4. Studio Set Up: How to Listen Correctly

At this point I would like to mention a very important aspect of conducting EQ tasks. To fully hear and feel the subtle changes in EQ you need two things: a great set of detailed headphones and an acoustically treated room.

The headphones will allow you to hear sound in isolation with the environment exhibiting no influence whatsoever on the sound. This is excellent for hearing very small detail on the quietest of sounds, and I regularly use headphones in tandem with monitors to detect and treat the smallest/quietest anomalies.

The room provides the overall listening of the sound and must be properly treated so as not to exhibit any bias or coloration of the sound, otherwise you are working blind/deaf.

If you cannot truthfully and accurately hear what goes in, how can you treat what comes out?

The following is a piece I wrote about how sound travels in a room. Please pay close attention to the facts presented in the text as they are more relevant to you than to a professional producer working in a commercial studio with high-end acoustic treatment. The following tutorial is based on not having your studio acoustically treated, and is only a guide to try to maximize the best assets in mixing in a home studio.

Sound Waves

Let us have a very brief look at how sound travels, and how we measure its effectiveness.

Sound travels at approximately 1130 feet per second.

Now let us take a frequency travel scenario and try to explain its movement in a room. For arguments sake, let’s look at a bass frequency of 60 Hz.

When emitting sound, the speakers will vibrate at a rate of 60 times per second. Each cycle (Hz) means that the speaker cones will extend forward when transmitting the sound, and refract back (rarefaction) when recoiling for the next cycle.

These vibrations create peaks on the forward drive and troughs on the refraction. Each peak and trough equates to one cycle.

Imagine 60 of these every second. We can now calculate the wave cycles of this 60 Hz wave. We know that sound travels at approximately 1130 feet per second, so we can calculate how many wave cycles that is for the 60 Hz wave. We divide 1130 by 60, and the result is around 19 feet (18.83 if you want to be pedantic about it). We can now deduce that each wave cycle is 19 feet apart. To calculate each half cycle, i.e. the distance between the peak and trough, drive and rarefaction, we simply divide by two. We now have a figure of 9.5 feet. What that tells us is that if you sat anywhere up to 9.5 feet from your speakers, the sound would fly past you completely flat.

However, this is assuming you have no boundaries of any sort in the room, i.e. no walls or ceiling. As we know that to be utter rubbish, we then need to factor in the boundaries.

These boundaries will reflect back the sound from the speakers and get mixed with the original source sound. This is not all that happens. The reflected sounds can come from different angles and because of their ‘bouncing’ nature could come at a different time to other waves. And because the reflected sound gets mixed with the source sound, the actual volume of the mixed wave is louder.

In certain parts of the room, the reflected sound will amplify because a peak might meet another peak (*constructive interference*), and in other parts of the room where a peak meets a trough (rarefaction), frequencies are cancelled out (*destructive interference*).

Calculating what happens where is a nightmare.

In this scenario trying to conduct small EQ changes can be both deceptive and fruitless.

This is why it is crucial for our ears to hear the sound from the speakers arrive before the reflective sounds. For argument's sake, I will call this sound 'primary' or 'leading', and the reflective sound 'secondary' or 'following'.

Our brains have the uncanny ability, due to an effect called the ***Haas effect***, of both prioritizing and localising the primary sound, but only if the secondary sounds are low in amplitude. So, by eliminating as many of the secondary (reflective) sounds as possible, we leave the brain with the primary sound to deal with. This will allow for a more accurate location of the sound, and a better representation of the frequency content.

But is this what we really want?

I ask this, because the secondary sound is also important in a 'real' space and goes to form the tonality of the sound being heard. Words like rich, tight and full all come from secondary sounds (reflected). So, we don't want to completely remove them as this would then give us a clinically dead space. We want to keep certain secondary sounds and only diminish the ones that really interfere with the sound.

Our brains also have the ability to filter or ignore unwanted frequencies. In the event that the brain is bombarded with too many reflections, it will have a problem localising the sounds, so it decides to ignore or suppress them.

The best example of this is when there is a lot of noise about you, like in a room or a bar, and you are trying to have a conversation with someone. The brain can ignore the rest of the noise and focus on 'hearing' the conversation you are trying to have. I am sure you have experienced this in public places, parties, clubs, football matches etc.

To carry that over to our real world situation of a home studio, we need to understand that reflective surfaces will create major problems, and the most common of these reflective culprits are walls. However, there is a way of overcoming this, assuming the room is not excessively reflective, and is the standard bedroom/living room type of space with carpet and curtains.

