

Visual Representations of "Imaging"

Section A



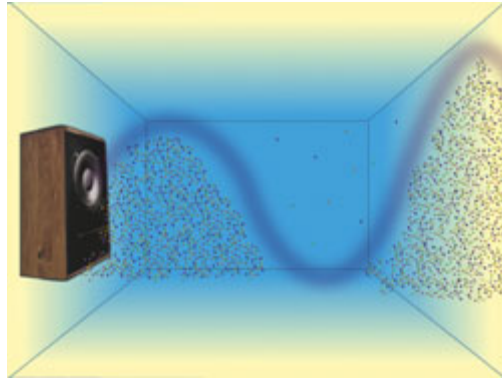
Physical Sound Waves versus the Imagined Placement of Sounds between the Speakers

We relate to sound in two ways: We feel (and hear) the physical sound waves that come out of the speakers, and we imagine the apparent placement of sounds between the speakers.

PHYSICAL SOUND WAVES

Whether in the control room or living room, sound first comes out of the speakers in sound waves and travels through every molecule in the room, hitting all parts of your body. Just as waves travel on water, sound waves travel through the air. When the speaker pushes out, it creates compressed air (denser air with a higher air pressure) in front of the speakers. This compressed air corresponds to the crest of a wave in water. When the speaker pulls back in, the sound doesn't return. It creates "spaced out" air (rarefied air). As we all know, when you have a water fight in the pool and you push the water and pull your hand back, the water doesn't come back. Instead, a trough is created. In the air, this trough corresponds to spaced out air. Therefore, sound travels in waves consisting of alternating compressed and rarefied air. This is one way that we perceive sound.

Visual 4. Sound Waves: Traveling Compressed and Spaced-Out Air



“IMAGING”

The second way we perceive sound is by imagining sounds between the speakers. The apparent placement of sounds between the speakers is called “imaging” because it is a figment of our imagination. So you see, we’re not talking about reality here. When we imagine a sound, like a vocal, to be between the speakers, there is, in actuality, no sound there. The same sound is coming out of both speakers, traveling throughout the room, and we just imagine the sound to be between the speakers.

The same thing happens when you listen through headphones: When you hear a sound in the middle of your head . . .

Visual 5. Imaging in Head



. . . there’s no sound there. Your brain’s there!

Visual 6. Brain in Head



With no imagination process, such as when you are asleep, there's no imaging. If you aren't paying attention to a mix or if you are off to the side of the speakers, imaging does not exist. On the other hand, physical sound waves still hit your body when you are asleep. Even if you aren't paying attention, sound waves are still slapping every cell in your body. You feel sound waves even if you aren't listening.

Imaging requires active imagination to exist. Sound waves do not.

Some people do not hear imaging. There are those who are simply not conscious of it. But there are also people who don't hear imaging because the shape of their outer ears actually causes phase cancellation. This physical difference destroys their ability to place a sound between the speakers.

People relate to sound in two ways: They feel the sound waves and/or they perceive imaging. Although professional engineers utilize both modes of perception to gain as much information about the mix as possible, they are often more concerned with the dynamics that exist in this imaginary world of imaging.

A wide range of dynamics are created by different placements of sounds between the speakers, and these dynamics are utilized to create all the various styles of mixes that fit all types of music and songs.

Visual 7. Dynamics Created with Studio Equipment



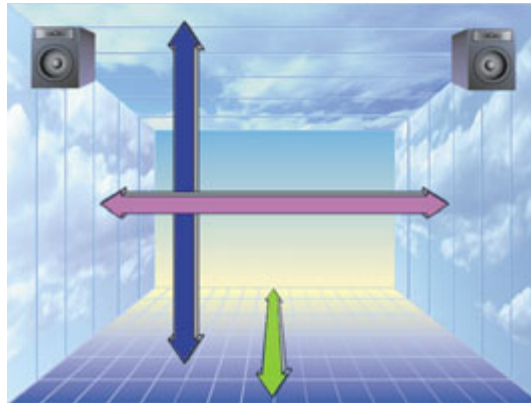
Section B

The Space between the Speakers

MAPPING VOLUME, FREQUENCY, AND PANNING VISUALLY

In order to explain different styles of mixes, let’s map out how each piece of equipment affects imaging, the apparent placement of sounds between the speakers. There are three basic parameters of sound corresponding to the X, Y, and Z visual axes.

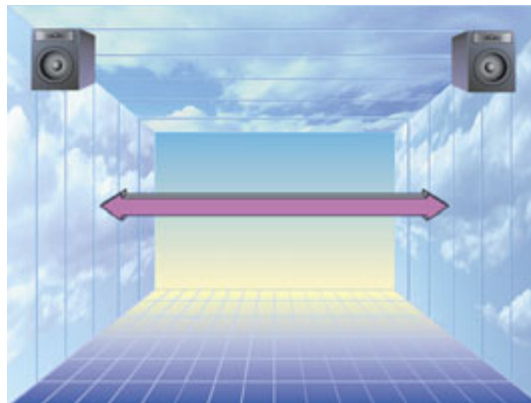
Visual 8. Sound to Visuals: X, Y, Z Axes



PANNING AS LEFT TO RIGHT

Panning, the left/right placement of sounds between the speakers, is naturally shown as a left to right placement visually.

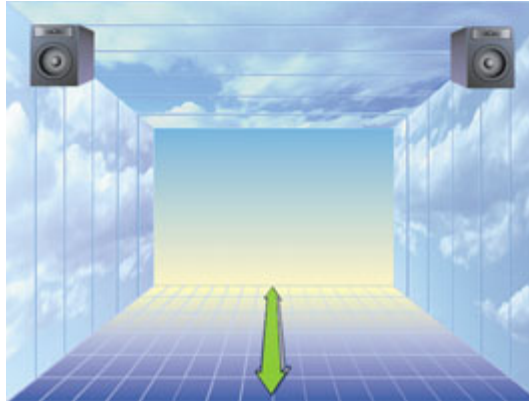
Visual 9. Panning: Left to Right Placement



VOLUME AS FRONT TO BACK

Sounds that are closer to us are louder and distant sounds are softer, therefore, the volume of a sound in the mix can be mapped out as front-to-back placement.

