RED PIN
PODCAST

EP. 7:
Sound in Space: Reverb and Acoustics

Every room has a sound of its own. In this episode, host Aleyna Neivandt-Brown unpacks the physics of sound, exploring how reflections and reverberation shape what we hear and how engineers manipulate those properties through acoustic treatment and studio design. From concert halls and metal plates to convolution algorithms and professional recording studios, you'll gain a deeper understanding of the acoustic principles that shape every recording. This episode is for musicians, audio engineers, architects, and anyone curious about the science of sound in space.

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Hi everyone, welcome back to the Red Pin Podcast. I'm your host, Aleyna Neivandt-Brown, the Founder of Red Pin Productions. I created this platform to share with you my complete toolbox of audio engineering skills, based on my original curriculum designed for my college students and expanded to reach audiences from hobbyist to professional. In this episode, I'm discussing how sound interacts with space, how it reflects off reverberant walls and how it gets absorbed in acoustically treated recording booths. If you listened to Episode 6, you heard me talk about IRCAM, the Institute for the Research and Coordination of Acoustics and Music, the underground Parisian stomping ground of Pierre Boulez in the 1970s and 80s. It was a creative hub that brought together composers and researchers from around the world in the largest and best-endowed institute dedicated to sound. I mentioned that the concert hall at IRCAM was customizable—the ceiling could be raised and lowered, and the walls themselves could be rotated to reveal three different acoustical surfaces. Well today, I'm going to talk about why. What are acoustics and why do they matter? How does sound interact with space?

[Red Pin Podcast Intro Music]

[2:05] In this episode we're going to talk a lot about **sound**, so let's review. Sound propagates through the air as waves—compressions and rarefactions of the air molecules as a wave moves through space at approximately 1130 ft/sec. Now that's in an average room at an average temperature. Humidity and temperature do play a role in the density of the air through which the sound wave is traveling, but for our conversation today, we're going to keep those variables controlled and just focus on the way those waves interact with the walls of a space, not the air itself. So our sound wave has a few fundamental characteristics to review. Amplitude describes the magnitude of the pressure variation, which we commonly measure as sound pressure level in decibels and perceive as loudness. Wavelength is the distance traveled in one cycle of the waveform, and the frequency is the cycles per second, measured in Hertz, which we refer to as pitch. And the period is how many seconds per cycle. Keeping our air constant, we have a set velocity, and from there, we can pretty much calculate all of those measurements by using one another. For example, wavelength is the velocity divided by the frequency. If you already know the velocity is 1130 ft/sec because you're in a controlled room like ours, and you know the pitch, you can divide the two and that's your wavelength.

Our perception of sound is through the sophisticated engineering of our ears as transducers. Our ear shape and placement means we can discern where sound is coming from. Left and right localization is determined by a sound being louder in one ear or the other. Front to back localization is through phase differences perceived by the contour of the ear. Distance perception comes largely from the ratio of

direct sound to reflected sound, along with loudness and other environmental cues. Our perception of space is also determined by our psychoacoustic map our ears create for us based on other reflections or obstacles the sound may have traveled through to get to us, informing us of the physical characteristics of the space we're in, just by listening. Understanding sound waves as they exist in our physical world, surrounding us, interacting with the spaces we're in, is an important first step in understanding acoustics.

[5:16] **Acoustics**, as a scientific study, refers to **the physics of sound as vibrations**. Practically speaking, we can think about acoustics as a study of design in how those vibrations exist within **boundaries**—walls, ceilings, floors. The size, shape, and materials of those boundaries affect how the sound travels through the space, and furthermore, to the listener. If the sound bounces off the surface, it's called **reflection**. How sound gets around or through an acoustical barrier is called **diffraction**. Architects and musicians alike must consider the various reflections and diffractions in a space to curate the best environment for performance, recording, rehearsal, or the many other reasons we gather and interact with sound. In a large room, like a concert hall, reflections are specifically designed to provide a trail of sound we typically consider quite pleasant, known as reverb. Other times, reflections can lead to standing waves that have negative effects. A **standing wave** is a stationary wave interference pattern—when the compression of an incident sound wave interacts with the rarefaction of its reflected wave—creating spots in a room where some frequencies are reinforced or even canceled out. Already you can see the importance in considering how sound interacts in space.

