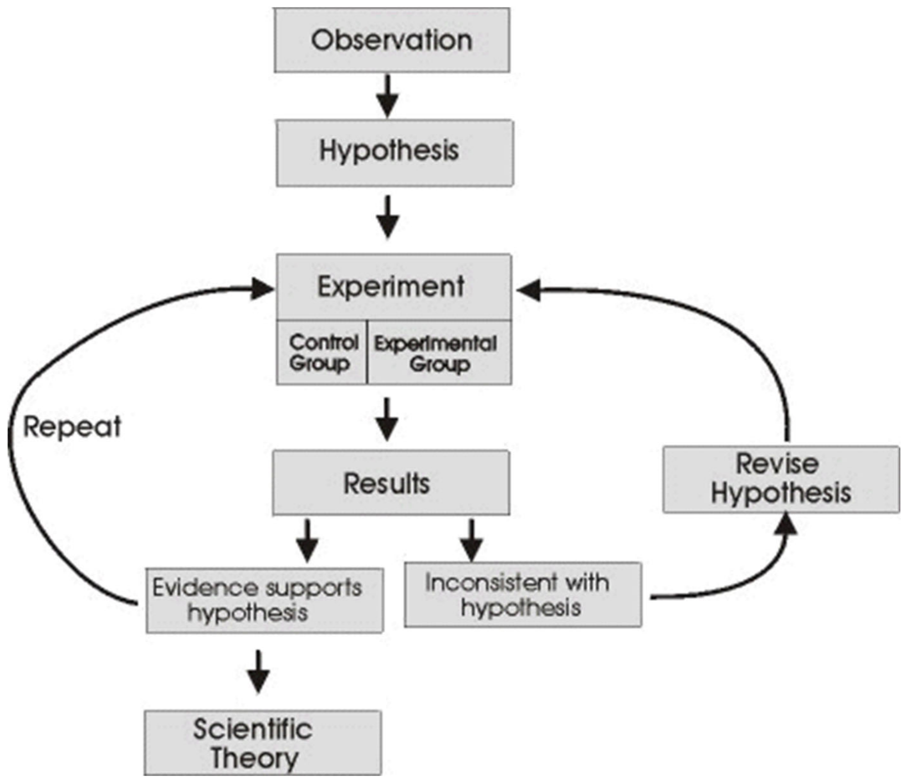
DIY ABSORPTION TESTING

By Ron Sauro and John Brandt

In today's world opinions are counted as facts until disproven. Science works in the other direction, by trying to find the truth, no matter what that might be. Preconceived ideas about what is true are usually wrong. The Scientific Process:



It is also very dangerous to make claims and then proceed to back up those claims with poor data or skewed results that will only back up the claim. A claim that in not falsifiable is not a valid claim. - A real scientist will go out of his way to try to prove his idea wrong and when he can't, he offers the idea up to other scientists who might be able to prove it wrong. When it can't be proven wrong, THEN it becomes scientific theory.

I have talked to many people who think they can measure absorption in their small rooms. DIY absorption testing. They create a product and test what it does in their room and CLAIM that it works this way and that. This is very much like kitchen counter cold fusion. It's bad science and leads to false information and errors and ultimately failure.

If you plan on putting hard-earned cash into a studio build based on DIY testing errors, I would advise caution since the entire project could end up being a complete loss.

[If you are selling shit based on your own fallacious claims and DIY testing, then doing so makes you a charlatan and snake-oil salesman. "Don't be THAT guy!"
"Change is frightening, especially to those in power." -Asimov]

One problem is that computers, software, and simulations are becoming a separate source of "facts". Computers are dumber than people and will just amplify the misinformation. Humans input data (with errors) and expect the computer to make them right. But it's garbage in = garbage out.

So, when a room is "measured" for changes, you cannot just throw in some item that you think might provide a change in the room. You MUST design an "experiment" that removes all other "possible" items and possibilities that might affect the changes in the room.

Examples: a - reflections that were not there before the test item is introduced. b - mean free paths changed c - mean free times changed. d - measurement mic moved 1/8 inch or less from the original position. e - different temperatures. f - different humidity. We have to predict how many things can change the room besides the absorption or diffusion introduced into the room. This is why we, who use labs to measure stuff, spend so much time trying to figure out how to measure stuff without pollution from other variables.

Actual Data is what is known as a "FACT". It is NOT a guess nor opinion. I see many people who put absolute faith that simulations are "facts" but that is only true if the simulation is based on actual measured data, not just ideas (hypotheses) or old formulas. Ideas, opinions, and hypotheses are NEVER facts until proven in well-executed testing. Then they become Theories. The general opinion for the last 10 years is that science is just a whole bunch of hypotheses (theory to the lay person) and opinions and they can be ignored just because *"I do not agree because of what I heard on the internet"*. That's kind of like, "we never landed on the moon because I saw a YouTube movie proving that".

Just because you measured something does not mean you have a valid measurement. You have to know basic physics and how sound propagates in a room.

Again, a different situation - the inside of a speaker box is not an acoustic room. A room does not pressurize the same as the interior of a speaker box. If your room is less than a wavelength you will only hear modal additions and cancellations but not the fundamental. You could be measuring in a superposition area or a phase addition.

To be able to measure a certain frequency and not a fractional you must have 5 overlapping modes in a room to not have superposition in the wave. A real fundamental is required at the frequency of interest.

