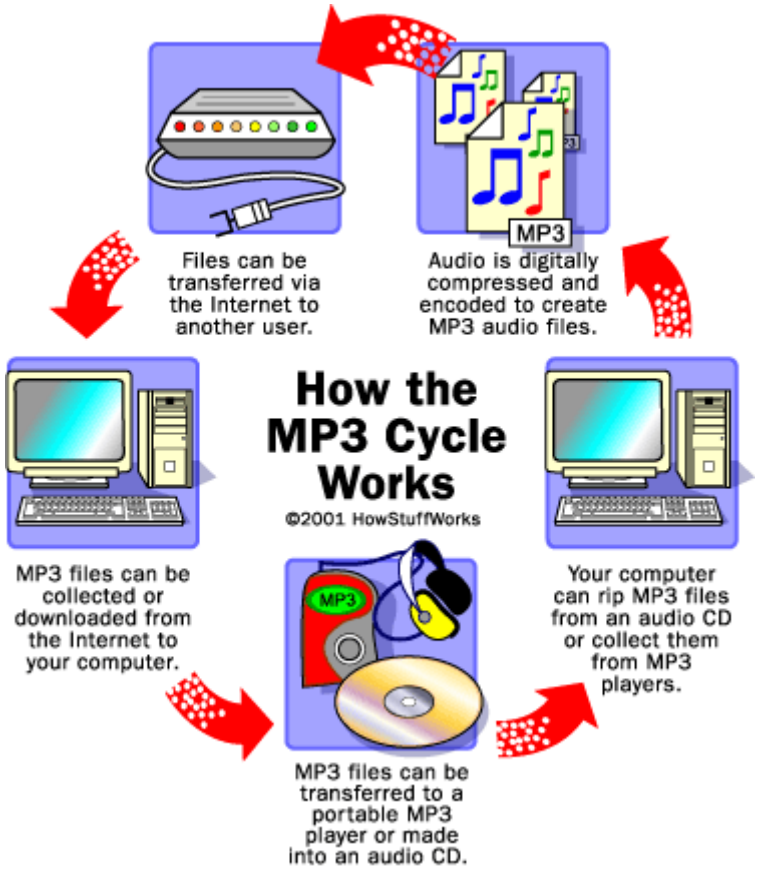
How MP3 Files Work

by Marshall Brain

The MP3 movement is one of the most amazing phenomena that the music industry has ever seen. Unlike other movements -- for example, the introduction of the cassette tape or the CD -- the MP3 movement started not with the industry itself but with a huge audience of music lovers on the Internet. The MP3 format for digital music has had, and will continue to have, a huge impact on how people collect, listen to and distribute music.

The Player

If you're interested in MP3s, you may also want to check out **How MP3 Players Work**!



If you have ever wondered how MP3 files work, or if you have heard about MP3 files and wondered how to use them yourself, then this article is for you! In this article, you will learn about the MP3 file format and how you can start downloading, listening to and saving MP3 files onto CDs!

The MP3 Format

If you have read How CDs Work, then you know something about how CDs store music. A CD stores a song as **digital** information. The data on a CD uses an uncompressed, high-resolution format. Here's what happens when a CD is created:

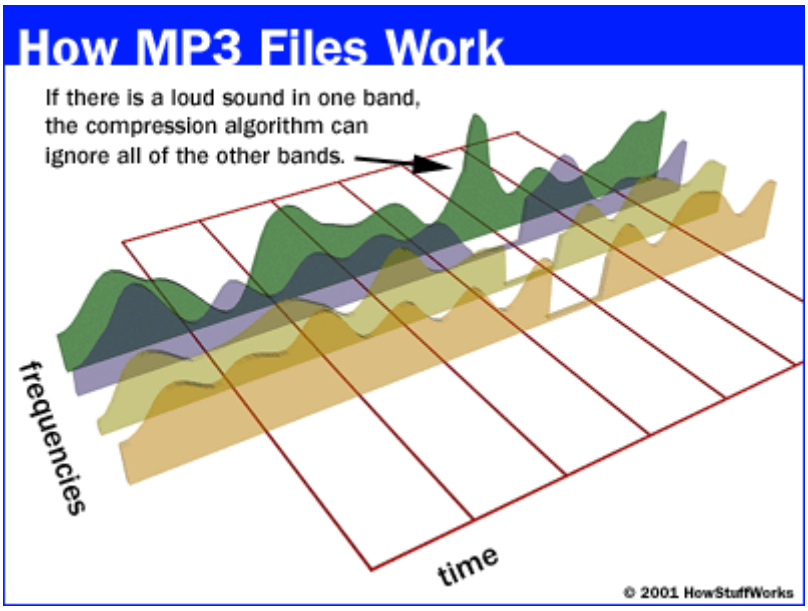
- Music is sampled 44,100 times per second. The samples are 2 bytes (16 bits) long.
- Separate samples are taken for the left and right speakers in a stereo system.

