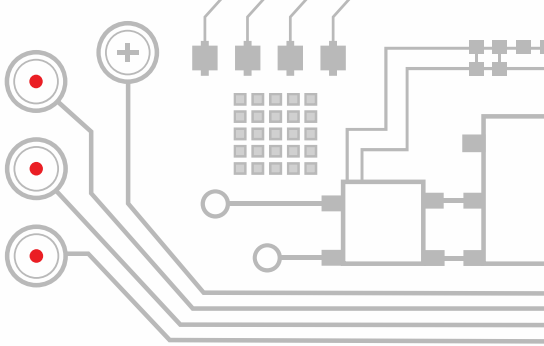
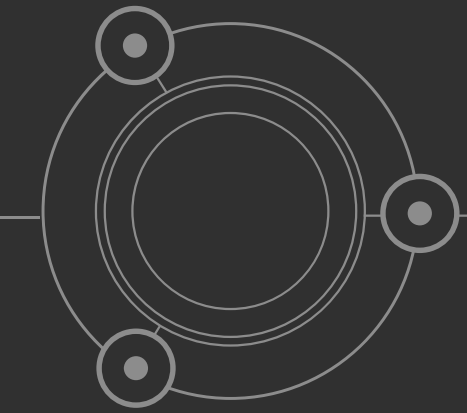
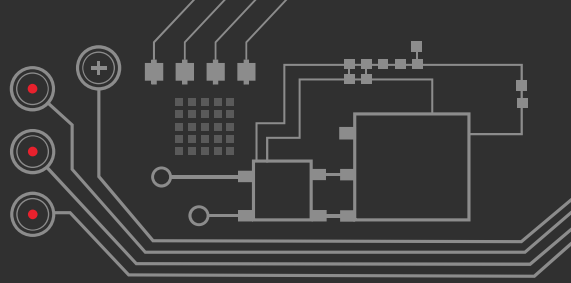
SOUND MATTERS





biamp.

WHAT WE'LL COVER



- What is sound?
- Hearing vs. Listening
- The four effects sound has on people
- Super-Additivity
- Designing a Soundscape
- Creating the right environment

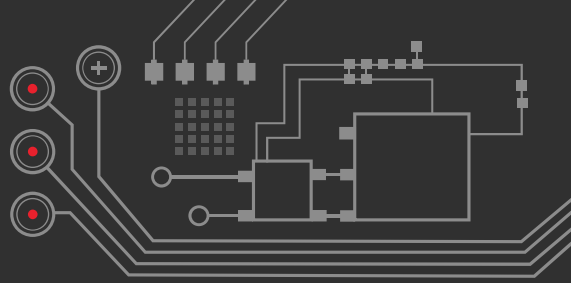
10 Hz 10^2 Hz 10^3 Hz 10^4 Hz 10^5 Hz 10^6 Hz 10^7 Hz 10^8 Hz 10^9 Hz

WHAT IS SOUND?

Almost every sound we hear is comprised of rich harmonics essential in producing the timbre and meaning of the sound.

That’s how we can discern one person’s voice from another, or read the emotion embedded in a spoken word. When a voice is crudely filtered, i.e., on the phone: we don’t have the information we need for clear comprehension

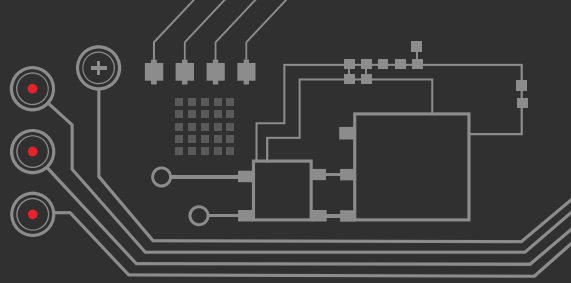
WHAT IS SOUND?



A person with excellent hearing perceives a spectrum from about 20 Hz to 20 kHz.

FEATURED TERM: Hertz (Hz) – a unit of frequency or oscillation in cycles per second. From 1,000 Hz up we use kilohertz.

WHAT IS SOUND?



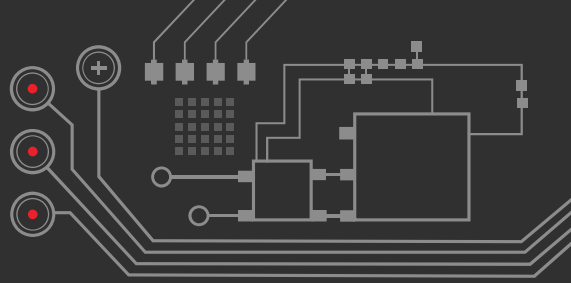
The maximum audible range for us is 10 octaves. Each octave is an exact doubling of frequency.

FEATURED TERM: Sound pressure level (SPL) – a measure of sound amplitude, rather than its perceived volume. SPL is measured in dB and an increase of 10 dB is perceived as a doubling of loudness.