Visual 10. Volume: Front-to-Back Placement



As you have probably noticed in mixes, some sounds are right out front (normally vocals and lead instruments), while other instruments, like strings and background vocals, are often in the background (consequently, the term *background vocals*). If you want a sound out front in a mix, the number one thing to do is to raise the fader on the mixing board. Lowering the volume will, of course, put the sound in the background.

Although volume is the number one function of front-to-back placement, other studio equipment can be used to make sounds seem more out front. Boosting an equalizer at any frequency range will normally make it more out front because the overall sound *is* louder. Boosting certain frequencies will accentuate the presence of a sound more than others, making it seem even more in your face. Compressor/limiters can also be used to make sounds more out front. They do this by stabilizing the sound so it doesn't bounce around so much in volume. When a sound is more stable, our minds can focus on it more clearly, making the sound more present. Short delays less than 30 milliseconds (ms), called *fattening*, will also make a sound more present. Also, certain harmonic structures of sounds will stick out more than others. For example, a chain saw will cut through a mix, much more than a flute. Time-based effects, such as chorus and flanging, and longer delay times tend to make a sound less present simply because it is obscured by a second delayed sound. All of these effects are discussed further in Chapter 4, "Functions of Studio Equipment and Visual Representations of All Parameters."

In reality, you need other cues, such as delays and reverb, to help gauge the distance a sound is from you. This is because you could have a loud sound that is really far away, or a soft sound that is really close. However, if you have a sound that is playing the same volume, and you raise or lower the fader level, technically you don't know if the sound is getting more distant or just getting softer in volume.

If you happen to be hanging out in an anechoic test chamber (a room that absorbs all sound so there are absolutely no reflections off the walls), you can't tell the distance of a sound by volume alone. However, for the purposes of creating a framework as a tool to explain all the structures of mixes possible, it works well to show volume as front to back. After all, the louder the sound, the more out front it will appear in the world of imaging and mixing.

PITCH AS UP AND DOWN

There is an interesting illusion that occurs with high and low frequencies in the world of imaging—highs are higher and lows are lower. Instruments such as bells, cymbals, and high strings always seem to be much higher between the speakers than instruments, such as bass guitars, kick drums, and rap booms. Check it out on your own system. Play a song and listen to where high- and low-frequency sounds seem to be between the speakers. Height is especially noticeable in a car.

Visual 11. Frequency: Low to High Placement



There are a number of reasons why this illusion exists. First of all, low frequencies come through the floor to your feet; high frequencies don't. A piccolo will never rumble the floor. In fact, professional studios are calibrated to exactly how many low frequencies travel along the floor to your feet. (This is why some engineers like to work barefoot!)

Another reason that explains why highs are high is the fact that our bodies have a large resonant chamber, the chest cavity, below a smaller resonant chamber, our head. Voice instructors teach you to use these resonant chambers to accentuate different frequency ranges. If you want to bring out the lows, resonate the stomach.

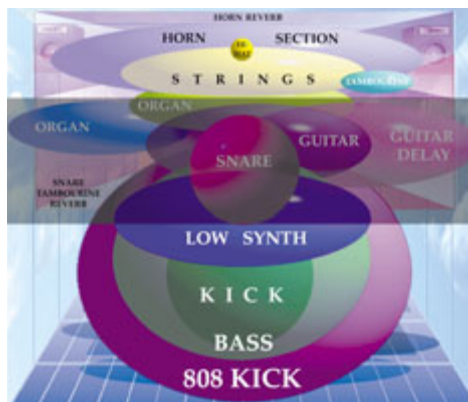
On a more esoteric level, there are energy centers in the body called *chakras* that respond to different frequencies. These frequencies are specifically mapped out from low to high, from the base of the spine to the top of the head.

Visual 12. Frequencies in Us



These energy centers might very well contribute to our perception of highs and lows in the world of imaging. But regardless of why it happens, the truth is that high frequencies do seem to appear higher between the speakers than low frequencies. This is also probably why they call high frequencies, “high,” and low frequencies, “low.” Therefore, we’ll put the high frequencies up high and the low frequencies down low in all the visuals.

Visual 13. Song with Highs and Lows Highlighted



You can raise or lower a sound by changing the pitch with harmony processors and aural exciters or by having a musician play their instrument in a higher octave or chord inversion. As we’ll discuss later, this becomes important when one sound masks, or hides, another at a particular frequency range. Spreading sounds evenly over the frequency spectrum can help make your mix much cleaner and clearer in the first place. Since equalization controls the volume of frequencies, with an EQ you can move a sound up and down . . . at least a little bit. No matter how much bass you add to a piccolo, you will never be able to get it to rumble the floor, and adding treble to a bass guitar will only raise it up so much.

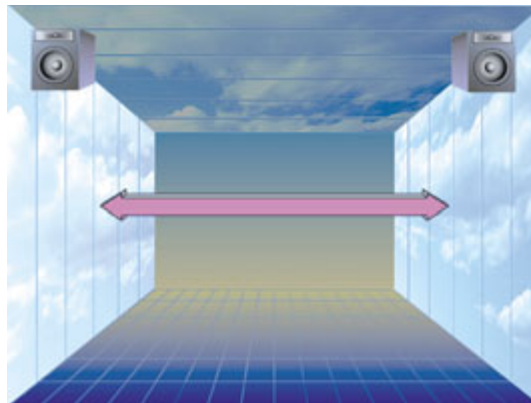
DEFINING THE BOUNDARIES OF THE 3D STEREO FIELD OF IMAGING

Consider this: The image of a sound never seems to appear farther left than the left speaker or farther right than the right speaker. Right? Right, unless the room is strange. (Sometimes unusual room acoustics can make sounds seem to come from odd places in the room.)

