3

TRANSFERRING VINYL LPS (AND OTHER LEGACY MEDIA) TO CD

A great way to preserve and enjoy old recordings is to transfer them from any legacy medium—vinyl LPs, cassette tapes, reel-to-reel tapes, vintage 78s, videocassettes, even eight-track tapes—to CD. Or you can transfer them to a hard drive, solid-state drive, or whatever digital storage medium you prefer.

Transferring phonograph records to CD is in demand, and you might even be able to get a nice sideline going doing this. A lot of people are still hanging on to their record collections but are afraid to enjoy them because LPs are fragile. A lot of great albums have never been released on commercial CDs, or the modern CD remasters are not done well. Some people simply prefer the sound of their old records.

Although you can copy any analog media and convert it to any digital audio format, in this chapter we'll talk mostly about transferring vinyl record albums and singles to CDs. Once you have converted your old analog media to a digital format, Audacity has a number of tools for cleaning up the sound quality. You may not always be able to perform perfect restorations, but you can reduce hiss, clicks, pops, and other defects to quite tolerable levels.

You can also customize dynamic range compression to suit your own needs, which is a nice thing because on modern popular CDs, dynamic range compression is abused to where it spoils the music. Even if they did it well, it might not be right for you, so Audacity lets you do it your way.

Finally, we'll discuss the merits of vinyl versus CD and other media, as well as the ins and out of connecting your various playback devices to your computer. If you need help setting up your hardware, skip ahead to the "Connecting Legacy Devices to Your Computer" on page 67 first.

For those of you with golden ears who are not satisfied with 16/44.1 CDs, the DVD-Audio format supports up to 24/196. That's right, 24 bits at 196,000 samples per second. DVD-Audio supports 5.1 surround sound, and so does Audacity in the 1.3.*x* releases. If you're not into surround sound, you can cram several CDs worth of music at 16/44.1 onto a DVD. We'll learn about authoring DVD-Audio disks in Chapter 6.

Okay then, let's dive into copying, editing, and then making CDs. Please review Chapter 1 if you need a refresher on the basics of using Audacity.

Preparing Vinyl LPs for Copying

First, clean up your vinyl records as well as you can. Sure, you can do a lot to clean up digital audio files, but it's not like on TV where the ace lab tech makes pristine restorations effortlessly. That's fiction, my dear readers, and we are stuck in the real world. It's better to start with the best-quality recording possible; it's less work, and you get better results.

I have my nice old Discwasher brushes from the olden days, and it's a good thing because the new ones are inferior. Real Discwasher brushes have a directional nap—hold them one way to clean the record, and then reverse your stroke on a clean lint-free cloth to clean the brush. There is an arrow embedded on the handle that points to the leading edge. You can use a real Discwasher brush dry or with a wet cleaning solution. The correct way to wet-clean with Discwasher is to apply the cleaning solution to the leading edge of the brush only, leaving the rest of it dry. You can clean a record on your turntable while it's rotating, but be careful you don't apply so much pressure that you damage the motor. Apply the wet leading edge of the brush for three to four turns, and then roll the brush to bring the dry part in contact with the record for another three to four turns. Give it time to dry completely before playing it, because playing a wet record can damage it. (However, on a record that is already in bad, nothing-to-lose condition, playing it wet might make it sound better. Moisten it carefully with distilled water or Discwasher D4 fluid, and give it a whirl. It won't hurt your stylus.)

A nice thing to have for everyday cleaning is a carbon antistatic brush. These are always used dry and are pretty good at lifting out dust, lint, and other particles that try to make a home on your records. But they're no good for cleaning fingerprints, sticky goo, or other muck that requires a wet cleaner.

There are all kinds of cleaning solutions, microfiber cloths, brushes, and even wet power washers. The debates over the best ways to clean vinyl

The History of Record Production

The earliest recordings were made on rotating wax cylinders with a needle in the middle of a vibrating diaphragm attached to a horn, like an old-fashioned ear trumpet. The horn functioned like a microphone. The needle vibrations cut an uneven groove into the wax. Modern mono recordings were made using the same principle of a vibrating needle cutting into a softer material, except the needle was moved by a magnet.

