Speaker Placement

The following document is an appendix used regularly in our consulting practices. However, we provide this free to all. The sections of this document are:

- Appendix A: Main Speaker Placement
- Appendix B: Center Channel Placement and when to use 2 Center Channels
- Appendix C: Rear speaker placement, dipole vs. direct radiating.
- Appendix D: Subwoofer placement and number of subwoofers

We hope you find the document useful.

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Appendix A: Main Speaker Placement

There are a variety of philosophies and theories. Oddly enough, while the methods vary greatly, most of the results are very similar. However, we will examine one variation of theories that lead to very different results.

The first variation of theories has to do with the speaker placement from adjacent walls. One theory states that the speakers should not be placed equal distant from each of the side walls, nor should this distance be the same. There are variations on this theory that break down what the ratios of these dimensions should be in order to reduce bass mode effects. However, the excitation of the parallel walls is typically a greater concern than the excitation created from the distance of the speaker to a particular wall. In our experience, this type of placement can improve frequency response characteristics, it is generally poor for overall soundstage balance. For the best soundstage balance the speakers should be equi-distant from the side walls and be a different distance from the rear walls. George Cardas has postulated on a formula for these distances. This is a good starting point for basic dynamic speakers, but can vary greatly for odd shaped rooms or for planer speakers.

The calculations that Rives Audio performs will usually yield near the best results. The absolute optimal results can only be found through listening, as there are so many interactions occurring in any room it is impossible to calculate all of them, including listener preference. For example, in general placing speakers closer to the rear wall will yield stronger bass, but generally at the expense of a clear image and soundstage. Bringing speakers together can create a more coherent image, but it also makes the soundstage smaller. In general you would like to avoid placement that gives large peaks or nulls in the bass region at the listening position. Nearly all of the formulas published use either a 1/3 rule or 1/5 rule. Meaning the speaker is placed either 1/3 or 1/5 the distance of the length of the room from the rear wall.

The biggest key to speaker placement is patience. It requires a lot of time, a lot of listening, and a lot of patience. You can not rush this process. Even though it requires patience, it should be a fun process. If you are not patient or simply don't want to bother with this step you should either have someone well trained in acoustics calculate values that will likely be within 95% of the best performance, and/or have them actually place the speakers for you.

If you are using Rives Audio calculations, start with the speakers in the location specified. Listen for a while (a couple of days) with the speakers in this position. The first thing we recommend is finding the optimal position with respect to the back wall. Move the speakers very close to the back wall so that you can hear what they sound like very close to the back wall. Then move the speakers much further into the room than is recommended and listen. Now you are ready to find the optimal place. This can take a while, even days, and the result may be a change of only a few inches or even less.

The second aspect is to determine the distance off the side walls. It is almost guaranteed that this distance should not be the same as the distance from the back walls, as this will re-enforce a particular wavelength (frequency). This should be a similar exercise to the first one. Listen at the recommended location and then take the speakers all the way to the side walls and listen again. You will quickly get a feel for what changes occur based on bringing the speakers closer together of further apart. There are two caveats to be careful of. The first is if you are using acoustical treatment on the sidewalls to absorb the first reflection you need to be sure it is still absorbing the first reflection when you move the speakers. The second caveat ties into the third parameter that will be set, which is how much the speaker is angled in to the listener. In general, the closer the speakers are together the less they should be angled in. This can make things a little tricky, because if you are looking to maximize the soundstage you will need to change both of these simultaneously to get the best results. In order to find a most likely location measure the distance

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of the speaker to the listener. Then mark a point that is half of this distance behind the listener. So if the speakers are 10 feet from the listener, mark a point 5 feet behind the listener. Aim the speaker at this point at all times while finding the distance the speaker should be from the side wall. There are some speakers that do not work very well with this speaker angle method, but most do, even planers. The method we find most effective is to start with the speakers closer together than they should be, gradually move them apart and maintain their pointing at the point marked (as described previously). Vocals, particularly female, work very well here. Listen to the vocal, it should be well defined between the speakers. As you move the speakers apart the vocal will become less defined, and ultimately will sound like it is coming from two separate speakers rather than a point in between. When this occurs you have moved the speakers too far apart and should move them in slightly.