Remember. . .we’re not talking about reality here. This is the world of “imaging.” Because the exact placement is a figment of our imagination, different people see the left and right boundaries differently. Some say that it can’t be farther left or right than the speaker itself. Some people with quite active imaginations see sounds as far as a foot or two outside of the speakers. However, most people see sounds about six inches to the left or right of the speakers (depending on the size of the speakers). Check it out for yourself. Pan a sound all the way to the left or right and listen to see how much farther the image seems to be beyond the speakers.

The left and right boundaries of imaging are shown like this:

Visual 14. Left and Right Boundaries of Imaging



When you turn the panpot (the left/right panning knob) it's as though you can "see" the sound moving left and right between the speakers. Now consider front to back boundaries in regards to volume. Just how far do sounds recede into the background as you reduce the volume? How far behind the speakers is a sound before it disappears altogether?

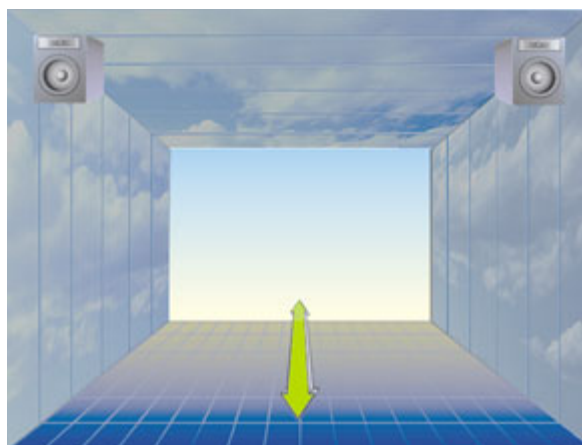
Most people seem to imagine sounds to be about six inches to two feet behind the speakers, depending on the size of the speakers. Check out how far back the sound seems to be around various speakers. Normally, sounds are only a short distance behind the speakers.

There is a psychoacoustic phenomenon based on previous experience wherein certain sounds appear to be even farther behind the speakers than the normal imagined limit. For example, if you place the sound of distant thunder between the speakers, it can seem to be miles behind the speakers. The sound of reverb in a large coliseum or a distant echo at the Grand Canyon might also seem to be way behind the speakers. This is a good illusion to remember when trying to create unusually expansive depth between the speakers.

As previously mentioned, when you turn a sound up, it appears to be more out front in a mix. But how far out front will it go? First, no matter how loudly you raise the volume of a sound, you can't make it come from behind you. In fact, sounds rarely seem to be more than a short distance in front of the speakers. Most people imagine sounds to be only about three inches to a foot in front of the speakers. Again, it depends on the size of the speakers. A loud sound in a boom box will appear only about two inches in front, whereas sounds in huge PA concert speakers might appear as far out front as six to 10 feet. (Check it out on your own speakers.)

Regardless of our perception of the exact limits of imaging from front to back, it is easy to imagine the placement of sounds from front to back, with volume being the main factor that moves a sound. Therefore, the normal stereo field is actually three-dimensional! We’ll show the rear boundaries of imaging like this (the front boundaries aren’t shown because they would just get in the way):

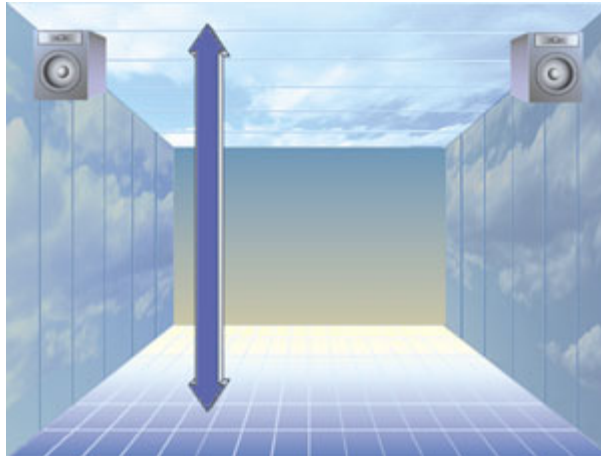
Visual 15. Front and Back Boundaries of Imaging



Finally, what about the upper and lower limits of imaging? As discussed earlier, high frequencies seem to be higher between the speakers than low frequencies. There are a couple of questions: How high are high frequencies? How high do the very highest frequencies we hear seem to be between the speakers? Some people say sounds never seem any higher than the speakers themselves. Some say sounds seem to float a few inches above the speakers. Again, the exact limit depends on the size of the speakers and the imagination of the listener. Regardless of the exact limit, sounds never seem to come from the ceiling. Imaging is limited to somewhere around the top of the speakers.

Now what about the lower limit? Low frequencies commonly come through the floor to our feet. Therefore, the floor is the lower limit. The upper and lower limits can now be shown like this:

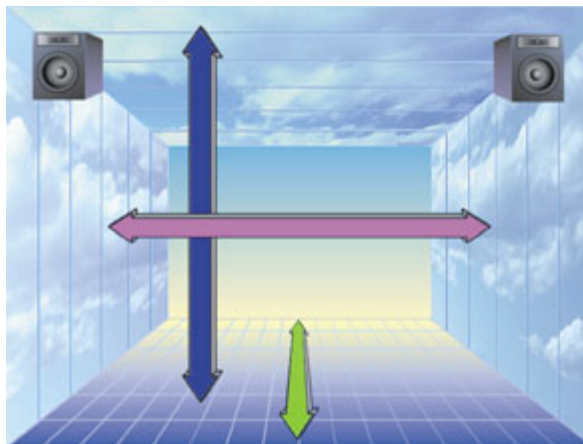
Visual 16. Up and Down Boundaries of Imaging



No matter how far we pan a sound to the left, it will never sound like it is coming from much farther left than the left speaker. Likewise on the right. We “see” sounds only a little bit in front of and behind the speakers. We don’t hear sounds higher than the speakers, but they do come through the floor.