Stereo came about when someone experimented with the angle of the magnet with respect to the needle and found that it could be controlled precisely enough to cut each side of the groove differently, creating two stereo channels. The technology for producing vinyl records, even with the advent of CDs and digital audio, has continued to improve, and some record labels are still producing high-quality vinyl recordings. With all of these advances, it's still a single needle doing the recording and playback for two channels, which results in a bit of *crosstalk*, so precision tuning of your turntable is required to get the best performance.

records are endless and loud; I shall leave it to you to do your own homework and figure out what you prefer. You can pick up nasty, dirty, nothing-to-lose records to practice on at thrift shops for cheap. Given the variety of claims over what works best, I suspect that vinyl is tougher than we give it credit for.

NOTE *Never use any kind of alcohol on vintage 78 rpm records or any acetate or nonvinyl records because it will damage them. The earliest records were made of wax, and there were many different wax compositions using carnuba, beeswax, and other materials. People who know about these things recommend not using liquid cleaners at all. If you have vintage records, I recommend consulting experts who know how to handle them safely. Solutions containing alcohol are fine for modern vinyl records, and most record cleaners contain alcohol. Whatever cleaner you use, it must be something that leaves no residue.*

You should also invest in a stylus brush and cleaner, because gunk builds up on your stylus. This is less controversial; I use the Stanton SC-4 brush and cleaner, and they do the job just fine. Remember, you cannot be too careful when you're handling your turntable's stylus; handle it as gently as you possibly can by its mounting brace only. Never touch it with your fingers.

Use a stylus gauge to adjust the vertical tracking force of your stylus. High-quality cartridges require a mere 0.5 to 3 grams. Medium-quality styli, and those designed for DJs, go as high as 5 grams. Set the tracking force per the instructions for your particular hardware. Too light and too heavy will both cause too much wear, so you really want it just right.

Depending on your turntable and tonearm, you may also have antiskate, vertical tracking angle, and azimuth adjustments. Your turntable documentation should tell you all about what these are and how to adjust them. The idea is to make correctly aligned contact without causing asymmetrical wear. It is worth spending some time tuning your turntable, and you may be surprised at how much difference tiny adjustments make.

Eight Steps to Converting Records to CDs

First let's list all the steps and then in the next sections go through them in detail. Vintage records require some special handling, which we'll get to in "Copying Vintage 78s" on page 66. If you don't know how to hook up your turntable, visit "Connecting Legacy Devices to Your Computer" on page 67 first. These are the steps to follow:

1. Set Audacity's frame rate to CDDA frames in the Selection toolbar.
2. Set the project rate to 32-bit float/44.1 or 16/44.1.
3. Copy your album into Audacity into one long track.
4. Make any fixes such as removing noise and pops, normalizing, compressing, and deleting unnecessary bits.
5. Enter metadata.
6. Export the Audacity tracks to CD-ready audio files.
7. Use your favorite CD-writing software to copy your songs to a CD.
8. Pop your new CD into a player and enjoy.

The most time-consuming part is fixing defects. This chapter has some tips for common fixes, and Chapter 12 is devoted entirely to fix-its and cleanups.

I like to record singles a little differently than in step 3: I prefer to record each single into its own track, so it looks like Figure 3-1.

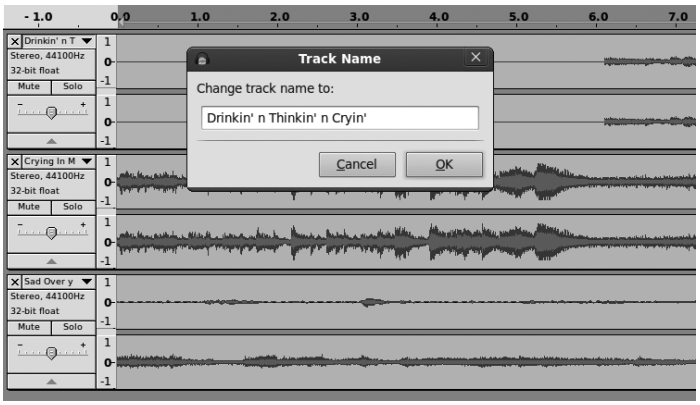

Figure 3-1: Putting each song into a separate Audacity track

Use the Track menu on each track to enter the song titles as the track names. At export, when all the tracks are exported to CD-ready files, each file will take the track name.