In a room you can calculate modes for multiple dimensions at the same time. When you get below the prime mode you get partials that move across the room in a travelling wave. As the wave moves it induces phase coherence and the additions move as the phases match thus increasing SPL peaks moving across various dimensions. Because the peaks are moving in the room a stationary mic will detect various levels. You can measure SPL in any room but it may be that you are at a phase addition or somewhere between max and min. There are always modes and mixing of them in any room.

I am going to point out something is often missed - have you ever sat at an organ in a medium-large room and played the bass pedals and found one or two that you could barely hear? These organs can be both pipe organs and electronic organs. I KNEW those particular notes were bring produced by the organ and I could hear other frequencies much louder than they really were. We found that by moving the organ itself a few feet in any direction we could get those frequencies to come back. Were the organs defective? No! They produced all those frequencies at any time. But because of reflections and modal position we had acoustic additions and cancellations at the seated position. Just because the speaker or pipe can create the frequency does NOT mean the room will support it. What was happening was superposition of sound waves in a series of partial wavelengths in a room.

Absorption is a physical description of a simple thing - the conversion of energy to heat. The problem with measuring absorption is this: to actually measure absorption you would have to be able to measure very small amounts of heat loss in many materials.

What is easier to measure is to measure things that are also easier to observe the loss of energy that has greater change, such as "sound power" or overall energy in a room. This effect is what Sabine observed in his studies of rooms and reverberation. He observed that a room had a sound field that lasted a very long time after the actual sound was turned off. He could measure the "time" this sound continued after the end of the stimulus. When people or other objects were introduced to the room the time it took for the sound to decay to being unhear-able could also be measured. These items were then assumed to being responsible for the difference in the time it took for the sound to decay. This term was then described by Sabine as "Reverberation Time".

The problem was how to differentiate what item was causing this effect. People, seat cushions, wall materials and air were all responsible for this effect. To describe this absorptive effect, Sabine came up with a mathematical formula to convert this time change into a measurement to describe how much "stuff" had to be put into the room to change the RT by that much. Sabine's Formula was introduced. The term "sabin" was also made to describe the amount of this "stuff" needed.

PLEASE NOTE, at this point we did not measure actual absorption but the effects on the environment we observed when this "stuff" was put in the room. We still did not understand that different "things" had a different amount of "stuff" than other "things". We had to come up with a way to separate one "things", "stuff" from another "things", "stuff". One problem observed was that as you physically approached the "things" the RT time changed as you got closer to the "things". To separate out the "stuff" from one "thing" to another "thing" you had to be sure that other "things "were not also in the room to pollute the observation. This led to an "ideal" room to observe this "stuff" from only one "thing". This meant that the room itself could not contain "things" or materials that contained "stuff". Hence the search for a room designed for reverberation. A reverberant room made of materials that did not contain much "stuff" or absorption. "Things" were then renamed "materials" and "stuff" was renamed "absorption" with a quantifier named a sabin.

The reverberation room was named such because materials that absorb sound were removed from that room and it was constructed so that walls were smooth and hard like smooth **concrete or marble** or **very thick steel**. This maximized the RT of the room so that the field was mixed in both amplitude and phase over the largest volume that could be constructed. There are limits to this homogenized sound field such as not using this field when too close to a boundary such as a wall or ceiling. To get an adequate "diffuse" field required large rooms where the field created could be measured as being the same in magnitude at all places in the field and having a long enough RT time to allow many thousands of reflections that then created a mean free time and distance that allowed for phase mixing that then created a phase deficient volume where the idea of phase was irrelevant because of the randomness. This essentially created a volume of "air" that had nothing that could be measured except magnitude. To then measure the losses being inserted into this volume by adding a material it was necessary to "move" this volume of air sufficiently to measure the difference in RT time. This then required many months of experiments to determine what quantity of material to add to the room to "move" the room without destroying the diffusiveness of the rooms field. This led to the size wars in the lab areas. Finally, ASTM decided on a standard size sample. This was to be 8ft by 9 ft, or 72 Sq ft. Why this size you might ask? Originally it was because most reverb rooms in the world fell within a small limit in the volumes of the rooms that reflected the size of the rooms at Riverbank Labs. The reason it was 8ft by 9 ft was because it was the size that fitted into the Riverbank reverb room. No other reason. ISO went on later to specify 10 square meters of material area. Again, no real reason.

Diffuse sound power does not have any phase relationships. Since the room did not have a way of specifically observing a mean free path or time it is not possible to create one out of nothing. If you cannot ascribe a specific time to a "particle" of sound in traversing the reverb room you cannot calculate a phase to its travels as well. This is why you cannot have a phase to the absorption characteristic of a specific material. To be able to ascribe a specific attribute to a material you have to remove all other possible reasons for it. This was the reason for the creation of the reverberation room; - to remove all other possible reasons for loss of energy in the room.

As you can see, DIY absorption testing can not be done in a small room of less than 200 cubic meters (7000 cubic feet), a gypsum board lined room with absorption in the walls, with microphones in the direct field of the speakers, with mics near the boundaries, with people in the room, in rooms where the noise floor is above an absolute minimum, where temperature or humidity is not controlled or compensated for, with uncalibrated microphones, with equipment that is not precision calibrated, without an absolute reference. And that is only the tip of the iceberg.