So a CD stores a huge number of bits for each second of music:

44,100 samples/second * 16 bits/sample * 2 channels = 1,411,200 bits per second

Let's break that down: 1.4 million bits per second equals 176,000 bytes per second. If an average song is three minutes long, then the average song on a CD consumes about 32 million bytes of space. That's a lot of space for one song, and it's especially large when you consider that over a 56K modem, it would take close to two hours to download that one song.

The MP3 format is a compression system for music. The MP3 format helps reduce the number of bytes in a song without hurting the quality of the song's sound. The goal of the MP3 format is to compress a **CD-quality** song by a factor of 10 to 14 without noticably affecting the CD-quality sound. With MP3, a 32-megabyte (MB) song on a CD compresses down to about 3 MB. This lets you download a song in minutes rather than hours, and store hundreds of songs on your computer's hard disk without taking up that much space.



Is it possible to compress a song without hurting its quality? We use compression algorithms for images all the time. For example, a GIF file is a compressed image. So is a JPG file. We create Zip files to compress text. So we are familiar with compression algorithms for images and words and we know they work. To make a good compression algorithm for sound, a technique called **perceptual noise shaping** is used. It is "perceptual" partly because the MP3 format uses characteristics of the human ear to design the compression algorithm. For example:

- There are certain sounds that the human ear cannot hear.
- There are certain sounds that the human ear hears much better than others.
- If there are two sounds playing simultaneously, we hear the louder one but cannot hear the softer one.

Using facts like these, certain parts of a song can be eliminated without significantly hurting the quality of the song for the listener. Compressing the rest of the song with well-known compression techniques shrinks the song considerably -- by a factor of 10 at least. (If you would like to learn more about the specific compression algorithms, see the links at the end this article.) When you are done creating an MP3 file, what you have is a "**near CD quality**" song. The MP3 version of the song does not sound exactly the same as the original CD song because some of it has been removed, but it's very close.

From this description, you can see that MP3 is nothing magical. It is simply a file format that compresses a song into a smaller size so it is easier to move around on the Internet and store.

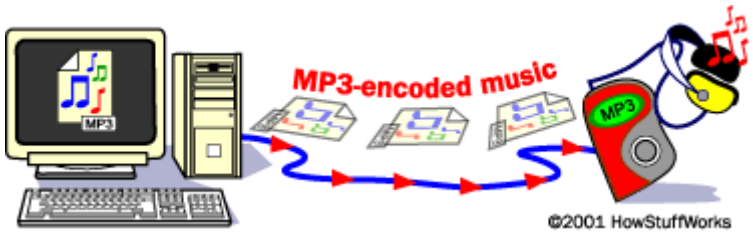
The Name

MPEG is the acronym for **Moving Picture Experts Group**. This group has developed compression systems used for video data. For example, DVD movies, HDTV broadcasts and DSS satellite systems use MPEG compression to fit video and movie data into smaller spaces. The MPEG compression system includes a subsystem to compress sound, called **MPEG audio Layer-3**. We know it by its abbreviation, **MP3**.

Using the MP3 Format

Knowing about the MP3 format isn't half as interesting as using it. The MP3 movement -- consisting of the MP3 format and the Web's ability to advertise and distribute MP3 files -- has done several things for music:

- It has made it easy for anyone to distribute music at nearly no cost (or for free).
- It has made it easy for anyone to find music and access it instantly.
- It has taught people a great deal about manipulating sound on a computer.