The limits of imaging can be shown with this one visual:

Visual 17. Only Place Mix Occurs



Speaker size affects the perception of the boundaries of imaging. With a boom box, we normally don't hear sounds more than a couple of inches left/right, front/back, or up/down beyond the speakers

Visual 18. Imaging Limits around Boom Box



When listening to a huge PA at a large concert, the image might appear as far out front as 10 feet, and it might be 10 feet behind the speakers. It might easily be seem to be as much as six feet farther left and right than the speakers themselves, and might be much higher and lower than the speakers.

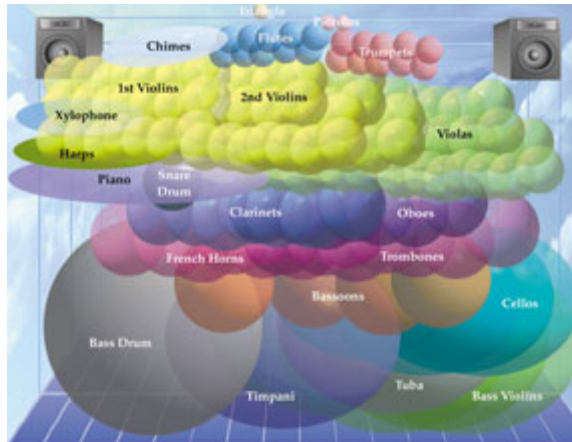
Visual 19. Imaging Limits around Large PA



This is the space where sounds in a mix occur. In the world of imaging, sounds do not occur anywhere else in the room. Most importantly, you can see, *this space is limited*.

Therefore, if you have a 100-piece orchestra between the speakers, it's going to be crowded.

Visual 20. Large Orchestra Crowded between Speakers



You can't hear each individual violin in the mix because it is too crowded; you only hear a violin section. However if you have only three violins, you can hear each one quite clearly.

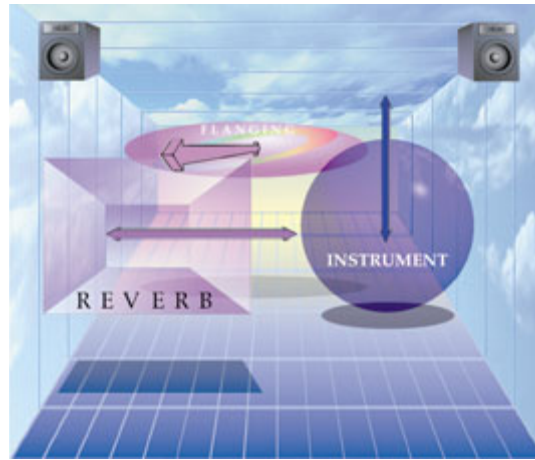
Visual 21. Three Violins with Plenty of Space in Between



Masking, where one sound hides or obscures another sound, is a major problem in mixing. If you have two sounds in the same place between the speakers, one of the sounds will often be hidden by the other sound. Because the space between the speakers is limited and masking is such a major problem in a mix, the whole issue of mixing becomes one of . . . crowd control!

As you can see, a sound can be moved around in the space between the speakers by changing the volume, panning, and pitch (equalization will make small up/down changes). These same three parameters are used not only to move sounds around between the speakers, but also to place and move effects, including delay, flanging, and reverb.

Visual 22. Movement of Sounds with Volume, Panning, EQ



A large part of mixing is simply to place each of the sounds in different places between the speakers in order to avoid masking so that you can hear each sound clearly. However, as I’ll get into later, there is a bit more to it. Sometimes you just might want sounds to overlap, creating a fuller type of mix (instead of placing sounds apart from each other). You might want some sounds to overlap and others to be separate in order to highlight them. There are a number of possibilities.

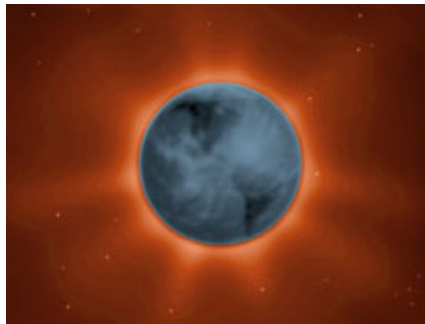
As you might well be thinking, if masking is such a big issue, then it is important to know how much space a sound takes up in this limited world of imaging. In fact, not only do different sounds take up more or less space, equalization and effects can make a huge difference as to how much space a sound uses up.

Section C

Visual Representations of Sounds

Just how big is each sound in this world of imaging? With limited space between the speakers, you need to know the size of each member of the crowd so you can deal with the big problem of masking. The more space a sound takes up, the more it will hide other sounds in the mix.