10 Hz 10^2 Hz 10^3 Hz 10^4 Hz 10^5 Hz 10^6 Hz 10^7 Hz 10^8 Hz 10^9 Hz

HEARING

HEARING

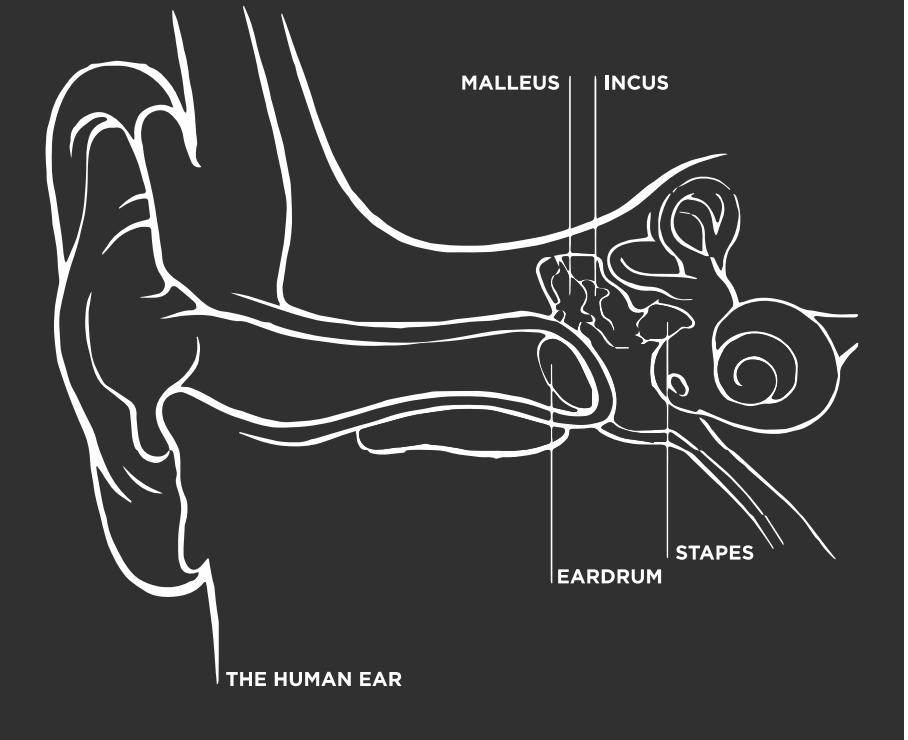


The first sense we develop 12 weeks after conception.

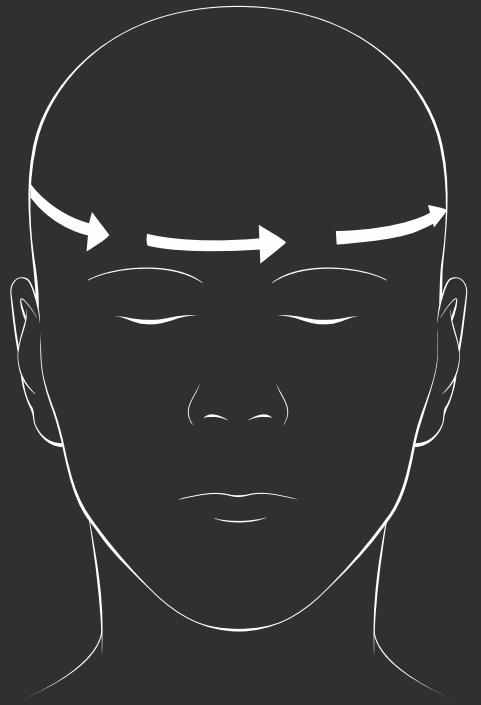
We do not hear all frequencies evenly.

FEATURED TERM: Decibel (dB): a logarithmic scale that measures Sound Pressure Level with 0 dB being roughly the threshold of human hearing.

HEARING



- Sound waves enter the ear canal, causing the eardrum to vibrate.
- The eardrum oscillates fluid in your inner ear, activating 3 tiny bones.
- These vibrations occur thousands of times per second, and are translated into electrical impulses to be decoded by the brain.
- This process starts before your birth and never stops until your final breath.



We hear in a sphere around us by calculating differences in arrival times at each ear.

Hearing is our primary warning sense;
hard-wired into our brain.

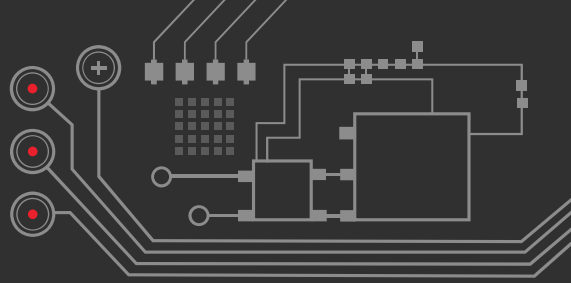
Hearing works whether we're awake or asleep.
It's passive. We don't have earlids!

Listening is an active skill.
And one we're in danger of losing.

10 Hz 10^2 Hz 10^3 Hz 10^4 Hz 10^5 Hz 10^6 Hz 10^7 Hz 10^8 Hz 10^9 Hz

LISTENING

LISTENING



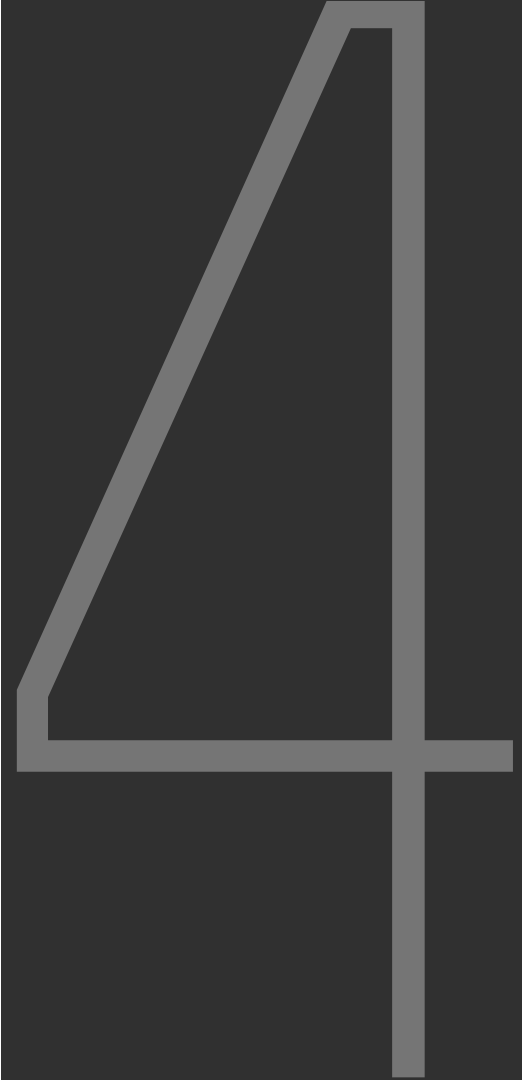
- Research shows that most of us aren’t good listeners:
- We spend up to 60% of communication time listening, but we retain only 25% of what we hear.
- We have very limited mental bandwidth for audio input – which is why you can’t understand two people talking at once.

