

# Digital Audio Basics

## Historical Background

Thomas Edison's favorite invention was the phonograph. In 1877, he created a way to record sound on tinfoil cylinders by using two needles, one for recording and one for playback. The first words that Edison recorded were "Mary Had a Little Lamb." The next year Edison formed the Edison Speaking Phonograph Company so that these machines could be sold to the public. This was the beginning of the sound recording industry. The first records sold by the Edison and Columbia Phonograph Companies were on wax cylinders. These were brittle and broke easily. Columbia ceased production of wax cylinders in 1909 when disks became popular. The Edison National Phonograph Company continued making cylinders and disks until 1929. These cylinder records and other recordings throughout the twentieth century are valuable primary resources that many institutions such as the Smithsonian and Library of Congress are trying to preserve under a program called *Saving America's Sounds*. There are several Websites to learn more about Thomas Edison and listen to early recordings.



Photo of Edison with cylinder phonograph in 1878

CREDIT: Edison, Thomas A.. "Edison with Cylinder Phonograph; Washington, DC; April 18, 1878." 1878. Photo courtesy of U. S. Department of Interior, National Park Service, Edison National Historic Site.



Black Wax Cylinder



Advertisement for Talking Doll



Edison Standard Phonograph

**Task:** Listen to one of the audio recordings from each of these Web sites:

Edison Sound Recordings

<http://memory.loc.gov/ammem/edhtml/edsndhm.html>

Tinfoil

<http://www.tinfoil.com/archive.htm>

Using the guide below, describe what you hear.

<p><b>Objective Observations</b></p> <p>Describe what you hear in the recording by investigating its parts. For example: Is the recording musical or nonmusical? Are there any recognizable instruments? If so, identify them. Are the words sung or spoken? Is there any slang or dialect used in the recording? Is a story being told? If so, what is the story about?</p>	<p><b>Subjective Observations</b></p> <p>Describe your personal feelings and what you think about the recording. Always base your subjective reaction on something that is heard. For example, "I heard ..., and it makes me feel or imagine ..."</p>
<p>Do you have any <b>Questions</b> about the recording?</p>	

## Digital Audio with Computers

Over the years, improvements in technology have changed the way music is recorded and the media used. Today, we use computers to record audio and save it to CDs, MP3 players, and other storage devices. In order to transform sound into a digital format, you must sample the sound. This process takes place while you are recording. The computer takes a snapshot of the sound level at small time intervals. The number of samples taken each second is called the sampling rate. The more samples that are taken, the better sound quality. For instance, audio sampled at 44 kHz is better than audio sampled at 22 kHz. It also means more storage space for higher quality sound.

Sampling rate kHz	Bit Depth	Channels	Disk Space for one minute of sound
44	16	stereo	10.5 Mb
44	16	mono	5.2 Mb
44	8	stereo	5.2 Mb
44	8	mono	2.6 Mb
22	16	stereo	5.2 Mb
22	16	mono	2.6
22	8	stereo	2.6
22	8	mono	1.3
11	16	stereo	2.6
11	16	mono	1.3
11	8	stereo	1.3
11	8	mono	.6

## File Formats

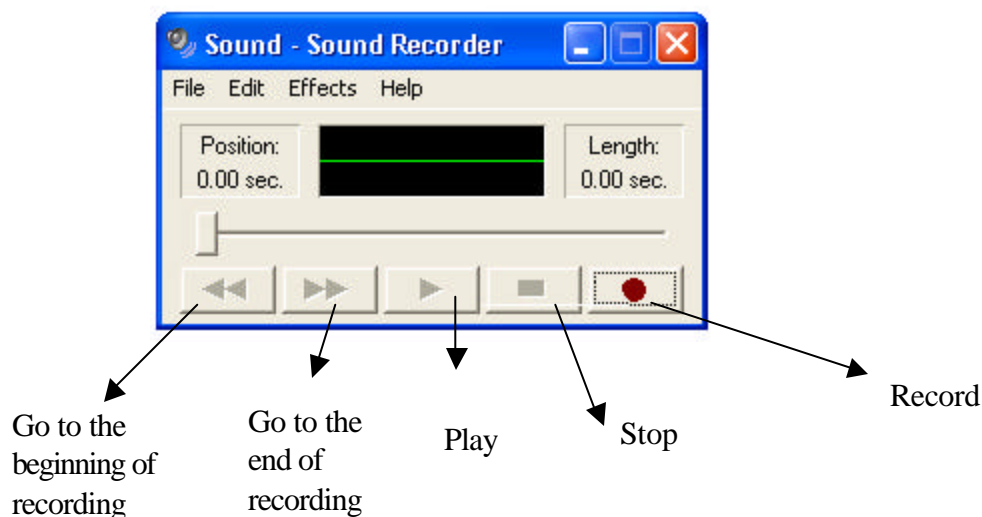
There are several different file formats used for digital sound. Some work only on Macintosh computers and others work only on Windows computers. Some software programs only recognize certain audio file formats. Audio files have an extension at the end of the filename that tells you the format type. For example, files with .snd or .aiff are common on Macintosh computers while .wav is most common on Windows machines. Therefore, it is important to know the file format extensions.