[7:01] Similar to how light reflects off of water or crystals differently than how it gets absorbed by a thick black cloth, sound waves interact differently across different surfaces too. When it comes to reflections in a room, sound waves will reflect off of a boundary at an equal and opposite angle. If the wall itself features different angles like a **convex** surface, the reflections will be dispersed outward in many directions. For a **concave** surface, the sound would be reflected in a narrowed, focused direction. And what about where two walls meet? We're talking about a room, after all, there are boundaries above and below, and corners! For **90-degree corners** and where intersections of the wall and floor meet, sound reflects back at equal angles to the original incident direction, causing build-up of sound in these areas, especially with bass frequencies. Too many **parallel walls** can cause those standing waves I mentioned, as well as undesirable **flutter echoes**. So when designing a studio, architects will often try to avoid having too many 90-degree angles and parallel walls.

Like I compared to light either reflecting or being absorbed by different materials, sound doesn't always reflect. It can also diffract. **Diffraction** is when sound actually bends around obstacles or moves through openings of an acoustical barrier. The size of the barrier relative to the size of the waveform will impede the sound differently.

[8:59] It's this combination of reflection and diffraction of sound that gives us a perception of space. When that space has reflections that continue to bounce around the room while decaying, that's called **reverberation**. And it's important not to confuse reverb with echo. An echo is a reflection that is far enough apart from the original sound that you hear it as a separate iteration of the sound, a call and response, like when you shout "Hello?" over the edge of the grand canyon. [Audio Example: Echoing "Hello"] But in a cathedral, do you hear every separate instance of reflection of your words off the walls? No, it's diffused, it surrounds you, with so many reflections they blend together. [Audio Example: Reverberant "Hello"]

Humanity has recognized the architectural influence of acoustics on the performing arts for thousands of years even if we didn't fully understand why—Ancient Greeks built amphitheaters into hillsides with steep stone seating down to the stage, allowing the performers' voices to carry across huge audiences. But until the late 1800s, we didn't actually have a quantifiable measurement of reverb. For that, we can thank a man named **Wallace Sabine** who helped us understand the relationship between the physical properties of a room and its acoustic behavior. One factor in Sabine's equation is the reverb time, or **RT60**, which is measured by how long it takes for the reverberant sound to decay by 60 decibels after the sound source stops. Imagine I sing one loud note in a small church at about 90 decibels. Even after I stop singing, you still hear the sound lingering as it reflects off the walls and ceiling. If those reflections take 2 seconds to fade from 90 decibels down to 30 decibels—60 decibels below the original sound—the room's RT60 would be 2 seconds. Sabine's research on reverb time and absorbing power began when he was a junior professor at Harvard in the 1890s, tasked with figuring out why the new lecture hall was terrible for teaching. Turns out, Fogg Hall had a Reverb Time of over 5 seconds! That long of a decay time would make any lecturer unintelligible. To quantify and combat this, Sabine experimented with cushions, an organ pipe, and a timer, and eventually figured out the way room size and absorbing power could be measured and therefore addressed with the first known acoustic treatment design. But it's not just the decay time that informs your ears of the space. Where you are in proximity to me singing will play a role in how you perceive the direct sound versus the early reflections of the sound. The time and character of those early reflections give you a perception of the size and

material of the space. Early reflections come off of the large-boundaries like walls, ceiling, and floor, while the scattered second, third, fourth and ongoing reflections that envelop you in a wash of sound is a parameter we call **diffusion**.

[*brief musical transition*]

[13:08] Audio engineers can harness the natural reverberation of real spaces like cathedrals, concert halls, or even natural caves or amphitheaters, by recording in those spaces. In which case, the microphones are picking up all those reflections in addition to the original sound source. Or they can create reverb by mechanically vibrating sound through a material that gives the effect of those reflections—one type of mechanical method is **plate reverb**. The plate is a big metal sheet, and I mean big, like, four feet by seven or eight feet. The metal sheet is suspended so it can vibrate freely, which is important, because it's these vibrations that provide the effect of reverberant reflections. You see the signal is played onto the metal, causing it to vibrate with the sound waves. The vibrations are picked up by contact mics that are placed around the plate. For an inside look at how contact mics work, be sure to check out Episode 5: Inside the Microphone. Plate reverb is unique because it doesn't provide the type of reflections that we're accustomed to in real spaces. Rather, it's a polished shimmery kind of texture that evokes size without actually feeling any farther away. The most famous plate reverb was the EMT 140 which came out in 1957 and can be heard on tons of famous records from the second half of the 20th century—Pink Floyd, Led Zeppelin, The Beatles, David Bowie, Fleetwood Mac, Marvin Gaye, The Temptations, The Beach Boys. I could go on. But the plate wasn't the only mechanical method of artificially creating reverb. We also have the **spring**. Inside the vintage Fender Reverb amps from the 60s lies a tank concealing an electromagnetic reverb generator using coiled springs. The signal is sent through the springs which vibrate with the sound wave with an iconic bouncy twang that gave rise to a whole new sound—Surf Rock. The splashy sound is known as "drip."