LISTENING IS MAKING MEANING FROM SOUND. 5 EASY EXERCISES CAN HELP DEVELOP YOUR LISTENING SKILLS.

- Silence
- The Mixer
- Savoring
- Listening Positions
- RASA

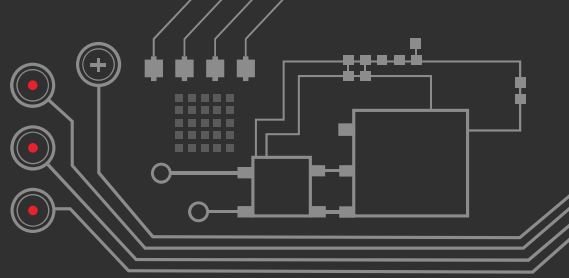
10 Hz 10^2 Hz 10^3 Hz 10^4 Hz 10^5 Hz 10^6 Hz 10^7 Hz 10^8 Hz 10^9 Hz

THE 4 EFFECTS OF SOUND



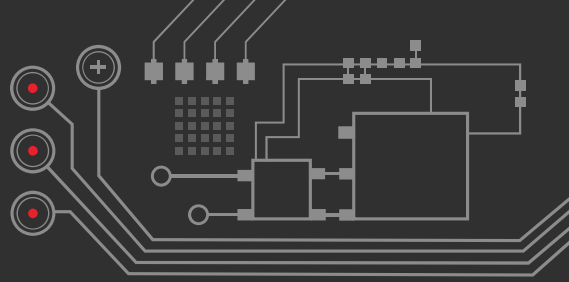
- Physiological
- Psychological
- Cognitive
- Behavioral

01 PHYSIOLOGICAL



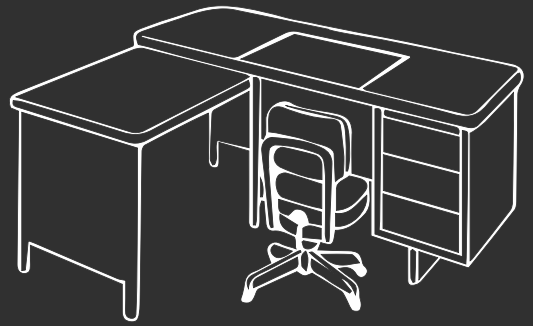
- The sound around us changes our heart rate, breathing, hormone secretions, and even brain waves.
- A fast beat in a nightclub will increase your heart rate whereas the slow sound of crashing waves will slow it down.
- Sudden, unexpected sounds trigger the fight or flight reflex

02 PSYCHOLOGICAL



- We all know how music changes our mood. Play your happiest or saddest piece of music, even just in your head, and your mood changes dramatically.
- Some natural sounds also have a psychological effect – for example, birdsong makes many people feel secure. When the birds are singing, our environment is safe. When they stop, we get worried.

03 COGNITIVE



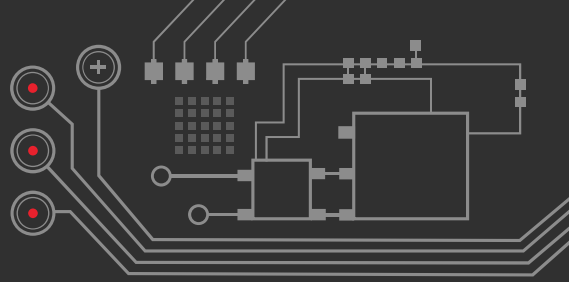
TYPICAL NOISE LEVEL: 65dB

Issue: WHO required hearing protection at this level of noise

Data: Background noise - even at low levels - has been found to increase employees' stress hormone levels and undermine short term memory, reading comprehesion and willingness to help or engage with others

- We feel overwhelmed when we try to concentrate in a noisy, distracting environment.
- Both writing and reading involve internal vocalization and symbol manipulation.
- If you can hear someone speaking at the same time, that input takes up valuable processing space.
- Productivity can drop by up to 66% in a noisy office situation.

04 BEHAVIORAL

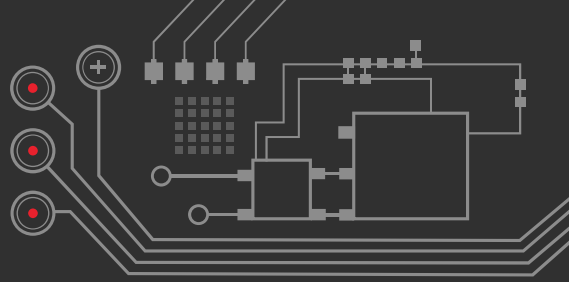


- Our pace of movement changes with the sound around us. Consider what happens if you play loud, pumping music in your car or at the gym.
- Slow-paced sound can increase retail sales by 38% because we tend to dwell longer in such spaces.
- We naturally move away from unwanted sound

10 Hz 10^2 Hz 10^3 Hz 10^4 Hz 10^5 Hz 10^6 Hz 10^7 Hz 10^8 Hz 10^9 Hz

SUPER-ADDITIVITY

SUPER-ADDITIVITY



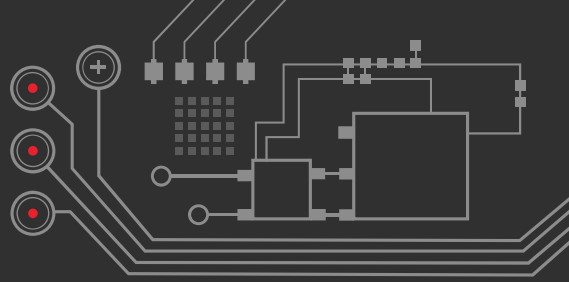
- Adding congruent sound to visual communication increases impact by 1100% because both sight and sound are receiving the same message.

- Conversely, adding incongruent sound reduces impact by a whopping 86%.