Visual 23. Solar Eclipse: Natural Masking



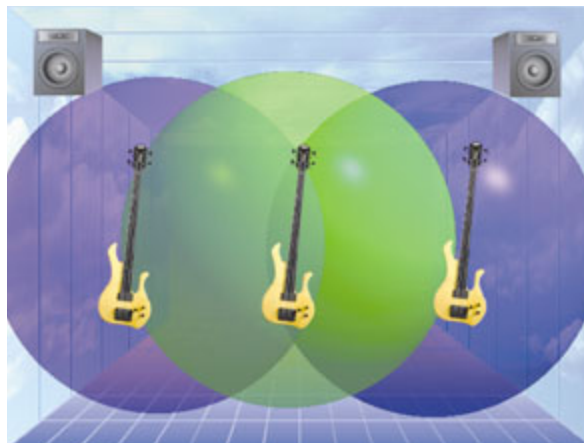
Limited Space

At first thought, you might think that you could make the space bigger by moving the speakers apart. The only problem is that the sounds become precisely proportionately larger in size, so you end up with no more space than you started with. On the other hand, a 3D sound processor allows you to place sounds outside of the space between the speakers. It does expand the space between the speakers. Surround sound (5.1 or any type of multichannel mixdown system) also expands the three-dimensional space between the speakers to include the entire room. These mixing techniques are explored later in Chapter 8.

SIZE AS A FUNCTION OF FREQUENCY RANGE

First, bass sounds seem to take up more space in the mix than high-frequency sounds. Place three bass guitars in a mix, and you’ll have a muddy mix.

Visual 24. Mud City



Bass sounds, being bigger, mask other sounds more. However, place 10 bells in a mix, and you can still discern each and every bell distinctly from the others—even if they are all playing at the same time. High frequencies take up less space in the world of imaging.

Visual 25. Ten Bells Playing at the Same Time



Therefore, the visuals representing high-frequency sounds are smaller and placed higher than the low-frequency instruments, which will be represented by larger images and placed lower between the speakers.

Technically, it is very difficult to tell exactly where low frequencies, below 400Hz, are coming from. Low frequencies are extremely difficult to localize between the speakers. Therefore, a more realistic visualization would have the low-frequency spheres less defined—they would spread out to cover the entire lower portion of the visual—creating even more masking. However, in order to be able to show the specific volume, panning, and EQ of bass, we will continue to use large, defined spheres.

SIZE AS A FUNCTION OF VOLUME

The louder a sound is in the mix, the more it will mask other sounds. Therefore, louder sounds are larger. A guitar that is extremely loud will tend to mask the other sounds a lot more than if it were soft. A bass guitar, already large, will hide other sounds even more when turned up loud.

Visual 26. Loud Bass Guitar Masking Rest of Mix



SIZE AS A FUNCTION OF STEREO SPREAD

When you have a delay longer than 30ms, you hear two sounds, which looks like this:

Visual 27. Delay Longer Than 30ms



An unusual effect happens when you put a delay on a sound less than around 30ms (1000ms = 1 second). Because our ears are not quick enough to hear the difference between delay times this fast, we only hear one fatter sound instead of an echo. This effect is commonly called *fattening*. When you place the original signal in the left speaker and the short delay in the right speaker, the effect is such that it “stretches” the sound between the speakers. It doesn’t put the sound in a room (like reverb), it just makes it “omnipresent” between the speakers.

A similar effect can be created by placing two microphones on one sound. Because sound is so slow (around 740mph), you get about 1ms of delay time per foot. Therefore, you will hear a short delay that will also create a stereo sound when the two mics are panned left and right between the speakers.

Visual 28. Close to 1ms
Delay Time per Foot



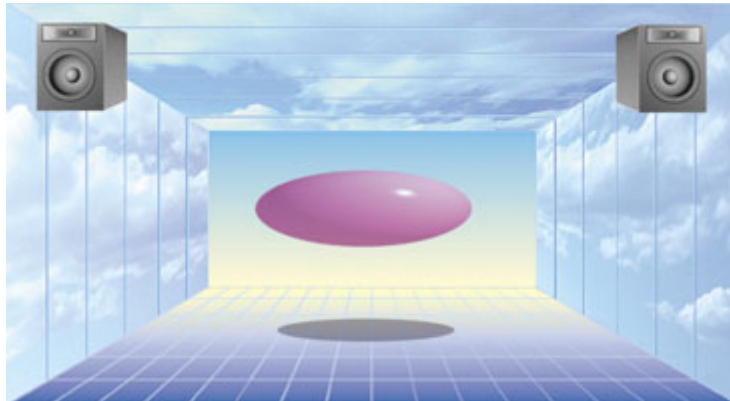
Additionally, sounds in synthesizers are commonly spread in stereo with these same short delay times.

*Visual 29. Fattening:
<30ms Delay Time*

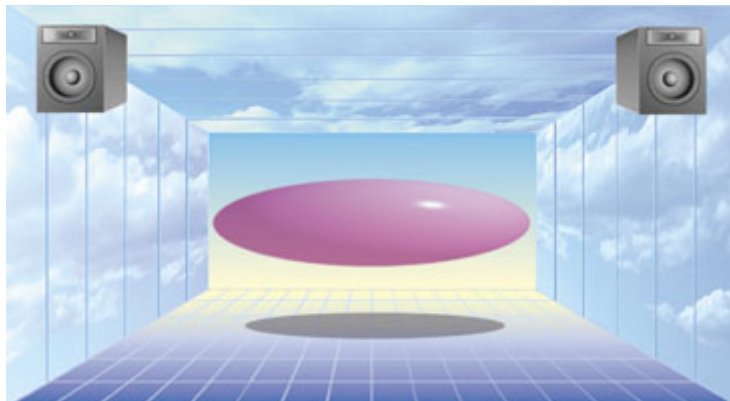


Just as you can use volume, panning, and EQ to place and move spheres, you also have control over the placement of the oblong sphere, or “line,” of sound created by fattening. You can place the line anywhere from left to right by panning the original signal and the delayed signal to a variety of positions. The wider the stereo spread, the more space the sound takes up and the more masking it causes.

