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.
"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

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

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.
Introduction to Sound cont.

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

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).

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 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 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.
• 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.

• 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.

• 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.
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)

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.