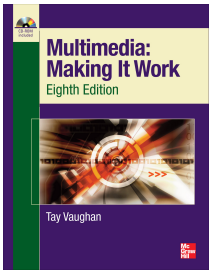
Chapter 4: Sound

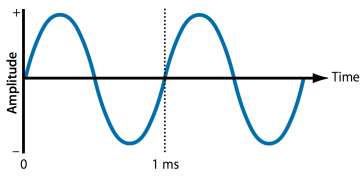


Overview

- **Introduction to sound**
- **Digital audio**
- **MIDI audio**
- **MIDI versus digital audio**
- **Recording and editing digital audio**
- **Audio file formats**
- **Adding sound to multimedia projects**

Introduction to Sound

- **Vibrations in the air create waves of pressure that are perceived as sound.**
- **Sound waves vary in sound pressure level (amplitude) and in frequency or pitch.**



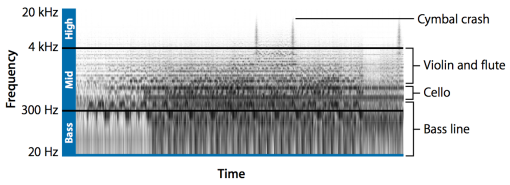
Introduction to Sound cont.

- "Acoustics" - the branch of physics that studies sound.
- Sound pressure levels (loudness or volume) are measured in decibels (dB).

- Sounds are produced by the conversion of energy into vibrations in the air or some other elastic medium
  - Sound -> vibrates eardrum -> inner ear -> nerve impulses -> brain interprets

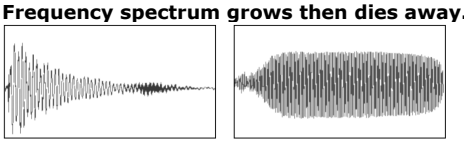
Introduction to Sound cont.

- "Frequency Spectrum" - a sound's description in terms of the relative amplitudes of its frequency components.



Introduction to Sound cont.

- Human ear ~ 20 Hz - 20 kHz.
  - Higher frequencies lost as we age.
- A single note has a distinctive attack, and subsequently will decay.
- Frequency spectrum grows then dies away.



Percussive volume envelope

Sustained volume envelope

Introduction to Sound cont.

- **Waveform - graphical plot of amplitude against time.**
- **Dynamic range - difference between the loudest and quietest sounds.**
  - **Boogie Woogie ex**

Music: Boogie-woogie

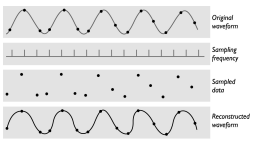
Singing: "Men grow cold…"

Digital Audio

- ***Digital audio data* is the actual representation of sound, stored in the form of samples.**
- ***Samples* represent the amplitude (or loudness) of sound at a discrete point in time.**
- **The quality of digital recording depends on the *sampling rate* (or frequency), that is, the number of samples taken per second.**

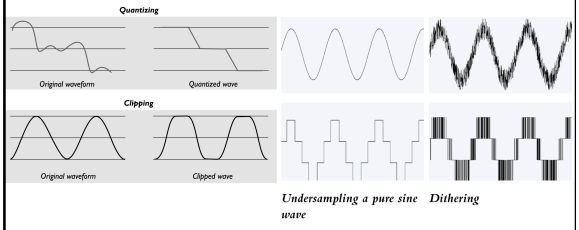
Digital Audio *(continued)*

- **The three sampling frequencies most often used in multimedia are CD-quality 44.1 kHz 16bit (65,536), 22.05 kHz, and 11.025 kHz.**
- **The number of bits used to describe the amplitude of a sound wave when sampled determines the sample size.**



Digital Audio *(continued)*

- **Digital audio is device independent.**
- **The value of each sample is rounded off to the nearest integer (quantization).**



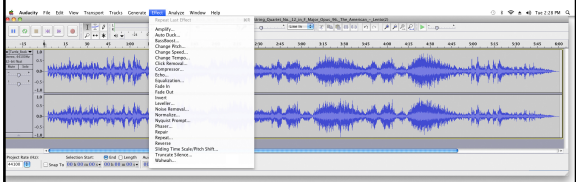
Undersampling a pure sine wave *Dithering*

Digital Audio *(continued)*

- **Crucial aspects of preparing digital audio files are:**
  - Balancing the need for sound quality against available RAM and hard disk resources
  - Setting appropriate recording levels to get a high-quality and clean recording
  - Avoid Clipping!!!