[15:49] Besides naturally occurring reverb and mechanical reverb, audio engineers can also replicate reverb artificially in the digital realm. Because RT60, early reflections, and diffusion are all measurable scientific characteristics of sound in a particular space, we can apply those same measurements to mathematically recreate the reverberation of a cathedral, for example, completely **inside the box** using algorithms that mimic how such a sound would react in a space of that size, shape, and materials. The digital plugin would generate early reflections and then a wash of diffused reflections as the sound continues to bounce around the "space" until decaying at a realistic RT60. For digital reverb that sounds really realistic, **convolution reverb** is a type of plug-in wherein the developers actually go to

these spaces and take **impulse responses**. They set up microphones all around the space to record the response of one calculated and delivered sound, like a loud pop, and then with that actual audio file, they map a realistic sonic footprint from the space. They can then apply the same behavior from their recorded impulse responses to your signal, and output what your voice would sound like at the Sydney Opera House or St. Peter's Basilica, or even inside a Volkswagen Beetle! Impulse responses can be taken anywhere. My favorite convolution reverb plugin is Altiverb by Audio Ease, and some of the more unique spaces they've mapped are: a tomb inside the Great Pyramid, the cockpit of a fighter jet, on the field at Wembley Stadium, all the way to night clubs, tiny tiled bathrooms, attics, classrooms, caverns, and castles. With convolution reverb, you can make your recordings sound like they were recorded at the famous studio, like Abbey Road or Ocean Way or Motown.

[*brief musical transition*]

[18:23] So if we can artificially recreate and curate a refined reverberant space with the power of mechanical or digital reverb, how can we best record our source signal in a controlled environment that isn't going to contribute a bunch of uncontrolled reflections? This is where **studio acoustics and design** comes into play. When designing a studio, either from the ground up or converting an existing space, factors like location, size, and cost can limit the most optimal construction, but having some understanding of what to prioritize can help you make the most of your budget and space. Studios have different needs based on the business: music recording, a mixing and mastering space, post-production like ADR and foley, or even game audio design studios. Or maybe it's a creative space for rehearsing, songwriting, or even hosting performances or masterclasses. No matter what your business is, you probably don't want sound from outside coming inside. So let's talk about **walls**. The first priority in studio construction is something called **transmission loss**—how much sound is prevented from traveling from one space to another. As we've already learned, not all frequencies behave the same way. Low frequencies are usually the biggest challenge because their wavelengths are so long. A kick drum or bass guitar can easily pass through walls that would completely block higher frequencies. That's why bass is often the first thing you hear through the walls from your neighbor's apartment, or standing outside the door at the concert venue. To increase transmission loss, studio walls are typically built with several layers of dense materials like drywall, often using multiple materials of different densities to make it more difficult for sound to pass through. Professional studios also try to avoid rigidly connecting the inside wall to the outside wall. Instead of both layers of drywall sharing the same wooden studs, they're often built on separate framing or connected with resilient channels or isolation clips. That way,

vibrations have a much harder time traveling directly through the structure from one room to the next. The same philosophy applies to the floor. Rather than building directly on the building's foundation, many professional studios use what's called a **floating floor**. Despite the name, it isn't actually floating—it's simply decoupled from the structure below using resilient materials that reduce the transfer of vibrations. Every drum hit, footstep, or bass note has another barrier to cross before it reaches the rest of the building. Now, if you don't have the ability or budget to construct a floating floor, you can always compromise with a riser in your drum booth. When it comes to ceilings, if it's your own house or you have control over the floor above you, you can put down carpet to reduce noise. Otherwise, you can float a second ceiling just like with the floors by adding a decoupled layer. When it comes to windows and doors throughout a studio, from control room to live room and live room to isolation booths, they're often dual-paned and decoupled. Also, having an extra little room with doors on either side creates a **sound lock** that proves even more effective than a single de-coupled door, kind of like an airlock on a spaceship—the room between the inside and the outside.