*Visual 30. Fattening
Panned 11:00–1:00*

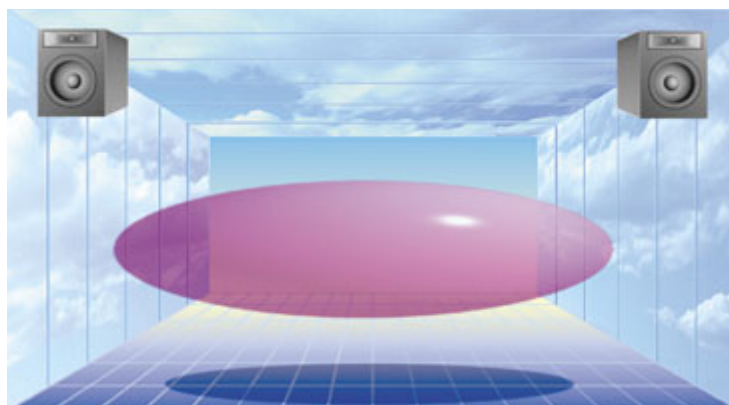


*Visual 31. Fattening
Panned 10:00–2:00*



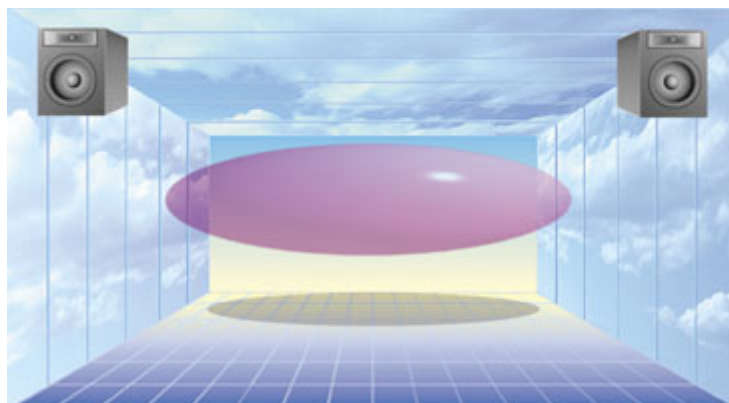
You can also bring this line of sound up front by turning the volume up . . .

*Visual 32. Loud Fattening
Right Up Front*



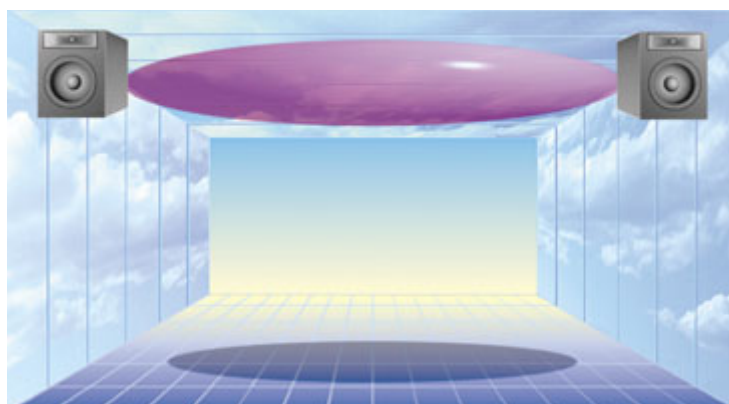
. . . or place it in the background by turning the volume down.

*Visual 33. Low Volume
Fattening in Background*

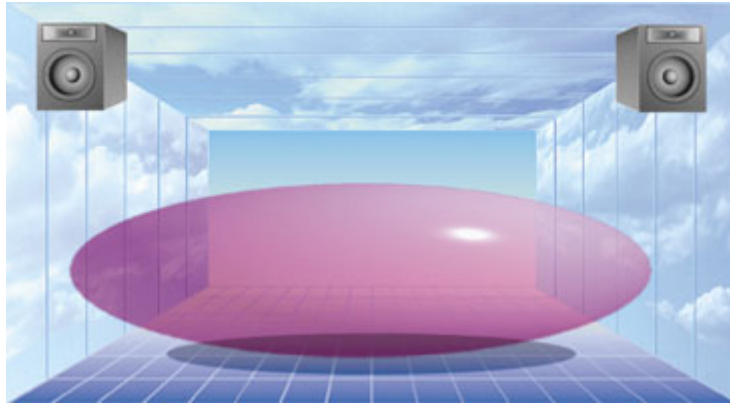


You can also move it up or down a little bit with more treble or bass EQ.

Visual 34. Fattening with High-Frequency EQ Boost



Visual 35. Fattening with Low-Frequency EQ Boost



SIZE AS A FUNCTION OF REVERB

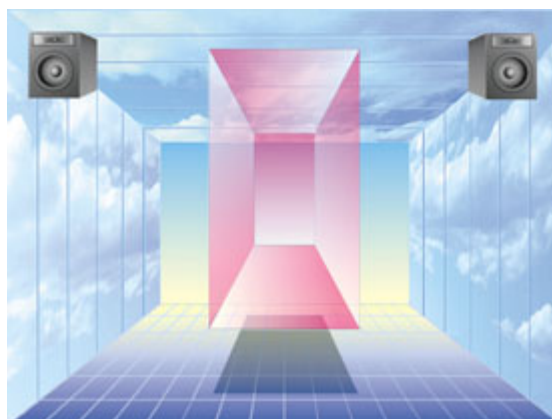
Placing reverb in a mix is like placing the sound of a room in the space between the speakers. A room, being three-dimensional, is shown as a 3D see-through cube between the speakers. Reverb is actually made up of hundreds of delays. Therefore, it occupies a huge amount of space when panned in stereo. It is like positioning hundreds of copies of the sound at hundreds of different places between the speakers. This is why reverb causes so much masking!