Technology has made it easier to download and play your favorite music.

That third one was accidental but important. A big part of the MP3 movement is the fact that it has brought an incredible array of powerful tools to desktop computers and given people a reason to learn how they work. Because of these tools, it is now extremely easy for you to:

- Download an MP3 file from a Web site and play it
- Rip a song from a music CD and play it directly or encode it as an MP3 file
- Record a song yourself, convert it to an MP3 file and make it available to the world
- Convert MP3 files into CD files and create your own audio CDs from MP3 files on the Web
- Rip songs off of various music CDs and recombine them into your own custom CDs
- Store hundreds of MP3 files on data CDs
- Load MP3 files into tiny portable players and listen to them wherever you go

To do all of these amazing things, all you need is a computer with a sound card and speakers, an Internet connection, a CD-R drive to create CDs and an MP3 player. If you simply want to download MP3 files from the Web and listen to them, then all you need is a computer with a sound card and speakers and an Internet connection -- things you probably already have!

Let's look at many of the different things you can do with MP3 files and the software that makes it possible.

Downloading and Listening

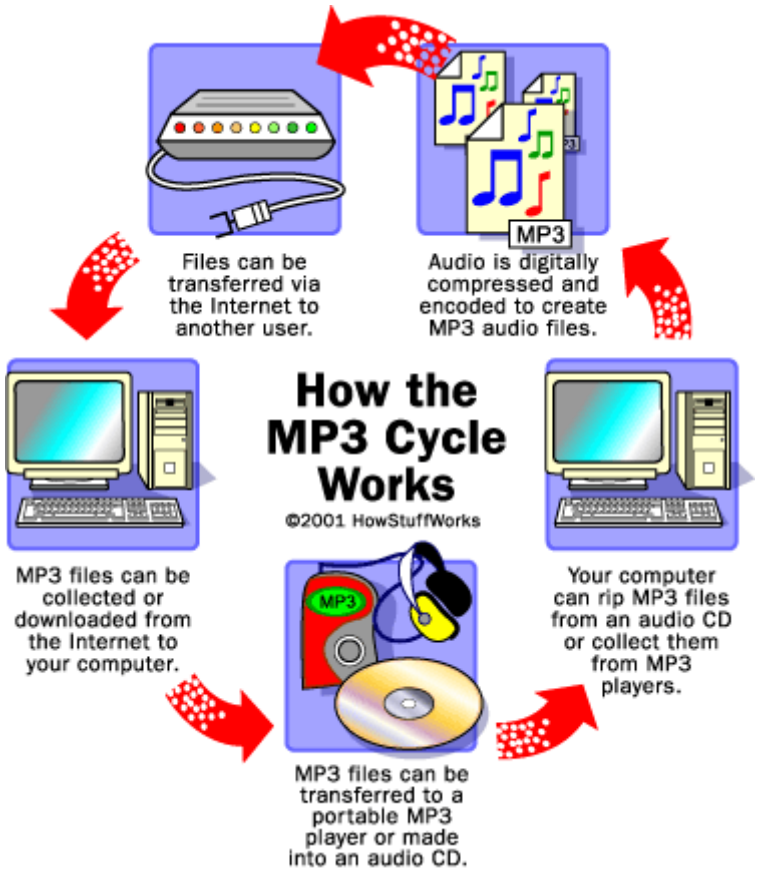
If you would like to download and then listen to MP3 files on your computer, then you need:

- A **computer**

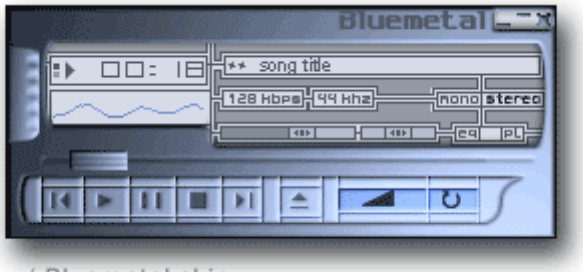
- A **sound card** and **speakers** for the computer (If your computer has speakers, it has a sound card.)
- An **Internet connection** (If you are browsing the Web to read this article, then you have an Internet connection and it is working fine.)
- An **MP3 player** (a software application you can download from the Web in 10 minutes)

If you have recently purchased a new computer, chances are it already has software that can play MP3 files installed on its hard disk. The easiest way to find out if you already have an MP3 player installed is to download an MP3 file and try to double-click on it. If it plays, you are set. If not, you need to download a player, which is very easy to do.