Type	Extensions	Codec
AIFF (Mac)	.aif, .aiff	*PCM
AU (Sun/Next)	.au	*u-law
CD audio (CDDA)	N/A	PCM
Midi	.mid	NA
MP3	.mp3	MPEG Audio Layer-II
Windows Media Audio	.wma	Proprietary (Microsoft)
QuickTime	.qt, .mov	Proprietary (Apple Computer)
RealAudio	.ra, ram	Proprietary (Real Networks)
WAV	.wav	*PCM

\* Can be used with other codecs.

**Task:** Find three different sound files on the Web and list the extension and the program that you used to play the sound.

## Basic Audio Recording



- Some computers have a built in microphone and others require a microphone to be plugged into the input of the computer audio board
- Open an audio recording program
- Select a sampling rate and other parameters if they are available

- Select “Record”
- Speak into the microphone
- Select “Stop” when you have finished recording
- Select the “Play” command to test the recording.
- Name the file and save it.

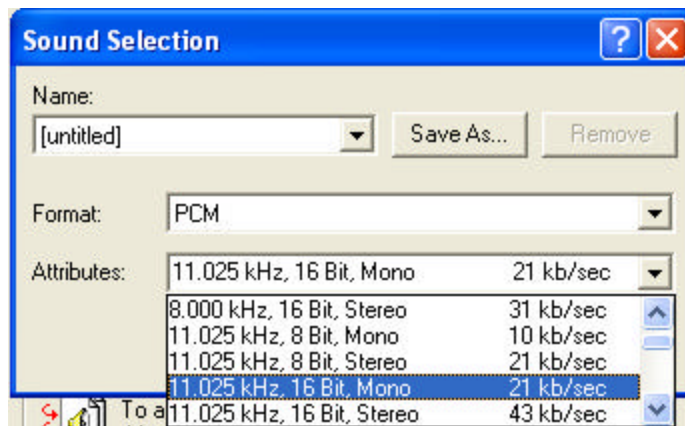
**Task:** Write a 30 second commercial and record it.

**Task:** Record 30 seconds of music that could be used with your commercial.

**Task:** Record your commercial with music in the background.

To adjust the quality of a sound file in Sound Recorder

1. On the **File** menu, click **Open**.
2. In the **Open** dialog box, double-click the sound file (.wav) you want to modify.
3. On the **File** menu, click **Properties**.
4. Under **Format Conversion**, click the format you want, and then click **Convert Now**.
5. Specify the format and attributes you want, and then click **OK**.



**TASK:** Change the quality of a sound file to PCM Format and 11.025 KHZ 16 bit stereo. Compare the original file with the changed file.

### Optional Tasks:

Add an Echo to a Sound File

1. On the **File** menu, click **Open**.
2. In the **Open** dialog box, double-click the sound file you want to modify.
3. On the **Effects** menu, click **Add Echo**.

Note: You can add an echo only to an uncompressed sound file.

Change the speed of a sound file

1. On the **File** menu, click **Open**.
2. In the **Open** dialog box, double-click the sound file you want to modify.
3. On the **Effects** menu, click **Increase Speed (by 100%)** or **Decrease Speed**.

Play a sound file in reverse

1. On the **File** menu, click **Open**.
2. In the **Open** dialog box, double-click the sound file you want to modify.
3. On the **Effects** menu, click **Reverse**, and then click **Play**.