10 Hz 10^2 Hz 10^3 Hz 10^4 Hz 10^5 Hz 10^6 Hz 10^7 Hz 10^8 Hz 10^9 Hz

HOW TO DESIGN A SOUNDSCAPE

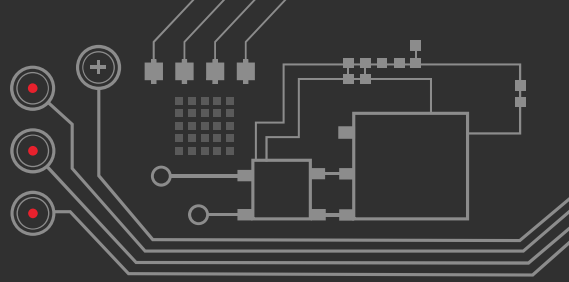
SOUNDSCAPE DESIGN



Start with defining the outcomes desired: Physiological, Psychological, Cognitive, and Behavioral.

FEATURED TERM: Acoustic Echo Cancellation (AEC) – a DSP algorithm that removes unwanted echoes in video and teleconferencing applications.

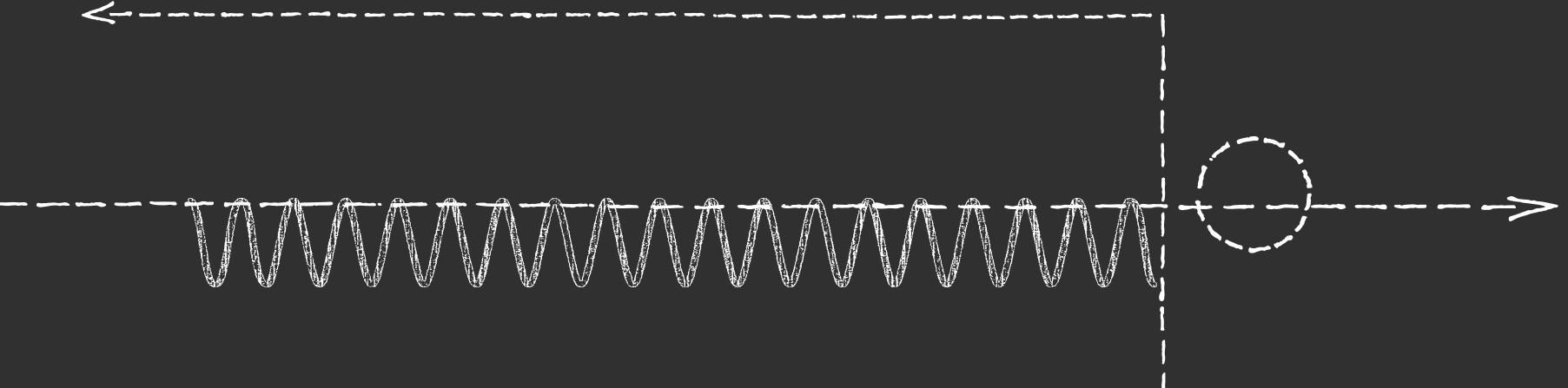
SOUNDSCAPE DESIGN



Then apply the filters: function, environment, people, and brand/values.

FEATURED TERM: Point source cluster: a group of loudspeakers positioned and processed to cover a wide area while giving the audience the impression that the sound is coming from a single point.

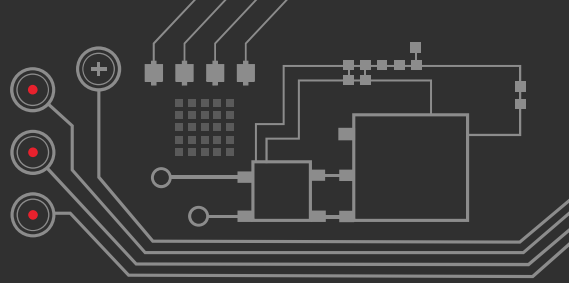
Determine the building blocks of sound: pace, frequency range, texture, density, dynamics.



10 Hz 10^2 Hz 10^3 Hz 10^4 Hz 10^5 Hz 10^6 Hz 10^7 Hz 10^8 Hz 10^9 Hz

CREATING THE RIGHT ENVIRONMENT

NOISE

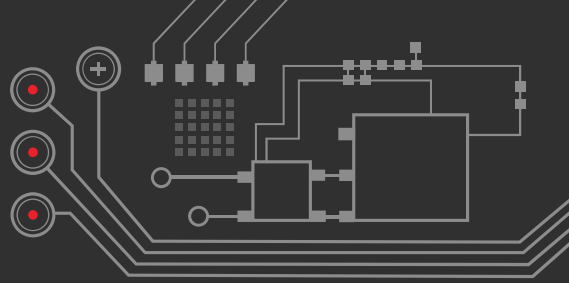


01 **Noise disrupts understanding:** Increased noise levels degrade our ability to understand speech.

02 **Noise reduces concentration:** Multiple studies of schoolchildren have found that noisy classrooms prevent concentration and delay development.

FEATURED TERM: Noise: Any unwanted sounds that disturb people or make it difficult to hear wanted sounds.

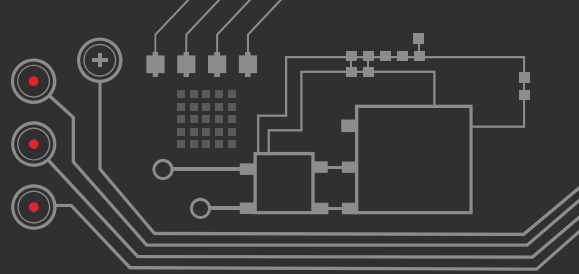
NOISE



As much as possible, sources of noise should be eliminated or relocated from listening & concentration environments.

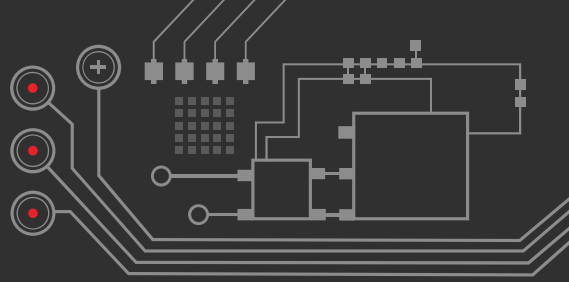
FEATURED TERM: NC35: The Noise Criterion curve value of 35, used to determine the acceptable noise level for a given space. NC20 to 25 curves are used for theaters and performing art centers; NC45 – 55 are used for kitchens, computer equipment rooms, etc.