Visual 36. Stereo Reverb on Sound

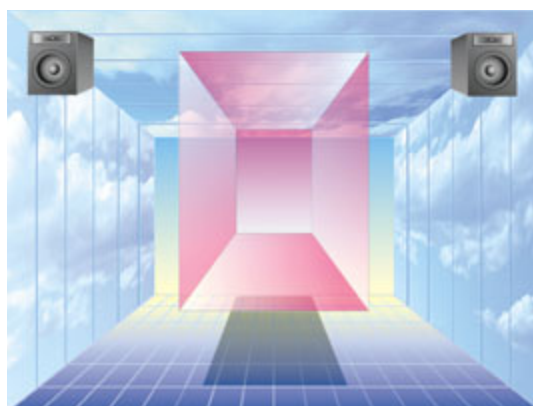


Just as spheres and lines of sounds can be placed and moved around in a mix, you also have control over the placement and movement of reverb with panning, volume, and EQ. You can place reverb anywhere from left to right by panning the two stereo outputs of the reverb in a variety of positions. The wider the stereo spread, the more space reverb takes up and the more masking it causes.

*Visual 37. Reverb
Panned 11:00–1:00*

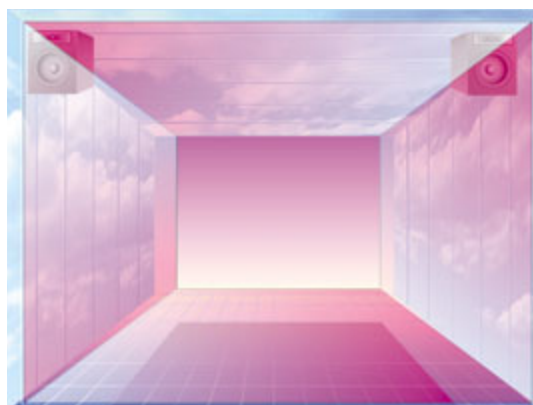


*Visual 38. Reverb
Panned 10:00–2:00*



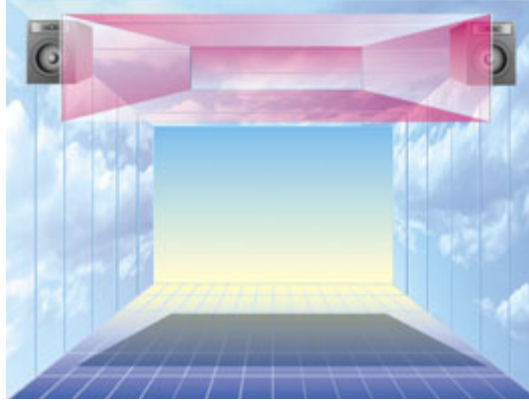
When you turn the volume level of the reverb up (normally done by turning up the auxiliary send on the sound going to the reverb), it comes out front in the mix.

Visual 39. Loud Reverb

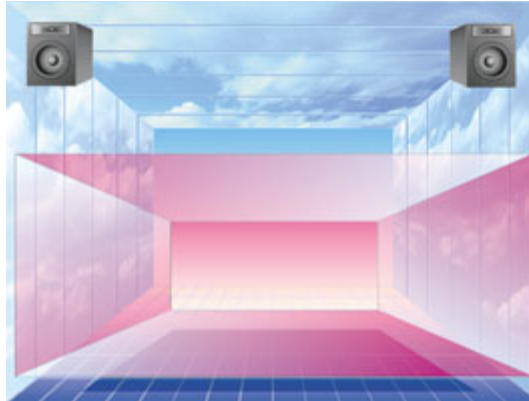


With EQ, you can raise or lower the placement of the reverb a little, which makes the reverb smaller (more trebly) or larger (bassier).

Visual 40. Reverb with High-Frequency EQ Boost



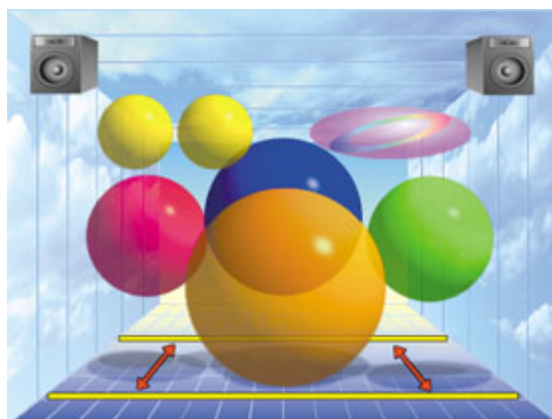
Visual 41. Reverb with Low-Frequency EQ Boost



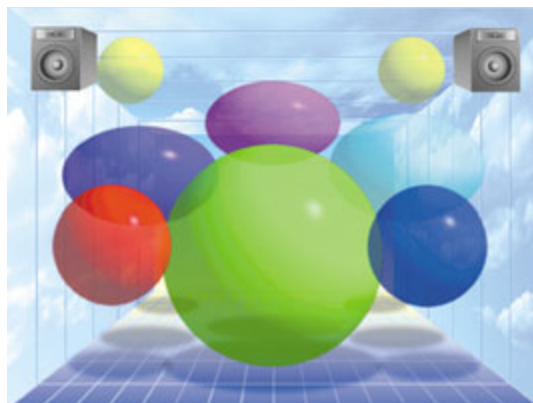
These three basic sound images—spheres, lines, and rooms—can be placed within the three-dimensional stereo field between the speakers to create every structure of mix in the world.

Spheres represent sounds, oblong spheres represent fattening, and translucent cubes of light represent reverb. All other effects, including different delay times, flanging, chorusing, phasing, and parameters of reverb are variations of these three images and will be described in detail in the next chapter. With these various sound images, you can create a wide range of mix styles appropriate for various music and song styles. For example, you can create even versus uneven volumes . . .