[22:42] Inside the live room, there are several things to consider—isolation between instruments; how much reverberation of the space you want; and frequency balance issues, be that from standing waves or corner reflections. For isolation between performers, you can, of course, have an isolation booth, which is essentially a mini room within a room, with its own walls and door and window, and typically with its own mic input panel. Or you can have a more flexible method that can be deployed in many different arrangements, using **partitions**. Sometimes called gobos. These are movable, usually rolling, dividers that are constructed with dense materials to combat sound—either bleeding between microphones when multiple players are in the same room, or just to further reinforce your acoustic barriers. But as I just mentioned, there's also the question of how *much* reverberation you want from your space. For different projects you may want a more "live" reverberant space, or a more acoustically "dead" space. Having some movable partitions can give you the flexibility to tame the reverberance that makes it into the mic. You can use them to shield the mic from reflections, prioritizing the direct sound from the performer. When it comes to those standing waves and corner reflections, we'll address those spaces with **bass traps**—acoustic wedges that absorb the sound that can build up in those particular pressure zones.

[24:30] While on the subject of sound absorption, let's dive into types of **acoustic treatments**. If soundproofing is to isolate our space from outside noise, acoustic treatment is to curate the way sound moves around inside. Acoustic treatments to the walls can ensure we aren't recording any unwanted

resonances or mixing with any frequency biases. Sound **absorbing** panels are typically made from porous materials like foam, wool, or fiberglass. They're meant to capture and deaden the sound by preventing any reflections. Remove the reflections, you remove the reverb. Rooms that are considered acoustically "dead" have highly absorbent materials. That's what gives you the clean, direct signal. It's worth noting that some materials absorb better than others, and often it's only the mids and high frequencies really getting dampened, which makes sense, right? High frequencies have smaller wavelengths and faster little oscillations, so they easily get trapped in the pores of foam and fabric. But bass frequencies on the other hand… Remember our formula for wavelength? Velocity divided by frequency. At the average speed of sound, a 50Hz bass tone would have a wavelength of around 22 feet, so that 2-inch foam panel —barely an obstacle. Long pressure waves of low frequencies just flex and continue past that little foam square. That's why bass traps are specially designed and placed with enough size and density to address those longer wavelengths. Now onto another type of acoustic treatment. Sound **diffusing** panels can be made from more solid materials because they're not meant to prevent reflections, they're meant to scatter them. Worried about smooth solid parallel walls creating those standing waves, or just having uncontrolled or undesirable reverb? Diffusers are designed to break up and randomize the reflections, the more complex they are the less focused and problematic one particular reflection can be in your room. Diffusers can come in all different kinds of designs, like 3D jagged textures, zig-zags, geometric or egg-carton patterns. I worked at one studio where they custom designed the large wooden geometric diffuser behind the sofa in the control room to kind of abstractly include their logo, which I thought was a pretty cool example of form meets function.

[*brief musical transition*]

[27:45] By now you may be itching to go test your room's acoustics with a clap or two, and when you do, listen close for those reflections. Then, try a different room. Is the decay time or harmonic content different? Can you find any standing waves in your space? Put on a continuous bass tone and walk around the room, listening for a lull when the compressions and rarefactions cancel out. And maybe next time you go to the movies versus maybe going to church, listen and observe the differences in the acoustic priorities.

[Red Pin Podcast Outro Music begins in the background]

As always, thanks for tuning in. For the full transcript, including links and resources for further reading, be sure to visit redpinproductions.com/podcast. And if you're enjoying these offerings and want

to support the mission and creation of new content, please consider joining Red Pin Productions on Patreon. I'm Aleyna Neivandt-Brown. Thanks for listening.

References and Further Reading

AcousPlan. “History of Sabine and Reverberation.” [https://acousplan.com/blog/history-sabine-reverberation](https://acousplan.com/blog/history-sabine-reverberation]

Audio Ease. “Altiverb Impulse Response Library.” [https://www.audioease.com/altiverb/browse.php](https://www.audioease.com/altiverb/browse.php]

Huber, David Miles, Emiliano Caballero, and Robert E. Runstein. *Modern Recording Techniques: A Practical Guide to Modern Music Production.* 10th ed. New York: Routledge, 2023.

See especially Ch. 2, “Sound and Hearing”; Ch. 3, “Studio Acoustics and Design”

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