NOISE



NOISE (dB)	EQUIVALENT	MANDATED / RECORDED NOISE LEVELS	HEALTH IMPACTS
15	Rustling leaves		
30	Library	WHO recommended noise level for optimum night-time sleeping and patient rooms in hospitals	
35		WHO recommended noise level for school classrooms	
40	Refrigerator hum	WHO recommended limit for night-time noise	
45		Recommended noise level for operating theaters	
50	Quiet office	Typical noise level in intensive care unit (ICU)	Increased blood pressure detected when night noise surpasses 50dB
55	Air conditioning unit	40% EU population exposed to daytime traffic noise levels exceeding 55dB	Sleep is disturbed and heart disease risk increases 40% of office workers report impaired concentration
60			Average time needed to get to sleep rises from 14 to 22 minutes
65	Busy office	European Commission considering mandatory ear protection at 65-75dB Average noise measured in a German classroom Average noise level in recovery care units (67dB)	Heart attack incidence increases
70	Street traffic		Permanent hearing loss
80	Aircraft one mile away	82-90dB - Typical level of street noise recorded in Kolkata	Higher cholesterol levels Higher likelihood of industrial accidents
85	Busy motorway	US Federal law mandates use of ear protection for prolonged exposure to sound above 85dB	Increased absenteeism
150	Shotgun		

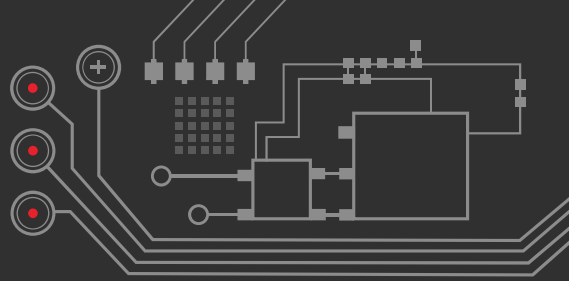
ACOUSTICS



Acoustics references the qualities of a room that determine how sound is transmitted in it. The most important aspect to a space is reverberation time.

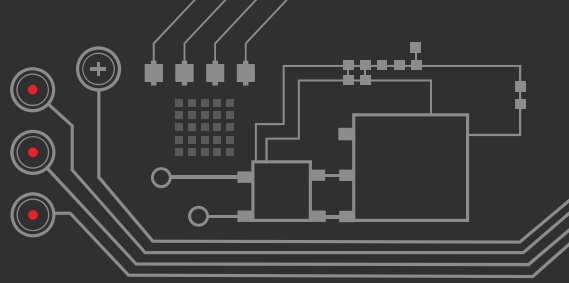
FEATURED TERM: Reverberation time (RT): In this presentation we mean RT60, which is the time it takes for the sound in a space to decay by 60dB below the SPL of the original sound.

ACOUSTICS



- Where speech intelligibility is important:
- RT60 should be under 1 second.
- Parallel walls should be avoided or fitted with non-reflective surfaces.
- Rooms should be insulated from outside noise
- HVAC systems should be quiet
- Achieving good, clear acoustics is usually a combination of acoustical ceiling tiles, wall treatments, carpet & curtains.
- Wall treatments can be made to look like virtually anything these days.

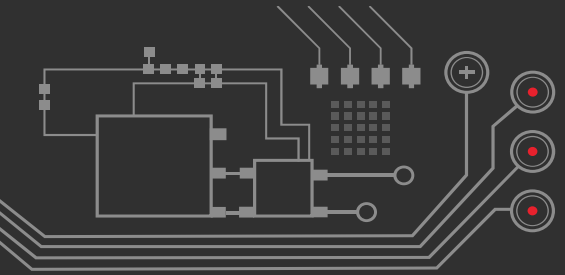
INTELLIGIBILITY



- Intelligibility refers to the measure of how comprehensible speech is and how easily it can be understood.
- In environments where audible communication is important, speech intelligibility could be considered the most important criteria in evaluating performance yet it is controlled by a combination of other factors.
- Noise, acoustics, and sound system design all contribute to how intelligible a system is.