Digital Audio *(continued)*

- **Once a recording has been completed, it almost always needs to be edited.**
- **Basic sound editing operations include trimming, splicing and assembly, volume adjustments, and working on multiple tracks.**



Digital Audio *(continued)*

- **Additional available operations: format conversion, resampling or downsampling, fade-ins, fade-outs, equalization, time stretching, digital signal processing, looping, and reversing sounds.**
- **Short loops may be used to create voices for samplers; longer loops may be combined to build songs from repeating sections.**

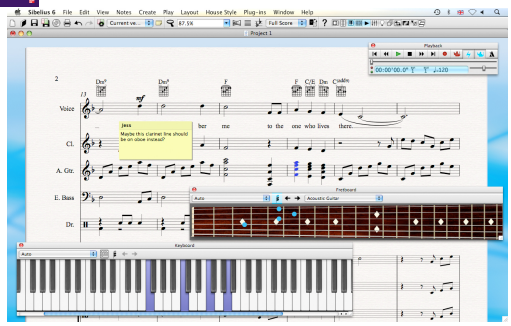
Digital Audio *(continued)*

- **Audio resolution determines the accuracy with which sound can be digitized.**
- **Size of a monophonic digital recording = sampling rate x (bit resolution/8) x 1.**
- **Size of stereo recording = sampling rate x duration of recording in seconds x (bit resolution/8) x 2.**

MIDI Audio

- **Since they are small, MIDI (Musical Instruments Digital Interface) files embedded in web pages load and play promptly.**
- **The length of a MIDI file can be changed without affecting the pitch of the music or degrading audio quality.**
- **Working with MIDI requires knowledge of music theory.**

MIDI Audio *(continued)*



MIDI Audio *(continued)*

- **MIDI is a shorthand representation of music stored in numeric form.**
- **It is not digitized sound.**
- **A sequencer software and sound synthesizer is required in order to create MIDI scores.**
- **MIDI is device dependent.**

MIDI Audio *(continued)*

MIDI Versus Digital Audio

- MIDI is device dependent, digitized audio is device independent.
- MIDI files are typically much smaller than digitized audio.
- MIDI files may sound better than digital audio files when played on a high-quality MIDI device.

MIDI Versus Digital Audio *(continued)*

- With MIDI, it is difficult to play back spoken dialog, while digitized audio can do so with ease.
- MIDI does not have consistent playback quality, digital audio does.
- Need knowledge of music theory in order to run MIDI, while digital audio does not have this requirement.

Recording and Editing Digital Audio

- Multimedia sound is either digitally recorded audio or MIDI (Musical Instrumental Digital Interface) music.

Audio File Formats

- A sound file's format is a recognized methodology for organizing data bits of digitized sound into a data file.
- On the Macintosh, digitized sounds may be stored as data files, resources, or applications such as AIFF or AIFC.
- In Windows, digitized sounds are usually stored as WAV files.

Audio File Formats *(continued)*

- MP3 compression is a space saver.
- MP4 is used when audio and video are streamed together.
- ACC (Advanced Audio Coding) is used by Apple's iTunes store.

Adding Sound to Multimedia Project

- File formats compatible with multimedia authoring software being used, along with delivery mediums, must be determined.
- Sound playback capabilities offered by end users' systems must be studied.
- The type of sound, whether background music, special sound effects, or spoken dialog, must be decided.
- Digital audio or MIDI data should be selected on the basis of the location and time of use.

Adding Sound to Multimedia Project *(continued)*

- **Create or purchase source material.**
- **Edit the sounds to fit your project.**
- **Test the sounds to be sure they are timed properly with your project.**

Adding Sound to Multimedia Project *(continued)*

- **Professional sound**
  - Compression techniques reduce space, but reliability suffers.
  - Space can be conserved by downsampling or reducing the number of sample slices taken per second.
  - File size of digital recording (in bytes) = sampling rate x duration of recording (in secs) x (bit resolution/8) x number of tracks.

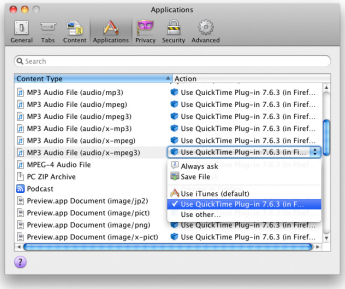
Adding Sound to Multimedia Project *(continued)*

- **Recording on inexpensive media rather than directly to disk prevents the hard disk from being overloaded with unnecessary data.**
- **The project's equipment and standards must be in accordance with the requirements.**
- **It is vital to maintain a high-quality database that stores the original sound material.**

Adding Sound to Multimedia Project *(continued)*

- **Keeping track of your sounds**
  - Audio CDs
    - The Red Book (ISO 10149) standard for digitally encoding high-quality stereo.
    - 16 bit sample size and 44.1 KHz sampling rate.
    - The amount of digital sound information required for high-quality sound takes up a great deal of disk storage space.
  - Sound for your mobile
  - Sound for the Internet

Adding Sound to Multimedia Project *(continued)*



Web browsers must be told what to do when they download file types.

Adding Sound to Multimedia Project *(continued)*

- **Sound and image synchronization must be tested at regular intervals.**
- **The speed at which most animations and computer-based videos play depends on the user's CPU.**

Adding Sound to Multimedia Project *(continued)*

- The sound's RAM requirements as well as the user's playback setup must be evaluated.
- Copyrighted material should not be recorded or used without securing appropriate rights from the owner or publisher.

Summary

- Vibrations in the air create waves of pressure that are perceived as sound.
- Multimedia system sound is digitally recorded audio or MIDI (Musical Instrumental Digital Interface) music.
- Digital audio data is the actual representation of a sound, stored in the form of samples.

Summary *(continued)*

- MIDI is a shorthand representation of music stored in numeric form.
- Digital audio provides consistent playback quality.
- MIDI files are much smaller than digitized audio.
- MIDI files sound better than digital audio files when played on a high-quality MIDI device.