We overcome this with clever speaker placement and listening position, and before you go thinking that this is just an idea and not based on any scientific foundation, think again. The idea is to have the primary sound arrive to our ears before the secondary sound. Walls are the worst culprits, but because we know that sound travels at a given speed, we can make sure that the primary sound will reach our ears before the secondary sound does. By doing this, and with the Haas effect, our brains will prioritize the primary sound and suppress (if at low amplitude) the secondary sound, which will have the desired result, albeit not perfectly.

A room affects the sound of a speaker by the reflections it causes. We have covered this and now we need to delve a little more into what causes these reflections. Some frequencies will be reinforced, others suppressed, thus altering the character of the sound. We know that solid surfaces will reflect and porous surfaces will absorb, but this is all highly reliant on the materials being used.

Curtains and carpets will absorb certain frequencies, but not all, so it can sometimes be more damaging than productive. For this, we need to understand the surfaces that exist in the room. In our home studio scenario, we are assuming that a carpet and curtains, plus the odd sofa etc, are all that are in the room. We are not dealing with a steel factory floor studio.

In any listening environment, what we hear is a result of a mixture of both the primary and secondary (reflected) sounds. We know this to be true and our sound field will be a combination of both. In general, the primary sound from the speakers is responsible for the image, while the secondary sounds contribute to the tonality of the received sound.

The trick is to place the speakers in a location that will take of advantage of the desirable reflections while diminishing the unwanted reflection.

Now let us touch on using headphones when mixing or processing.

Good quality headphones can reveal details that some good speakers/monitors omit. In terms of sound processing, a good headphone is imperative as it will be unforgiving in revealing anomalies. In terms of maintaining a clean and noise free signal path, it is crucial.

On the flip side, stereo imaging and panning information is much harder to judge on headphones. Determining the spatial feel of a mix is very difficult to convey on headphones, but far simpler with speakers. Pans are pronounced and extreme on headphones and do not translate across well. Even EQ can come across as subdued or extreme.

I find that if I mix on headphones alone, then the mix never travels well when auditioned with monitors.

When using monitors and because the monitors are placed in front of us, our natural hearing perceives the soundstage as directly in front of us. With headphones, because the 'speakers' are on either side of us, there's no real front-to-back information.

Headphones also provide a very high degree of separation between the left and right channels, which produces an artificially detailed stereo image.

Our brains and ears receive and analyze/process sound completely differently when using headphones as opposed to monitors. When using headphones, each ear will only hear the audio carried on the relevant channel, but when listening to a pair of speakers in a room, both ears will hear the signals produced by both the left and right loudspeakers. The timing differences associated with this acoustic 'crosstalk' between the two channels and each ear lie at the core of the 'stereo illusion'.

You also need to factor in the fact that different people perceive different amounts of bass - factors such as the distance between the headphone diaphragm and the listener's ear will change the level of bass. The way in which the headphone cushion seals around the ear also plays a part, which is why pushing the headphones closer to your ears produces a noticeable increase in bass. This increases the bass energy and this alone negates the idea of having correct tonal balance in the mix being auditioned. Trying to EQ with bias to any frequency demotes the whole process as useless.

With monitors both ears hear both the left and right channels. When listening to ordinary stereo material via headphones, we have only the differences in level between the two channels to go on, and hence the stereo images become non-linear and ill-defined. In fact, most people perceive the individual sound sources to lie on a line running directly through the centre of the head, instead of being portrayed in front of us as they would be with loudspeakers. This radically different presentation is what makes judging stereo signals and panning mono ones so much more difficult on headphones.

If your room is acoustically problematic and you have poor monitors, then headphones may well be a better and more reliable approach. But it is a lot harder to achieve the same kind of quality and transferability that comes more naturally on good monitors in a good acoustically treated room.

I find that if I record and check all my signals with headphones, then I am in a strong position to hear any anomalies and be in a better position to judge clarity and integrity of the recorded signals. This, coupled with speaker monitoring, assures me of the best of both worlds; clarity and integrity married with spatial imaging.

Ultimately, any processing that you conduct will require a truthful (accurate) listening environment, be it headphones or acoustically treated room or, preferably, BOTH.

When dealing with EQ this becomes even more vital as EQ usually entails processing with very small changes and these changes can be almost inaudible in the bigger picture of a mix. In an acoustically treated room with good frequency and flat monitors, EQ changes of less than 1 dB can be heard.