10 Hz 10^2 Hz 10^3 Hz 10^4 Hz 10^5 Hz 10^6 Hz 10^7 Hz 10^8 Hz 10^9 Hz

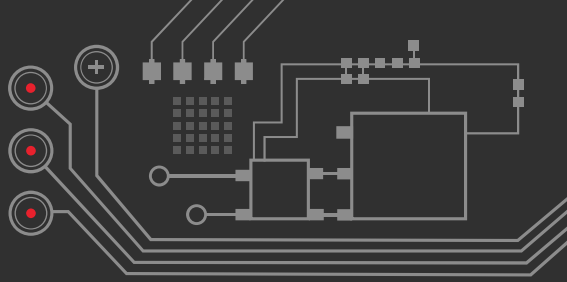
DESIGNING A SOUND SYSTEM



DESIGNING A SOUND SYSTEM

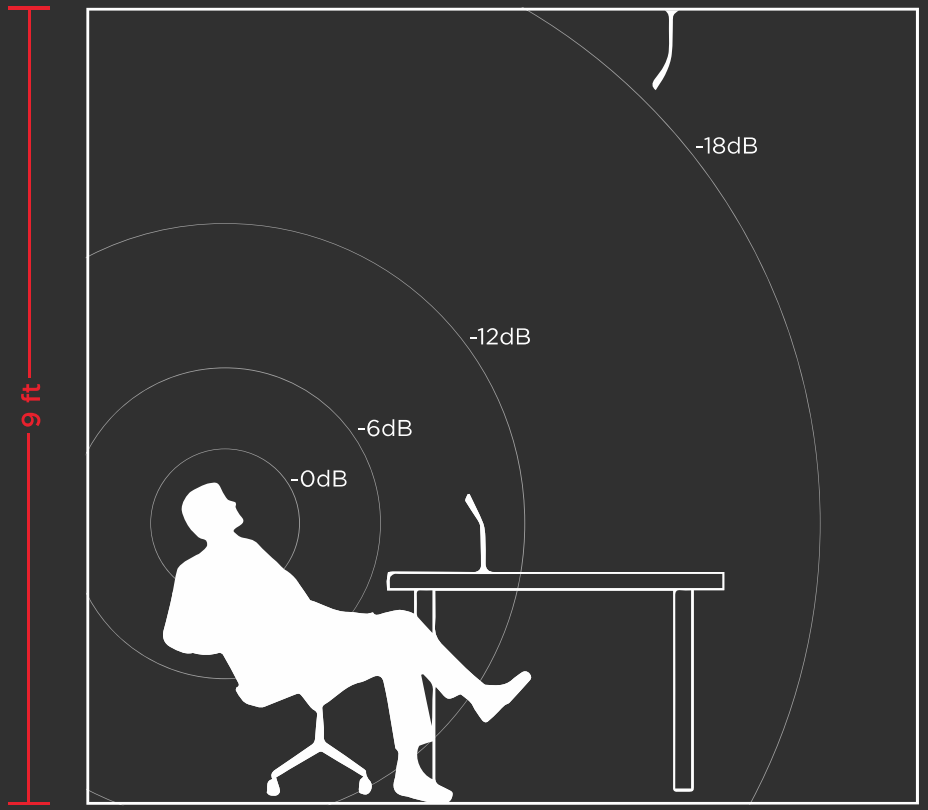
- Calculate speaker coverage and power requirements. Free tools are available and the actual math isn't complicated.
- Establish consistent microphone coverage & ensure the style is carefully selected based on expected performance, room function and expected acoustical performance.
- Always get the best system you can afford, matching quality standards of the brand to the desired outcome.
- Ensure field teams are spending the time to properly calibrate the system. (Gain structure, AEC referencing, equalization, etc…)

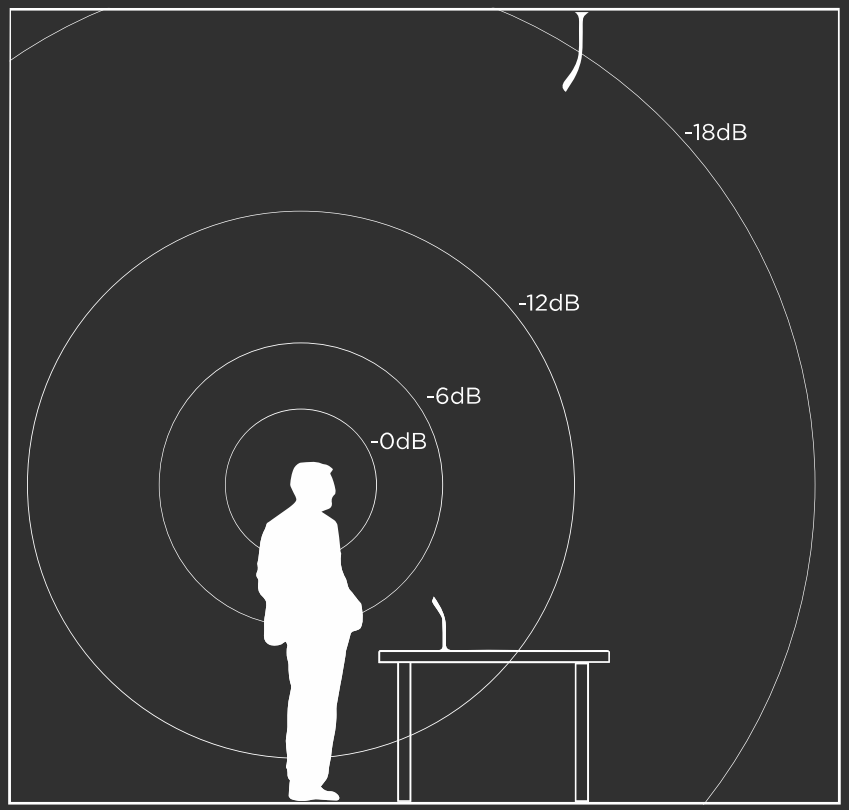
MICROPHONE PLACEMENT



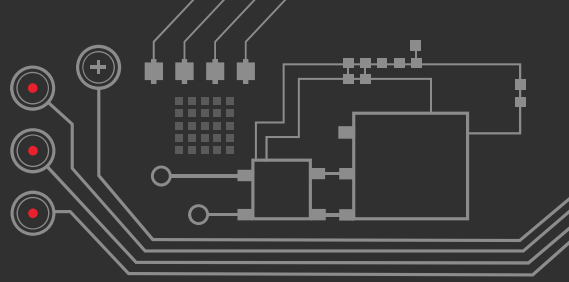
For best results the microphone should always be as close to the source as possible. Why?

- It will sound better! As the distance from the source increases, we must increase the microphone’s analog input gain to maintain the same relative level, which makes it more sensitive to background noise and reflected sound.


9 ft
-18dB
-12dB
-6dB
-0dB


-18dB
-12dB
-6dB
-0dB

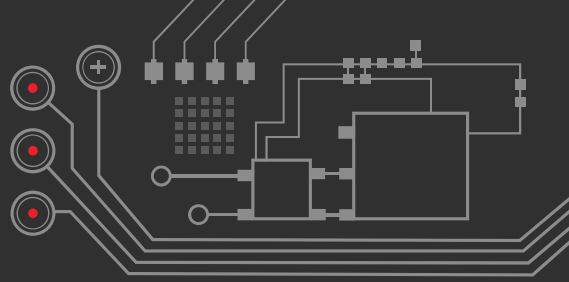
MICROPHONE PLACEMENT



- **Signal to Noise Ratio**: The measure of a signal's level compared to the background noise level of the room. To be understood, a speech signal must be at least 6dB above the background noise level. Obtaining higher signal-to-noise ratios will result in higher quality, more easily understood audio signals.

