

GLOSSARY

ADAPTIVE AUDIO refers to sound that occurs in the game environment, reacting to gameplay, rather than responding directly to the user. An example is *Super Mario Bros.* (Nintendo, 1985), in which the music plays at a steady tempo until the time begins to run out, at which point the tempo doubles.

ADDITIVE SYNTHESIS (sometimes referred to as Fourier synthesis, as it is based on Fourier's theorem that all sound waves are made up of sine waves), refers to the creation of a sound wave by adding together simpler sound waves (typically sine waves).

ADPCM *Adaptive Differential PCM* (also known as adaptive delta PCM), is essentially a method of compressing a PCM sample. The difference between two adjacent sample values is quantified, reducing the pitch or raising the pitch slightly, to reduce the amount of data required. ADPCM uses only 4 bits per sample, therefore requiring only one quarter of the space of a 16-bit PCM sample. This works well for lower frequencies, but at higher frequencies can lead to distortion. PCM and ADPCM are now subclasses of the Microsoft waveform, WAV, although Windows system hardware does not understand ADPCM, and so it must be decompressed before playing as a PCM sample.

ADR Automatic Dialogue Recording: post-production audio re-recording of an actor's lines in the studio, as opposed to production recording.

AI Artificial intelligence comprises the routines or algorithms that control actions in a game. AI engines typically control the physics and actions of non-playing characters and environments, although there is also a desire among game audio personnel to create audio AI engines that can intelligently respond to the game parameters.

ARCADE GAME A stand-alone game unit, typically in a cabinet style, but also found as countertops or sit-in ride games in public spaces, generally coin-operated and therefore also known as a *coin-op*.

BIT A bit, derived from binary digit, is the smallest unit of information in computer language, a one (1) or zero (0) (also sometimes referred to as "on or off," or "white or black"). In referring to processors, the number of bits indicates how much data a computer's main processor can manipulate simultaneously. For instance, an 8-bit computer can process 8 bits of data at the same time. Bits can also be used to describe sound fidelity or resolution. Bit depth is used to describe the number of bits available in a byte. Higher bit depths result in better quality, but larger file sizes. 8 bits can represent 28 (binary being base 2), or 256 variations

in a byte. When recording sound, 256 divisions are not very accurate, since the amplitude of a wave is rounded up or down to fit the nearest available point of resolution. This process, known as quantization, distorts the sound or adds noise. CD quality sound is considered 16-bit, although often the CDs are recorded in 24-bit and converted to 16-bit before release.

CHIPTUNES popular music recorded with “retro” sound chips, typically from the early 8-bit era. Also known, or with subgenres known, as *bithop*, and *micromusic*.

CONSOLE Game hardware connected to a television set.

CONTROLLER The peripheral user interface with which the user interacts with the game.

DACS Digital-to-analog converters involve the re-creation of a sound wave from sample data (binary code) to an analog current (an electrical pressure sound-wave). DACs have bit depths and sample rates. The higher the bit rate and sample rate, the “better” the resulting sound. DACs most often work through pulse code modulation (see below).

DIEGETIC Diegetic sounds (*source music* or *real sounds*) are sounds that occur in the diegesis (the narrative space, or character’s space). Nondiegetic sound refers to “background” music and sound effects.

DSP Digital signal processing/processor: refers to the processing of a signal (sound) digitally, including using filters and effects.

DYNAMIC AUDIO Any audio designed to be changeable, encompassing both interactive and adaptive audio. Dynamic audio, therefore, is sound that reacts to changes in the gameplay environment and/or in response to a user.

ENGINE The software or code that controls a game and enables it to function.

FREQUENCY MODULATION (FM) synthesis: FM uses a modulating (usually sine) wave signal to change the pitch of another wave (known as the carrier). Each FM sound needs at least two signal generators (oscillators), one of which is the carrier wave and one of which is the modulating wave. Many FM chips used four or six oscillators for each sound, or instrument. An oscillator could also be fed back on itself, modulating its original sound.

GENERATOR An oscillator is capable of either making an independent tone by itself, or of being paired up cooperatively with its neighbor in a pairing known as a generator. To create realistic musical sounds two sorts of generators are needed: (1) oscillators to produce the basic waveform, and (2) envelope generators to change the waveforms as the notes age.

GRANULAR SYNTHESIS A relatively new form of synthesis that is based on the principle of microsound. Hundreds—perhaps thousands—of small (10–50 milli-

second) granules or grains of sound are mixed together to create an amorphous soundscape that can be filtered through effects or treated with envelope generators to create (often variable) sound effects and musical tones.

INTERACTIVE AUDIO Sound events occurring in reaction to gameplay, which can respond to the player directly. In other words, if for instance a player presses a button, the character on screen swings his or her sword and makes a “swooshing” noise. Pressing the button again will cause a recurrence of this sound. The “swoosh” is an interactive sound effect.

LINEAR ARITHMETIC (OR LA) SYNTHESIS See Wavetable synthesis.