Now it is time to adjust the angle. This works in a very similar fashion. Turn the angle so that the speakers face the listener. Now adjust the angle outward slightly. Listen for the same type of breakdown in the center of the vocal. When it no longer sounds like a point source between the two speakers, the angle is too far out. Adjust slightly inward. If this angle is very different from the original angle that you used to establish how far apart the speakers were made you should re-adjust the distance between the two speakers. Adjusting the distance between the two speakers and the angle can be a time consuming and iterative process. Most cases only require 2 iterations, but in some extreme cases it can require several.

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Appendix B: Center Channel Placement and when to use 2 Center Channels

Center channel placement is fairly straight forward. With today's processors the distance from the center channel to the listener is not terribly important. There are still a few things to be careful of. First the center channel should be centered about the TV screen, even if the screen is not centered between the two main speakers. The center channel is the dialog channel, and it should appear that the dialog is coming from the people speaking, not elsewhere. It is of course recommended that the TV screen be centered between the two main channels, but sometimes this is not possible. Second, the center channel should be located as close to the screen as possible without causing visual interference or electro-magnetic interference with the TV. Most center channels are well shielded (or have a neutral magnetic field) so the latter is not a problem.

Most center channels are limited in bass frequency so their placement relative to the rear wall is not very critical. If they do have full range capabilities, then it is recommended they are placed the same distance from the rear wall as the main speakers if possible.

Another caveat to avoid is placing the speaker too high or too low. This can cause reflections off the floor or ceiling and degrade the clarity of the center speaker. If the speaker must be close to the floor or ceiling it is best to put some sound absorbing material on either the floor or ceiling to absorb the first reflection of the center channel. If it is on the ceiling products such as Sonex or fabric wrapped Owens Corning 703 board work well, if it is on the floor an area rug can be very effective.

Lastly, is to determine when 2 center channels are warranted. Many people like the idea of 2 center channels because there is a lot of sound coming from the center channel, and 2 channels can handle that better than one. It is estimated that the average movie soundtrack has 60% or more of the sound directed at the center channel. Also, many people with projections screen TVs do not like the notion of sound coming from above or below the screen, and therefore try a speaker above and below. All of this may seem well and good, but in most cases 2 center channels are more problematic than they are worth. Typically you wind up with interfering wave patterns between the two speakers that cause areas where certain frequencies are cancelled out and other areas where they are doubled. If this seems difficult to understand imagine dropping a pebble in a pool of still water. The ripples radiate from where the pebble entered the water. Now drop a second pebble in the water in a different location, and you can see how the two ripple effects interfere with each other. This is similar to what happens with two center channels. It is not a problem with stereo channels, because their signals are different and designed to function in a stereo mode. But with two center channels the signal is the same and thus the interference pattern. In general we recommend avoiding 2 channels, and rather than buy 2 center channels, and the necessary amplifiers, buy one better center channel.

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Appendix C: Rear speaker placement, dipole vs. direct radiating.

First is to determine which, dipole or direct radiating speakers should be used. Lucas THX recommends dipole speakers for the rear channel movie soundtracks. This is generally good advice for larger theaters where you will seat 8 or more people. The dipole has the advantage of disappearing as it is producing sound in two directions at once. It is unlikely that any one person will have it directly radiating at them, but rather it will be producing a large area of sound in the rear of the theater.

Direct radiating speakers frequently sound better for smaller theaters that seat fewer people. The advantage is that they can better define the rear soundstage. This can be very impressive when that jet flies overhead. However, they have the disadvantage of being a point source and clearly defined, particularly if someone in the theater is seated to close to the speaker. In this case the rear speaker can sound too loud for that individual and can be annoying rather than the great special effects it was meant to be.

Some processors, like the Lexicon, use a combination of both. This can be very effective in very large theaters. But as it is not often used we will handle this type of theater on a case by case basis.