There are literally thousands of sites on the Web where you can download MP3 files. (Click here to do a search for MP3 download sites.) Go to one of these sites, find a song and download it to your hard disk (most MP3 sites let you either listen to the song as a streaming file or download it -- you want to download). Most songs range between 2 and 4 MB, so it will take 10 to 15 minutes unless you have a high-speed Internet connection. Once the song has finished downloading, try to double-click on the file and see what happens. If your computer plays it, then you are set.



If you find that you cannot play it, then you need to download an **MP3 player**. There are dozens of players available, and most of them are free or shareware (shareware is extremely inexpensive). One of the most popular is WinAmp, which you can download from www.winamp.com. For a complete list of all of the top digital music downloads, check out this page from CNet.com. Once you download and install a player, double-click on the MP3 file that you downloaded and it will play.



WinAmp w/ Bluemetal skin

You are now ready to begin collecting MP3 files and saving them on your computer. Many people have hundreds of songs they have collected, and they create jukebox-like playlists so that their computer can play them all day long!

Taking the Files With You

Many people who start collecting MP3 files find that they want to listen to them in all kinds of places. Small, portable MP3 players answer this need. These players are like portable cassette players except that they are smaller.

These players plug into your computer's parallel, FireWire or USB port to transfer the data, and a software application lets you transfer your MP3s into the player by simply dragging the files. See How MP3 Players Work for details.

Creating Your Own

If you have a CD collection and would like to convert songs from your CDs into MP3 files, you can use **ripper** and **encoder** software to do just that. A ripper **copies** the song's file from the CD onto your hard disk. The encoder **compresses** the song into the MP3 format. By encoding songs, you can play them on your computer or take them with you on your MP3 player.

AudioCatalyst is a popular ripper/encoder that you can use to do the job. This page contains a list of other rippers and encoders.

Writing MP3s to CDs

If you have a writable CD drive in your computer, there are two ways to save your MP3 files on a CD:

- You can write the MP3 files themselves onto a **data CD** in order to save them and clear some space on your hard disk. You can then listen to the files on any computer. Some car stereos and DVD players now let you play data-encoded MP3s, too.
- You can convert (decode) your MP3 files into full-size CD tracks and then save them to an **audio CD**. This allows you to listen to your MP3 files on any CD player.

WinAmp has a plug-in that creates full-size WAV files from MP3 files, and some of the encoders will also decode. Once you have the full-size CD tracks, then the software that comes with your CD-R drive will let you create an audio CD easily.

The CD-Recordable FAQ is an excellent source of information on getting data and music onto a CD.

Distributing Original Music

If you are an artist who is recording music at home or in a small studio, you can use MP3 files and the Web to distribute your music to an extremely large audience. The first step is to create a song, either on a cassette tape, minidisc or CD. If it is on a CD, you can use the ripper and

encoder tools described in the previous section to create an MP3 file. If it is on a cassette (or minidisc), you can connect the output of your cassette (or minidisc) deck to the line-in or microphone jack of your sound card and record the music digitally on your computer. Then you can encode that file to create the MP3.

Once you have an MP3 file in hand, you have two distribution options:

- You can go to an MP3-distribution site and let them distribute your music. The advantage of this approach is that large MP3-distribution sites gets millions of visitors every month, so the potential audience you can reach is very large.

  Music.Download.com is expected to launch in 2004. You'll be able to upload MP3s here and share them with a lot of people. In the meantime, you can receive updates by submitting your e-mail address.

- You can create your own Web site for your music or band and promote the site yourself. This gives you more control and individuality, but requires you to get the word out on your own. See How Web Pages Work for details on creating and hosting your own Web site.

One good option is to make your MP3 files available on a large Web site and then link to the download area from your band's Web site. This lets you get the best of both worlds, and you can take advantage of the larger site's servers for those big MP3 files.