Visual 42. Even Volumes

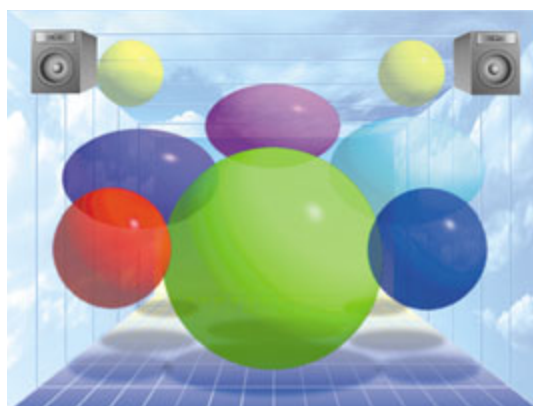


Visual 43. Uneven Volumes

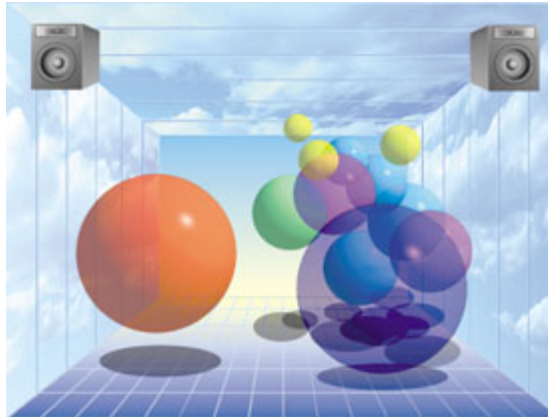


... balanced versus unbalanced mixes ...

*Visual 44. Symmetrical
(Balanced) Mix*



*Visual 45. Asymmetrical
(Lopsided) Mix*

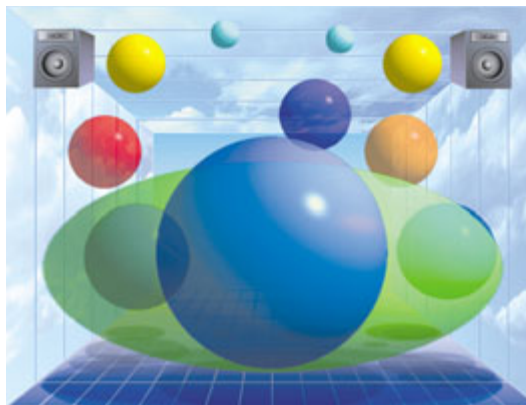


... natural versus interesting EQ ...

Visual 46. Natural EQ



Visual 47. Interesting EQ



... and sparse versus full (wall of sound) mixes with effects.

Visual 48. Sparse Mix



Visual 49. Full (Wall of Sound) Mix



This limited space between the speakers where imaging occurs is the stage, or pallet, on which you can create different structures of mixes. An engineer must be adept at coming up with any of the structures and patterns that can be conceived. Each one of these structures creates different feelings or dynamics. Just as a musician needs to explore and become thoroughly familiar with all the possibilities of his or her instrument, so must an engineer be aware of all possible dynamics that the equipment can create.

The art of mixing is the creative placement and movement of these sound images. The mix can be made to fit the song so that the mix becomes transparent or invisible. Or the mix can be used to create musical dynamics of its own. It can be a tool to enhance and highlight, or it can create tension or chaos. A great engineer uses the mix to push the limits of what has already been done.

The art of mixing is also the appropriate placement and movement of these sound images. Once you know how to create any style of mix, the key is to create mixes that fit the music and song in some creative way.

An engineer has the same range of control as the sculptor: Both are working in 3D. In sculpture, the artist deals with shaping the images in a three-dimensional space. In photography and painting, the artist deals with composition and the way color tones relate to each other. In construction, the carpenter deals with first building a strong foundation. In Feng Shui, the consultant deals with the placement of elements in a 3D space. Here you are dealing with the Feng Shui of mixing.

You now have a framework with symbols for each parameter of sound. Chapter 4 will go into the details of each piece of equipment in the studio. Chapters 5 and 6 use the visuals to discuss how each piece of equipment can be utilized in the mix to create all the dynamics that the “engineer as musician” wields. But first, I’ll explore all of the reasons for creating one style of a mix or another in Chapter 3.

Notes on Design of Visuals

SHAPE

At first thought, a dot between the speakers might seem appropriate. When a sound, such as a vocal, is panned to the left speaker, the dot would move to the left speaker; the dot would move right to represent panning to the right. This is a common representation used by many people when discussing left/right placement of sounds in the stereo field.

A round image is most appropriate, especially when you consider the way two sounds seem to meet when they are panned from left and right to the center. When they are brought together and start to overlap in the middle, the image suggests that the sounds should be round and symmetrical. If you were to use an image of

a guitar, the neck of the guitar would puncture the adjacent sound first because they are both panned toward the center, unlike the way two sounds actually meet and then overlap.

A solid dot has its faults, though. Sounds are not solid objects. Two sounds can be in the same place in a mix yet still be heard distinctly. Therefore, it makes sense to make the sounds transparent or translucent. If you use transparent spheres to represent the sound field of the image as it appears between the speakers, then two sounds can be seen and heard in the same spot.

COLOR

People all over the world have tried to figure out which frequencies correspond to which colors. Of course, only psychics and highly evolved beings from other planets really know. It is my feeling that it depends on the structure of your personality as to what colors feel the most right on.

The primary function of color is to differentiate between different types of sounds. Different colors could be made to correspond to different sound colors, types of waveforms, or frequency ranges. But since I don't want to require people to learn such a system to be able to understand the visuals, I will only use color to help differentiate between sounds in the mix.

When harmonic structures and equalization are discussed, colors will be assigned to specific frequency ranges.

Visual 50. Virtual Mixer EQ