LOCALIZATION The process of adapting a game’s dialogue (or other elements, which is referred to as blending) to cultures and languages other than the one for which the game was originally designed.

MIDDLEWARE A third-party supplementary software package that enables a programmer to build part of a game or assets for a game.

MIDI Musical instrument digital interface: A musical standard by which instruments can be connected to each other, as well as a series of codes (data) to control musical playback.

MMO Massively multiplayer online games: Online games in which many players participate.

OSCILLATOR An electric signal that generates a repeating shape, or wave form. Sine waves are the most common form of oscillator.

PCM Pulse code modulation (otherwise known as raw, or AI2 synthesis): Analog sound converted into digital sound by sampling an analog waveform. The data is stored in binary, which is then decoded and played back as it was originally recorded. The downside of this method is the amount of space required to store the samples: as a result, most PCM samples in early games are limited to sounds with a short envelope, such as percussion. 8-bit PCM samples commonly have an audible hiss owing to the resolution problems.

PLATFORM The hardware and/or the operating system on which a game is played. For instance, PlayStation is a platform, as is Microsoft Windows.

PLATFORM GAME A two-dimensional game that requires the player to jump about on platforms of various levels.

POLYNOMIAL COUNTERS also known as linear-feedback shift registers (LFSR): A type of binary counter that uses a pseudo-random way of counting, rather than the normal binary incremental/decremental sequences. A number is divided down from the system clock, meaning many pitches are not in tune with others, making it difficult to program melodies.

PORT A copy of a game for a platform other than the one for which it was originally designed.

PSG Programmable sound generators: silicon sound chips designed for audio applications that generate sound based on the user's input. These specifications are usually coded in assembly language to engage the oscillators. Instrument sounds are typically created with a waveform (tone generator) and envelope generator.

PULSE WAVES Pulse waves contain only odd harmonics, and are rectangular waveforms with “on” and “off” slopes, known as the duty cycle. When the duty cycle is of equal length in its “on” and “off” period, it is known as a square wave. Changing the duty cycle options (changing the ratio of the “on” to “off” of the waveform) alters the harmonics. At 50 percent (square), the waveform is quite smooth, but with adjustments can be “fat,” or thin and “raspy”. Square waves are often referred to as “hollow” sounding.

PWM *Pulse Width Modulation* works by generating variable-width pulses to represent the amplitude of an analog input signal (sample). The PWM method can attain higher volume and achieve a range of interesting timbres (such as a pseudo-chorus or phasing sound), but the samples are low quality (4-bit). On the Commodore 64, the noise channel could double as a simple PWM sampler. PWM was used for sampling short sounds like percussion, and to simulate a low-frequency oscillator (LFO) to the volume (creating a tremolo effect, as heard on *Parallax*).

REDBOOK Standard (uncompressed) CD audio.

SAMPLE RATE (also known as sample frequency): A sample is a measurement of amplitude. A sample contains the information of the amplitude value of a waveform measured over a period of time. The sample rate is the number of times the original sound is sampled (measured) per second. A CD-quality sample rate of 44.1 KHz means that 44,100 samples per second were recorded. If the sample rate is too low, a distortion known as aliasing will occur, and will be audible when the sample is converted back to analog by a digital-to-analog converter. Analog-to-digital converters will typically have an anti-aliasing filter, which removes harmonics above the highest frequency that the sample rate can accommodate.

SUBTRACTIVE SYNTHESIS Starts with a wave form created by an oscillator, uses a filter to attenuate or subtract specific frequencies, and then passes this through an amplifier to control the envelope and amplitude of the final resulting sound. Subtractive synthesis was common in analog synthesizers, and is often referred to as *analog synthesis* for this reason. Most PSGs were subtractive synthesis chips, and many arcades and home consoles used subtractive synthesis chips, such as the General Instruments AY-8910 series.

UI User interface: The controls and connection points between the game and the user, referring to both the hardware (joystick, keyboard, etc.) and the software (clickable icons, etc.).

WAVETABLE SYNTHESIS Uses preset digital samples of instruments (often combined with basic waveforms of subtractive synths). It is therefore much more realistic sounding than FM synthesis, but is much more expensive as it requires the soundcard to contain its own RAM or ROM. The Roland MT-32 MIDI soundcard used a form of wavetable synthesis known as *Linear Arithmetic*, or LA synthesis. Essentially, what the human ear recognizes most about any particular sound is the attack transient. LA based synthesizers used this idea to reduce the amount of space required by the sound by combining the attack transients of a sample with simple subtractive synthesis waveforms. This was known as cross modulation.

WHITE NOISE Sound that contains every frequency within the range of human hearing in equal amounts. In games, it is commonly used for laser sounds, wind, surf, or percussion sounds. Pink noise is a variant of white noise. Pink noise is white noise that has been filtered to reduce the volume at each octave. It is commonly used for rain or percussion sounds in games, sounding a bit like white noise with more bass.