The whole of this chapter has been written to offer you an insight into how crucial the 'listening' experience/environment is particularly when dynamic processing with small changes comes into play.
EQ adjustments are not about huge sweeping changes to a sound but about subtle changes that can either define a sound or colour it. A poor room and poor headphones will offer an inaccurate presentation of the sound that needs processing.

Listening set up

The best way I can explain how to set up the listening position is to use my own home studio set up as an example.

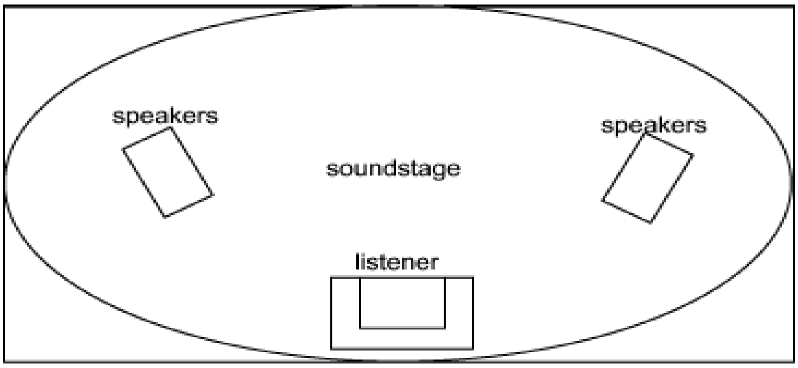
I use PMC TB2S+ passive monitors powered by a Bryston 4B Pro amplifier. Because my home studio has had a great deal of acoustic treatment, I am able to position the monitors from the back wall at a sensible distance without too much worry about reflections or cancellations.

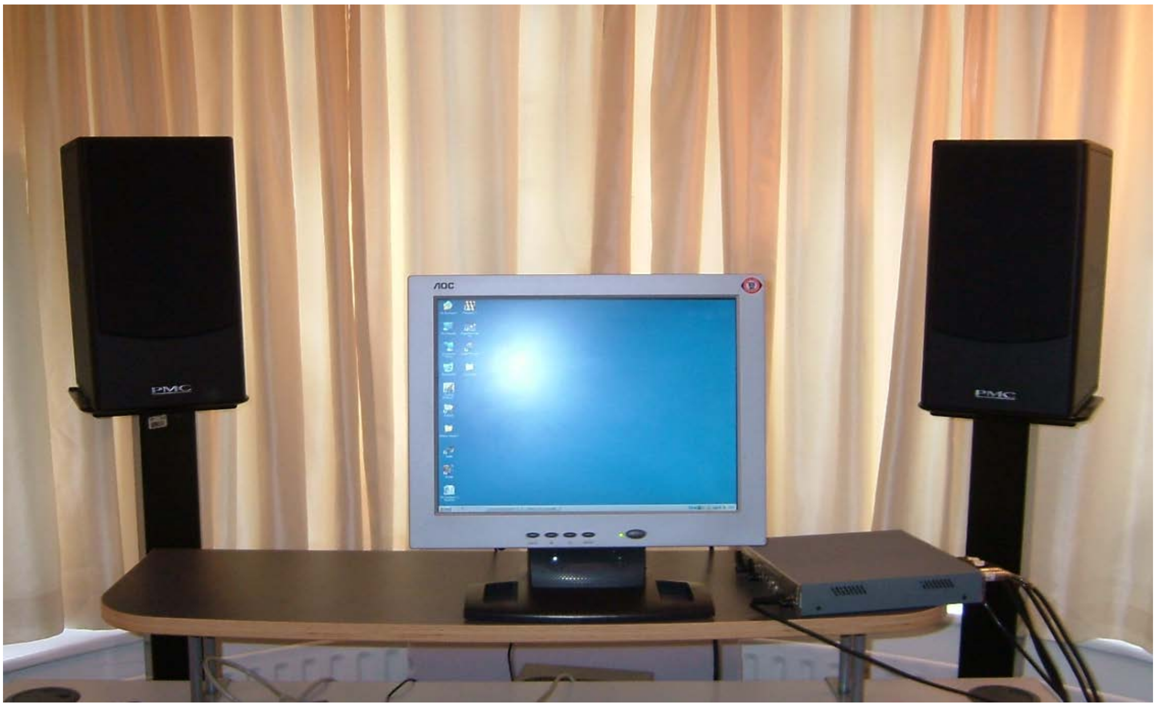
We have touched on reflections, but not phase cancellation. The principle is very simple; when two identical signals are in anti-phase (180 degrees out of phase) they cancel each other. If the monitor is a quarter wavelength away from a reflective surface, the reflective wave returns to the monitor in anti-phase and the original signal then gets cancelled out.