Once you determine what your theater will be like and which speakers you will use then you will have to figure out placement. We do not recommend placement based on frequency response, but rather based on listener position. Dipoles are the easiest to place. If there is one row of seating the center of the dipole should be parallel to that row. If there are two rows, it should be between the two, approximately 2/3 back from the first row. Dipoles can either be ceiling mounted or wall mounted. Wall mounted is generally preferred and the dipole should be at approximately the listeners ear height or sometimes slightly higher. In these cases we do want the reflective surfaces near the speakers as this reinforces this channel, and it is not designed to have much in the way of clarity. It is really designed for effects. It is interesting to play the rear channels of a movie soundtrack through the main speakers with all other channels off. This way you can hear how little information and typically limited bandwidth these tracks have on them. It is also for this reason, we do not recommend spending large sums on the speakers for the rear.

If you have decided on direct radiating speakers this will improve the rear effects, but there are some things to be careful of. They can not be too close to any listener or they will be annoying. Placing them near the ceiling and far back in the room is generally a good idea. If they are full range speakers, you may want to be somewhat cautious of getting them too close to the corners as it could over re-enforce the bass on the rear channels.

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Appendix D: Subwoofer placement and number of subwoofers

This can be the most difficult speaker to place. There are a variety of reasons for this, but in general, bass frequencies are most affected by their placement in the room. First let's examine placement with one subwoofer. This is actually the more difficult than two subwoofers. Subwoofers can either be placed in corners, where they have the benefit of sound reinforcement from adjacent walls. This means less amplification is required and less distortion on the sound the woofer is producing. However, this comes at a price. While many subscribe to the thought that bass is omni directional, a woofer placed in one corner can usually be detected as being in THAT corner. Omni-directional does not necessarily mean it can not be detected as a sound source. The other expense is that corner placement excites room modes and generally delivers less than a flat frequency response.

When we calculate room response curves theoretically, we do it to find out how flat a response we can achieve. This usually yields a subwoofer placement that is slightly off center in the room and fairly far out into the room. This gives us a good idea of how flat we are able to achieve, but inevitably this is not the best overall sound for the subwoofer. It is for this reason that we do not even specify subwoofer placement, rather we give a location where we found the flattest frequency response.

There really are two potential locations, near center and near the rear wall (within 1/8 of a wavelength of highest frequency the subwoofer is set to produce*), or in a corner and within 1/8 of a wavelength of that corner. We recommend that you try both of these locations. If you can not distinctly detect the subwoofer when it is in the corner, then this is a good place for it. Otherwise, move it to the center. Also, if the subwoofer is in the corner, we generally recommend a non-symmetrical angle for the subwoofer. In other words, not perpendicular or at 45 degrees to the adjacent walls.

Two subwoofers are easier to place and result in a flatter frequency response in almost all situations. If you have two subwoofers, corner placement behind the main speakers is almost frequently the best placement if you use the subwoofers in stereo. If the subwoofers are only used in mono and for HT then placing the subwoofers mid way along opposite walls will result in the flattest frequency response. In odd shaped rooms, there is almost always better buy non-symmetrical placement, but this may not be practical for other reasons. When we evaluate rooms with odd shapes we will note where theoretically the second subwoofer should be placed if it is not in the corners behind the main speakers. In either case the subwoofers should be within 1/8 of a wavelength to the corner or wall they are placed against.

When placing two subwoofers in adjacent corners they should be placed slightly differently. In other words, there should be a difference in their distance from the rear to side wall for each subwoofer, and their should be a difference in these dimensions and the other subwoofer. The reason for this is to avoid exciting one particular mode with both subwoofers. Also the subwoofers should be angled and again not symmetrically. If you can afford a second matching subwoofer, this is generally preferred to a single more expensive subwoofer. You will almost always achieve a flatter frequency response and a more realistic overall integration with the main system.

The second aspect of setting up a subwoofer is getting the phase correct. Getting the subwoofer in phase can be a little tricky for a novice. The best way is to use a test tone at the crossover frequency of the subwoofer. Play this tone and adjust the phase so that the tone is the loudest at the listening position. Using an SPL meter can be a great help here. When it is at the loudest the subwoofer is in phase at that frequency at the listening position. It is only in phase for that frequency and at the listening position, but this is subjectively the most critical area.

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* Note: 1/8 of a wavelength (in feet) = 1130/wavelength * 1/8
Thus for a 80 Hz wavelength = 1 foot 9 inches

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