it becomes clear we must, in effect, have two cabinets. One that is an inner high loss enclosure, and one that is an acoustic barrier (sorry for the engineering term). Here we must realize that single materials that exist in nature are *either* good energy absorbers *or* good acoustic barriers. This is the reason for the foam/rigid cabinet argument. The foam is simply too inefficient to fill the task. Therefore, I *know* that no single material can fill this role. Multiple materials must be used each with a specific purpose. They cannot all be rigid (barrier) or all absorbing. The only proper answer to our enclosure is a composite of dissimilar materials or a new family of materials that do not behave like traditional materials. Either that or *Magic Foam*!

Composites open an entire new world of possibilities, not specific only to enclosures. We have the trade off of rigid versus damped (paper) cones. Single material metal or ceramic cones are great pistons, but ring. Some creative applications are used to force these resonances out of the listening spectrum, but they will never be *inherently stable*. I know this is how materials behave, but some attempts at working around them are successful (please no angry letters). Paper cones are very stable and are well controlled, but lack the stiffness to be successful pistons loosing detail. Composite cones are capable of combining elements of both worlds resulting in true pistonic behavior with tremendous energy damping characteristics. These are drivers that are inherently stable and detailed needing no super human means of correcting for their flaws. Composite drivers are the coming revolution in audio (because they make sense at an engineering level).

The Forming of a Design Philosophy

Keep it Simple (Stupid). Choose designs that are stable with the fewest negative side effects. Have a clear understanding of what you are actually trying to achieve and let that guide you to the solution. Never start with a "preliminary" solution based on a preliminary assessment of tasks to be accomplished. Once you head down the wrong road it gets harder to find "reverse". If you are going to design something based on current design ideas or "common knowledge" chances are it has been designed and marketed already. Don't fear the results of new thinking, no matter how scary it can be at first examination.

Finally, don't take either the Red pill or the Blue pill. Take the Aspirin...

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