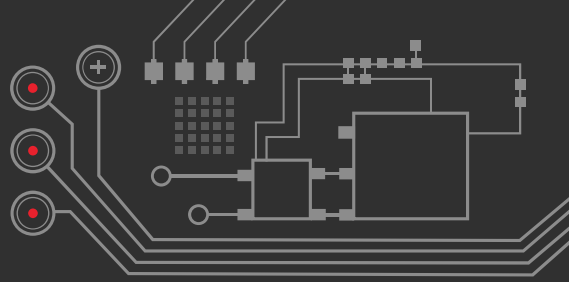
- **Direct to Reverberant Ratio:** The measure of the level of the direct sound, compared to the level of the reverberant sound that is picked up by the microphone. The more direct sound the microphone picks up, the easier it is to understand the speech.

MICROPHONE PLACEMENT



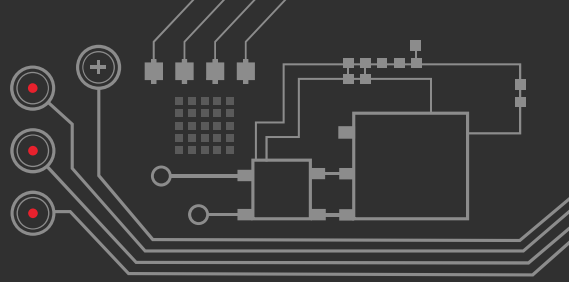
- According to the 3-to-1 rule, if you measure the distance from the sound source to the nearest microphone, the next closest microphone must be at least three times that distance away.
- The further away the microphone, the harder it becomes to satisfy this rule. i.e., placing ceiling mics in adherence this rule would lead to huge gaps in coverage.
- Meant to prevent comb filtering

COMB FILTERS



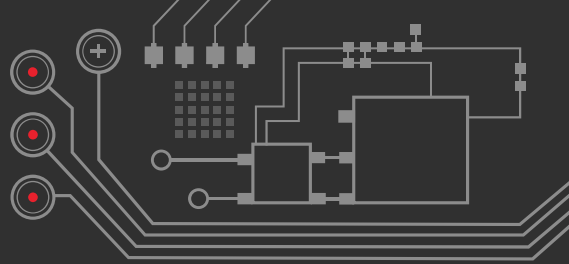
- Comb filters occur when two identical audio signals are summed together with a small delay between them.
- This is commonly experienced when two or more microphones pick up the same source and sum to the same output.

COMB FILTERS



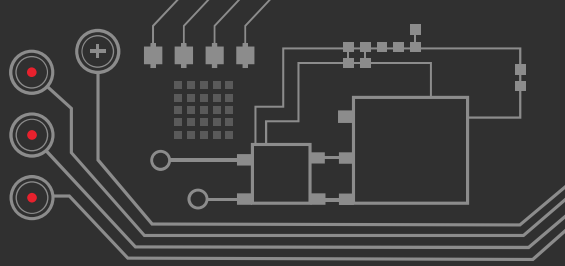
- If two microphones are exactly the same distance from the source, then the sound will arrive at each microphone at exactly the same instant and the signals will add together constructively across the audio spectrum.
- If there is *any* difference in arrival time, then the signals can interfere with one another and result in comb filtering reducing intelligibility.

AUTO MIXERS



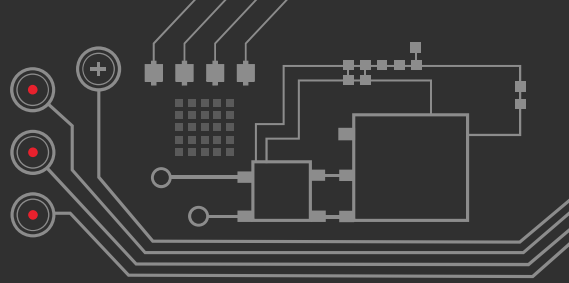
- Auto mixers are effective tools for minimizing comb filtering and improving situations where the 3-to-1 rule cannot be satisfied.
- Auto mixers will help by attenuating the secondary microphones, thereby increasing the gain difference between the microphones and reducing the depth of the comb filters.
- Biamp’s gating auto mixer senses similar material in multiple microphones (e.g., one person heard by three microphones) and only un-mutes the dominant microphone.

DIGITAL SIGNAL PROCESSORS



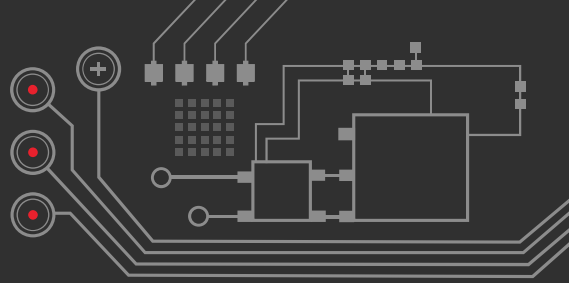
- DSPs provide the tools to establish quality audio systems
- Automixers (Gated & Gain Sharing)
- Echo Cancellation
- Automatic Gain Control (SpeechSense™)
- Equalization and Filtering
- Properly interface with phone systems (Cisco, Avaya, Shoretel, Mitel)

SOUND MATTERS



- Sound is one of the most important, as well as the most overlooked, determinant of our well-being, communication and productivity.
- Researchers are now devoting significant resources to studying the ways in which noise, reverberation (echo), and distortion can affect our stress levels, health, and overall ability to concentrate.

