

### Chapter 3 Main Points

- Acoustics is the science of sound, including its generation, transmission, reception, and effects. Psychoacoustics deals with the human perception of sound. The term *acoustics* is also used to describe the physical behavior of sound waves in a room. In that context psychoacoustics is concerned with the relationship of our subjective response to such sound waves.
- By processing the time and intensity differences of sound reaching the ears, the brain can isolate and recognize the sound and tell from what direction it is coming.
- Processing these time and intensity differences also makes it possible to hear sound three-dimensionally. This is known as binaural hearing.
- Direct sound reaches the listener first, before it interacts with any other surface. The same sound reaching the listener after it reflects from various surfaces is indirect sound.
- To be audible a sound reflection arriving up to 30 ms after the direct sound must be about 10 dB louder. In which case the direct and reflected sounds are perceived as one. This is known as the Haas effect.
- When hearing two sounds arriving from different directions within the Haas fusion zone, we perceive this temporal fusion of both sounds as coming from the same direction as the first-arriving sound, even if the immediate repetitions coming from another location are louder. This is known as the precedence effect.
- The acoustic "life cycle" of a sound emitted in a room can be divided into three phases: direct sound, early reflections, and reverberant sound.
- Indirect sound is divided into early reflections (early sound) and reverberant sound (reverb).
- Early reflections reach the listener within about 30 ms of when the direct sound is produced and are heard as part of the direct sound.
- Reverberant sound, or reverb, is the result of the early reflections becoming smaller and smaller and the time between them decreasing until they combine, making the reflections indistinguishable.

- Reverberation is densely spaced reflections created by random, multiple, blended reflections of a sound.
- Reverberation time, or decay time, is the time it takes a sound to decrease 60 dB-SPL after its steady-state sound level has stopped, usually from average loudness—85 dB-SPL—to, generally, inaudible—25 dB-SPL.
- If sound is delayed by 35 ms or more, the listener perceives echo, a distinct repeat of the direct sound.
- Direct sound provides information about a sound's origin, its size, and its tonal quality. Early reflections add loudness and fullness to the initial sound and help create our subjective impression of room size. Reverberation adds spaciousness to sound, fills out its loudness and body, and contains most of its tonal energy.
- No one sound room is acoustically suitable for all types of sound. Therefore it is important to match studio acoustics to sonic material.
- Rooms with reverberation times of one second or more are considered to be "live." Rooms with reverberation times of one-half second or less are considered to be "dry," or "dead."
- Four factors influence how sound behaves in an acoustic environment: (1) sound isolation, (2) room dimensions, (3) room shape, (4) and room acoustics.
- Noise is any unwanted sound (except distortion) in the audio system, the studio, or the environment.
- The noise criteria (NC) system rates the level of background noise.
- Sound isolation in a room is measured in two ways: (1) by determining the loudest outside sound level against the minimum acceptable NC level inside the room, and (2) by determining the loudest sound level inside the studio against a maximum acceptable noise floor outside the room.
- Transmission loss (TL) is the amount of sound reduction provided by a partition, such as a wall, floor, or ceiling. This value is given a measurement called sound transmission class (STC).
- The dimensions of a sound room—height, width, and length—should not equal nor be exact multiples of one another. Room dimensions create additive resonances, reinforcing certain frequencies and not others and thereby coloring the sound.

- Resonance, another important factor in studio design, results when a vibrating body with the same natural frequencies as another body causes that body to vibrate sympathetically, thereby increasing the amplitude of both at those frequencies if the variables are in acoustical phase.
- The shape of a studio is significant for good noise reduction and sound dispersion.
- When sound hits a surface, one or a combination of five reactions occurs: it is absorbed, reflected, partially absorbed and reflected, diffracted, or diffused.
- The amount of indirect sound energy absorbed is given an acoustical rating called a sound absorption coefficient, also known as a noise reduction coefficient (NRC).
- Three classifications of acoustic absorbers are porous absorbers, diaphragmatic absorbers, and Helmholtz absorbers or resonators.
- When sound reaches a surface, in addition to being partially absorbed and reflected, it diffracts—or spreads around the surface.
- Diffusion is the uniform distribution of sound energy in a room so that its intensity throughout the room is approximately uniform.
- To be more acoustically functional, many studios are designed with adjustable acoustics—movable panels, louvers, walls, and gobos (portable baffles) to alter reverberation time.
- Studios are designed for sound that is appropriate for microphone pickup. Control rooms are designed for listening through loudspeakers.
- To accurately assess the reproduced sound in a control room, the main challenge is to reduce the number of unwanted reflections at the monitoring location(s) so it is a relatively reflection-free zone.
- Four basic control room layouts are the cockpit and railroad styles, each in symmetrical and asymmetrical arrangements.
- Ergonomics addresses the design of an engineering system with human comfort and convenience in mind.