Sound

When the lead singer of Meatloaf belts out a note, he is just creating a wave of air pressure disturbances, which your ear interprets as music (or noise). Because air pressure is measurable at any instant in time, the sound is called continuous*.*

A computer, however, has no way of storing sound information for every *instant in time. Just as the computer represents a continuous curve with a bunch of tiny dots on the screen, so must it represent a continuous sound with* samples *of sound information.*

Try to familiarize yourself with these terms and concepts of digital sound. More important, come back to this sheet if you come across anything you don't understand.

analog signal A continuously-defined signal. Real-world sounds are analog signals.

digital signal A signal which is defined only for certain values of time, e.g. every ten-thousandth of a second. Computers store sounds digitally... in tiny chunks of information called samples.

sample One little chunk of sound information used by a computer. Computers store each sample as a number, typically an integer.

hertz, or **Hz.** One cycle per second. If a signal repeats itself (goes through one cycle) 22,050 times each second, then its frequency is 22,050 Hz. A thousand hertz equals one **kilohertz**, or **kHz**.

sampling rate The rate at which a computer gathers sound information. At the 44,100 Hertz sampling rate common to compact discs, 44,100 samples are collected every second.

speaker cone The physical object that vibrates back and forth inside a speaker to produce a sound.

frequency The "pitch" of a sound. Higher frequencies occur as the speaker cone vibrates faster.

waveform The wave of sound as it travels through the air. It is usually represented by a graph of the position of the speaker cone over time.

FFT "Fast Fourier Transform"... an oh-so-important method for figuring out how much of each frequency appears in a signal over a time interval.

spectrogram Usually a graph of how much of each frequency appears *at each instant* in the sound, as opposed to an FFT of the entire sound. The spectrogram is a just a series of FFT's taken in rapid succession.

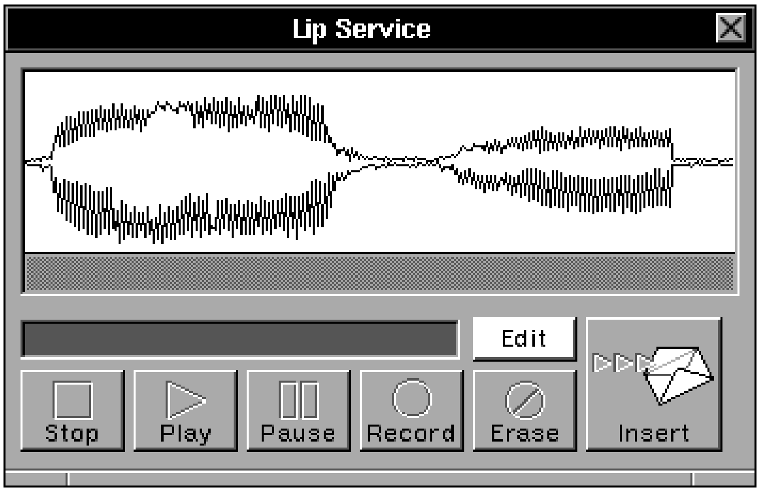
DSP "Digital Signal Processor" — a chip inside the NeXT that makes for *fast* processing of sounds and other digital signals.

channels A one-channel sound is monophonic, and two-channel is stereo.

Digital Sound is the secret to the high-quality music of Compact Discs. Record labels just put sound sampled at 44,100 hertz onto the CD's. In fact, Apple™ CD-ROM disk drives can play music right off audio CD's! It's all headed in the same direction...

Visual representation

When you work with sounds on the NeXT machine, you will commonly see this representation of the sound waveform:



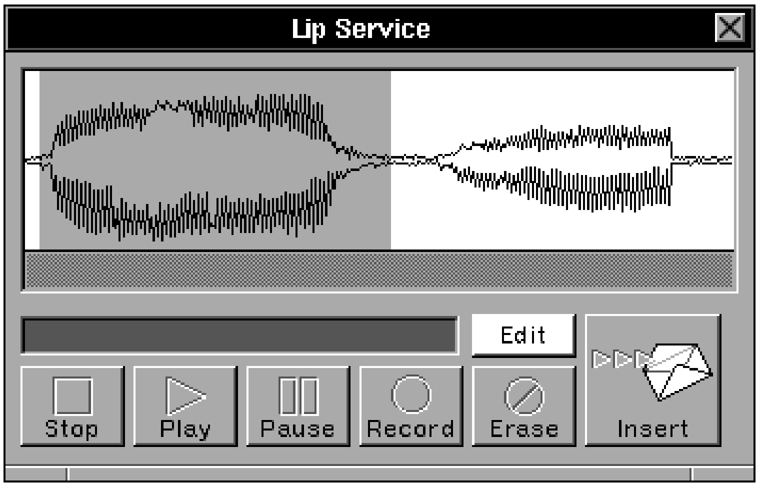
Since the speaker cone is responsible for creating the air disturbances (sound) which you hear, it's fair to show a graph of the speaker cone versus time, and claim that it represents the sound waveform.