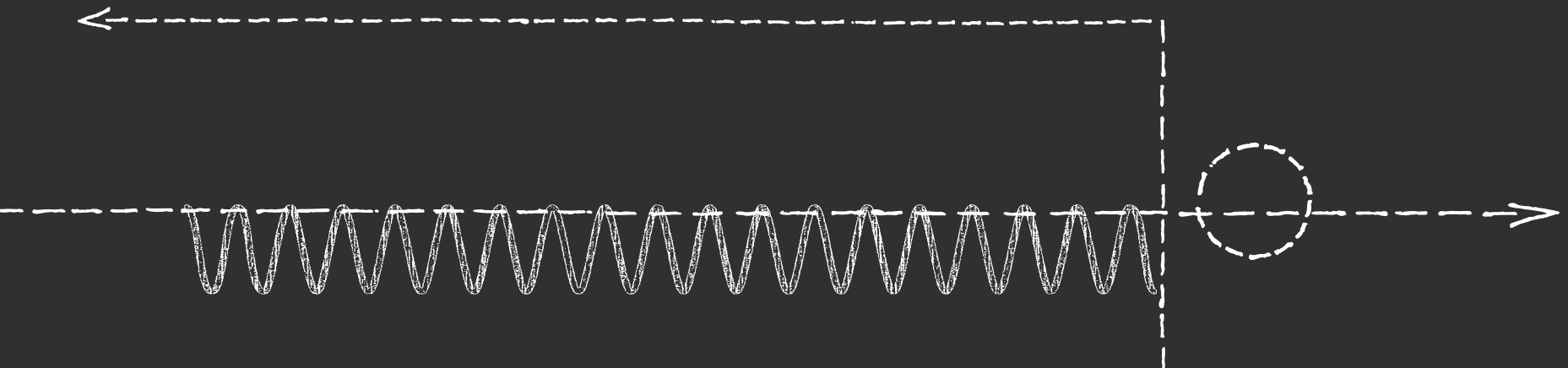
SOUND MATTERS

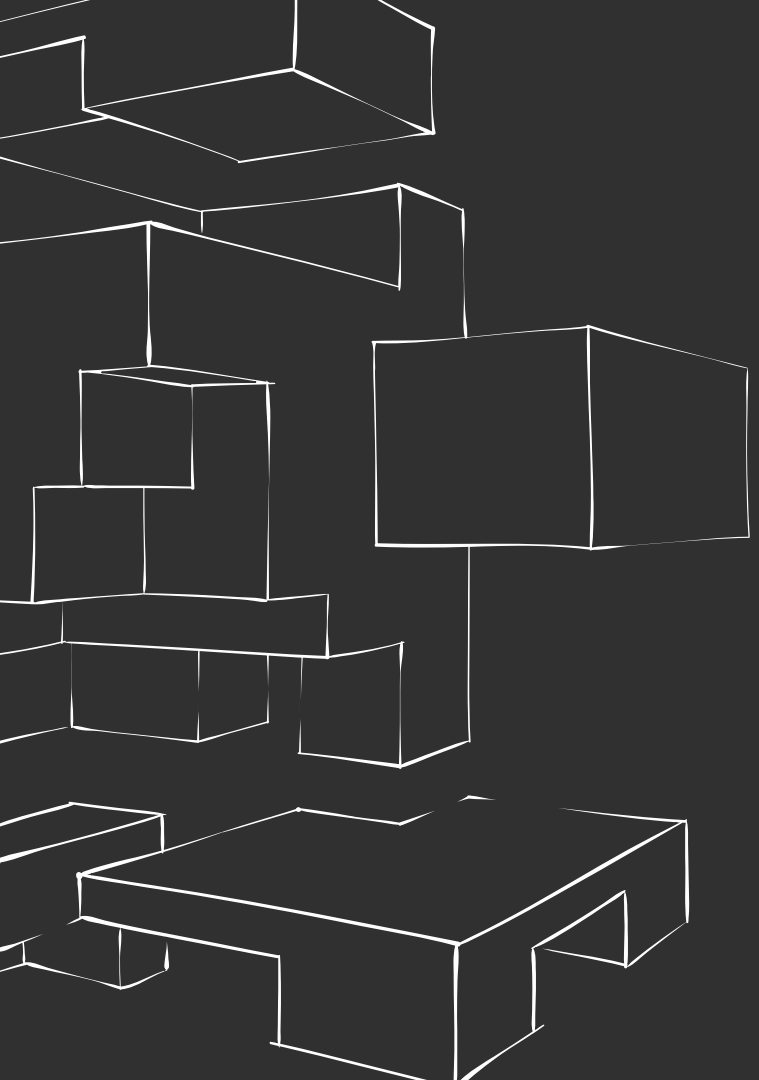


- Noise, acoustics, microphone selection / placement and speaker design are interrelated with respect to speech intelligibility.
- Compromises to any one area can dramatically impact our clients' ability to communicate effectively and efficiently.
- Better communication is needed early on between architects, designers, end users and integrators; establishing performance expectations based on room and technology design.

You can have effective communication if you are able to speak to someone but can’t see them.

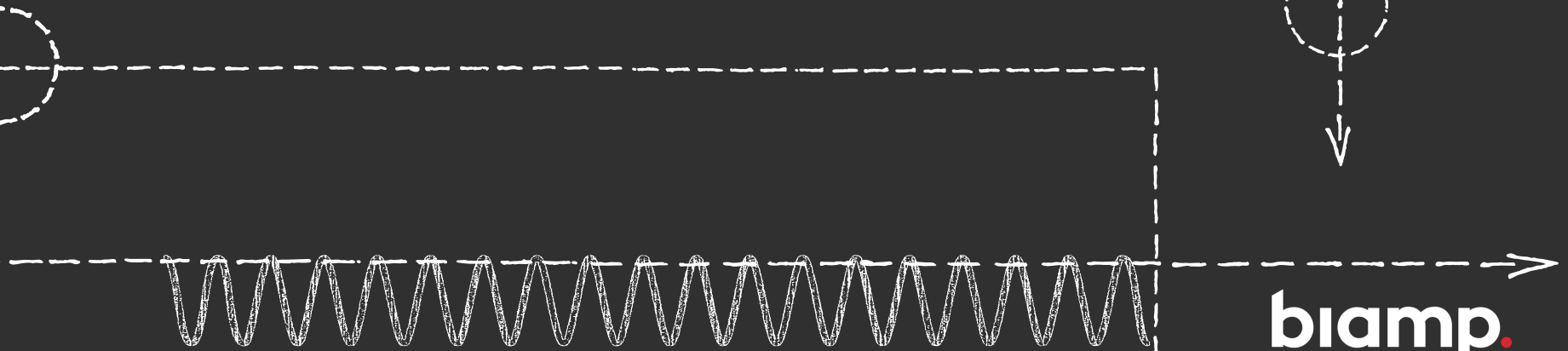
However, if you can see someone but can’t hear them, the ability to communicate is drastically diminished





Always design spaces
for experience,
not just appearance.

Michael Bucklin
Area Manager
mike.bucklin@biamp.com
619.818.7986



biamp.