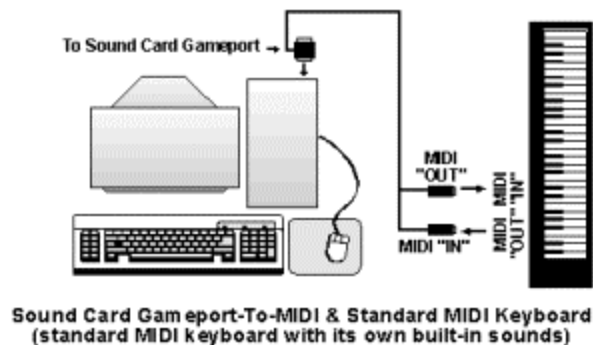
To undo changes made to a sound file

1. On the **File** menu, click **Revert**.
2. Click **Yes** to confirm the restoration.

After you save a file, you cannot undo any changes made before you saved it.

## Synthesized Music (Optional)

A synthesizer is a device such as a piano keyboard that produces music electronically when connected to a computer. The music format created by this configuration is a MIDI file. MIDI (musical Instrument Digital Interface) music is popular because it can be compressed to a very small file thus taking very little bandwidth on the Internet. It can also create very complex arrangements with many different musical instruments. Unlike other digital audio that requires sampling, MIDI music contains information about the note value, pitch, and duration.



The MIDI keyboard connects to your PC sound card with a MIDI adapter cable. This allows your PC to record the notes played on the MIDI keyboard so you can edit them on the screen. In addition, if the MIDI keyboard also has a built-in synthesizer, your PC can use it to play the music you've written.

<b>Processor</b>	Pentium-class 233MHz processor with MMX or better (Celeron 400 for Windows 2000/XP)
<b>RAM</b>	256 MB recommended
<b>Display</b>	800 x 600 high color (16-bit) video display
<b>Soundcard</b>	16-bit DirectSound-compatible soundcard
<b>CD-ROM</b>	4X speed or higher CD-ROM
<b>Other</b>	Printer for printing sheet music MIDI keyboard with MIDI cable interface

### **Scanned Sheet Music (Optional)**

Scan sheet music and create midi files with PhotoScore Midi from Nueratron. Once the music has been scanned, it can be opened in other music programs. A free demo is available from their Web site: <http://www.neuratron.com/photoscore.htm>.

### **Copyright**

Now that you have access to hundreds of audio files on the Internet, what are the copyright laws and guidelines for use of these files? Copyright protects the works of authors, artists, composers, and others from being used without permission. Works that are not copyrighted are public domain and may be used without permission. However, you should still give credit to the source. Fair use allows you to use a limited amount of copyrighted material for your educational use. A student who uses an audio file in a project generally falls under the fair use rule. However, if you are publishing projects to the Web, other rules apply. For music, lyrics and so forth you can use up to 10% but no more than 30 seconds of an individual work. The best policy is to write for permission to use the file. Find the contact person and compose an email message. Put "Permission to Use" in the subject line. In most cases, you will receive a reply to your request. Do not assume that "no response" means it is okay to use it.

U.S. Copyright Office  
<http://www.loc.gov/copyright/>

Copyright with CyberBee  
<http://www.cyberbee.com/copyrt.html>

## Music Web Sites

### Creating Music

<http://www.creatingmusic.com/>

Creatingmusic.com is a children's online creative music environment for children of all ages. It's a place for kids to compose music, play with musical performance, music games and music puzzles.

### Find Sounds

<http://www.findsounds.com/>

Search the Internet for sound effects and musical instrument samples in these file formats, AIFF, AU, and WAVE.

### Inventing Entertainment: the Early Motion Pictures and Sound Recordings of the Edison Companies

<http://memory.loc.gov/ammem/edhtml/edhome.html>

This site features 341 motion pictures, 81 sound recordings, and other related materials, such as photographs and original magazine articles. Cylinder sound recordings will be added to this site in the near future. In addition, histories are given of Edison's involvement with motion pictures and sound recordings, as well as a special page focusing on the life of the great inventor.

### K-12 Resources for Music Educators

<http://www.isd77.k12.mn.us/resources/staffpages/shirk/k12.music.html>

A compilation of links that is useful to teachers. A special feature on the page is the Music Box of Sound and Software with complete downloadable music compositions in QuickTime format.

### Smick and Smodoo's Old Codger's Midi Page

<http://www.smickandsmodoo.com/aaa/oldcodgers/oldcodgers.htm>

Find a great selection of familiar tunes that turn back the clock to the turn of the twentieth century.