In a real world scenario this means that positioning the monitors too close to the rear wall can cause cancellation, resulting in troughs in the frequency response, or bounce back in phase causing peaks in the frequency response.

Of course, there are ways to overcome this problem and the first and foremost solution is to acoustically treat your room. If this is not a feasible solution then flush mounting the speakers tightly against the rear wall helps to eliminate cancellation. If this is not viable then placing the monitors further away from the rear wall can be helpful, but there are other issues that can make this problematic. Firstly, this means you are getting too close to other reflective surfaces. Secondly, the distance between the rear wall and the boundaries becomes too equal and thus reflections will start to dominate.

My advice is to acoustically treat your room, even if it is a little and temporary, and this does not have to include a huge budget. My set up is as follows:





I generally suggest the monitors be placed at an angle of 60 degrees to the listener and the whole listening 'stage' to form an equilateral triangle. This provides the optimum angle to fully image the entire stereo field.

My room (as seen from the above image) is a rectangular room with a bay window area that acts as a half decent bass trap. My monitors are placed in the bay and the angle of slant between them forms a 60 degree apex to me. I have also made sure to be the 'right' distance from the monitors so I receive the full stereo image.
Some people like to have their monitors pointing at their nose and in between their eyes. Others like to have the monitors facing a little past the ears. To find the optimum placement you need to read the specifications of your monitors. Some monitors are designed to be aimed directly at the listener (Genelec is an example) and others are designed to face forward into the room, for example, PMC.

Try to find the best possible position (based on monitor specs and room dimensions) and experiment with some good mastered reference mixes to make sure the full stereo image is heard. I am not going to get into testing software for room acoustics as this is pertinent to the room's treatment, but it does help to test the reference mix with varying monitor placements.

The image also shows that I have my monitors mounted on good solid speaker stands that are sand filled to abate any vibrations etc. If your room does not allow for the use of stands and your monitors are placed on your desk, then consider using some form of dampening and place the monitors on these so as to avoid any vibrations etc.

The following are brief explanations of the terminology used when dealing with monitor placement.

Distance to side wall and back wall

Differences among speakers can influence positioning, so you must always read the manufacturer's specifications before starting to position the speakers. A figure-of-eight pattern may be less critical of a nearby side wall, but very critical of the distance to the back wall.

The reverse is true for dynamic speakers that exhibit cardioid patterns. In general, the further away from reflective surfaces, the better. It is also crucial to keep the distances from the back wall and side walls mismatched. If your speakers are set 3 feet from the back wall, do NOT place them 3 feet from the side walls, place them at a different distance.

Another crucial aspect of the listening position and speaker placement is that the distance from your listening position to each speaker be absolutely identical. It has been calculated that an error of less than ½" can affect the speaker sound imaging, so get this absolutely correct.

Distance to speakers from listening position

Once you have established the above, you now need to sort out the distance from the listener to the speakers. I work off an equilateral triangle with the seating position being at the apex of this triangle. The distances must all be equal. The other factor to consider is the distance between the speakers. Too close and you will get a narrow soundstage with the focus being very central. Widening the distance between the speakers will afford you a wider stereo width, but too far and you will lose the integrity of the soundstage.

Toe-in

This is the angle of the speakers facing the listener. There are a number of factors that influence the angle of the speakers. The room, the speakers themselves, and your preferable listening angle I always start at an excessive toe-in and work outwards until I can hear the soundstage perfectly. The 60 degree recommendations is a good one, so please bear that in mind and start from this before venturing into other angles.

Tilt

Depending on the brand of the speakers, most speakers are meant to be level set, but some might require tilting and in most cases, the tilt is rear high. If you have to have the speakers tilted then start off level and work from there.

Listening height

You will find that the optimum listening height is that of the speaker's centre being at exactly ear height. However, certain speakers have their own specific height recommendations. You will find that with 3-way systems that incorporate top, mid and sub woofers, the listening height is more customized to account for the woofer placements in the speaker cabin or housing.

A little understanding of the dynamics and physics of how sound travels in a given environment can only be an asset to you.

I hope this chapter goes a little way in helping you to bend your head around how sound travels in an environment and how you can get the most out of the listening process.