Look carefully at the picture. Imagine that a horizontal line through the center represents a "resting" position for the speaker cone. Think of the speaker cone, then, as vibrating between the top and bottom lines of the graph. That's what produces the sound, and that's all you need to understand!

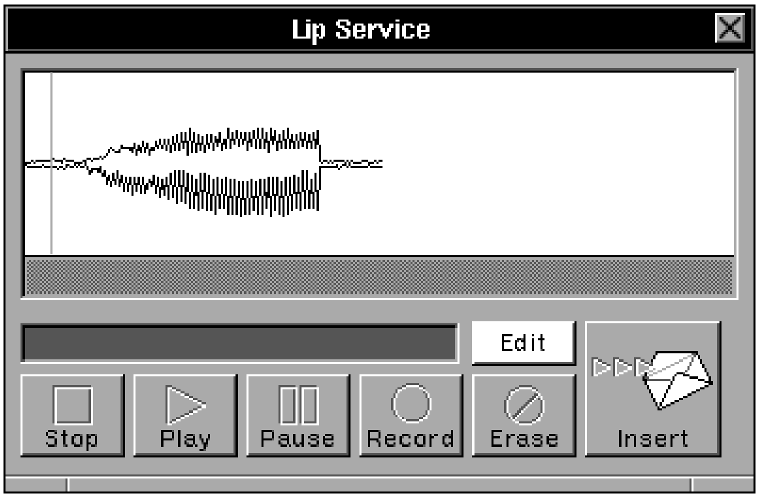
Editing

*Editing sound is much like editing text. You can **Cut**, **Copy**, and **Paste** to your heart's content. For instance, to move the beginning of the above sound to the end, I might follow this procedure:*

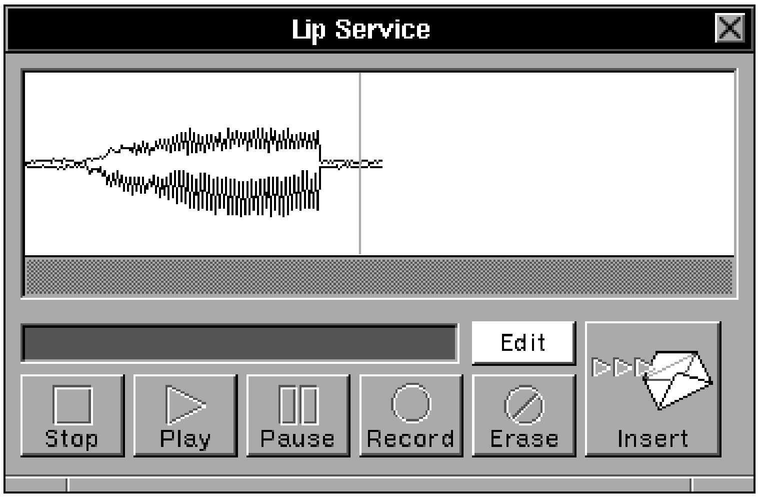
• Select the beginning of the sound (drag over it with the mouse), like this:



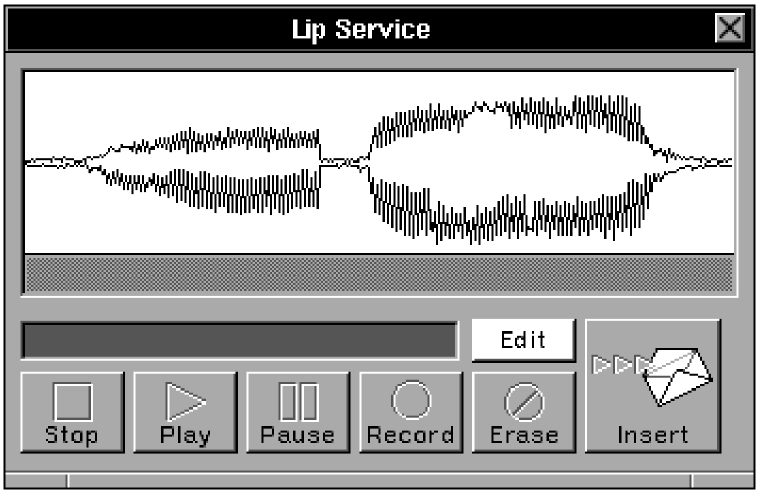
• Choose **Cut** from the **Edit** menu, to get this:



• Click once near the end to put in an "insertion point" (just like a text insertion point):



• Choose **Paste** from the **Edit** menu, to end up with this:



There ya go! Play the sound. If you are just reading along, look at Lab 5 for sound tools. Have a blast...