The advantage of using individual Audacity tracks per single is it's easier to reorder them, and you can normalize volume levels in one operation. When all the songs are in one track, normalization won't bring the quiet songs up to the same volume as the loud songs. Any variances have to be corrected one song at a time. But when multiple tracks are normalized, all of them are brought up to the same volume level in one step.

Audacity Settings

First, set the correct frame rate for CD audio in the Selection toolbar, as Figure 3-2 shows. This ensures that any splits you make will start and end on a CD frame. Any audio that lands outside of these frames will be lost and possibly create clicking noises. You can choose either hh:mm:ss + CDDA frames (75 fps) or CDDA frames (75 fps). The former shows the time plus CD frames, and the latter displays only CD frames. Check the "Snap To" box to ensure that stops and starts are always on the CD frame boundaries.

Figure 3-2: Setting the correct frame rate for CD audio

Then set your quality preferences in the **Edit** > **Preferences** > **Quality** dialog to a sample rate of 44,100 Hz and a bit depth of 32-bit float. The Red Book CD Audio standard is 16/44.1, but if you have enough disk space, working in 32-bit float has a number of advantages. It gives you the largest possible dynamic range, which means less noise and a lot of headroom for editing, so you can do a lot of processing without losing quality.

Recording at 16/44.1 works fine if you want to conserve disk space, especially if you're doing straight copying with minimal editing. The more manipulation you do, the better it is to work in 32-bit float.

While you're in the Preferences menu, review these options as well:

- On the Recording tab, uncheck "Overdub: Play other tracks while recording new one" and "Software Playthrough: Listen while recording or monitoring new track."
- On the Import/Export tab, check "Show Metadata Editor prior to export."
- Make sure the number of recording channels is set correctly (Devices tab), which is two-channel stereo. Even old mono LPs use two tracks.

Recording

Then click **File** > **Save Project As** and give your project a name, start your record player, and set your recording levels. You have plenty of headroom, so give yourself some space to avoid clipping. Using a 32-bit float bit depth means you can record to a peak of −24 dB and still have more dynamic range than your hardware can use; I usually record to a peak of −9 dB because a record is not unpredictable like a live show. If it surprises me with a sudden super-loud passage, I can easily re-record it. Click **View** > **Show Clipping**, and Audacity will highlight any clipping with a bright red line.

Then click the **Record** button and start playing your record. There's nothing much to do except kick back and enjoy the music until it's time to flip to side two. Click the **Pause** button to pause recording while you flip the record. Every time you click **Record**, it starts a new track, so use **Pause** to keep going on the same track. If you accidentally hit **Stop** instead, you can append to your existing track with SHIFT-Record.

It is a good idea to record some noise, like at the beginning of the record before the music starts and at the end after the music stops, so you can do some effective noise removal later. A pure noise sample with no music in it is best. Save this in a separate track.

Fixing Defects

First do a rough trim to delete any unwanted sections. Don't cut too closely but leave some extra, and then apply the finishing touches later. Trimming away unwanted sections of your tracks is easy; just select the parts you don't want and press the DELETE key, or click the **Cut** button. Another way to do deletions is to select what you want to keep and then click the **Trim** button. This keeps your selection and deletes the rest.

Deleting part of a track makes it shorter, and sometimes you might not want to do this but rather keep it the same length. Do this by silencing instead of deleting—select the part you want to get rid of and click the **Silence** button. This makes it silent instead of removing it, and your track stays the same length.

The next step is to fix any clipping or scratches. It is common for defects to be in only one channel. This is more characteristic of vinyl because the needle is pushed by the groove, so the side pushing the needle inward gets more wear. Tapes will also wear unevenly because one track is on the "inside" away from the edge of the tape. The track closest to the edge will be affected the most by magnetism, electrical fields, and physical damage from the tape guides.

NOTE *The definition of* track *is a bit squishy. An audio track is a single mono track or a two-channel stereo track, or it's a single song on a long track with multiple songs.*

To fix a defect in only one channel, use the **Split Stereo Track** command in the Track panel to break your stereo track into two separate tracks. Then you can edit each one separately, and when you're finished, you can use

Make Stereo Track to put them back together. A nice benefit of dividing them is that the undamaged track will mask less-than-perfect repairs in the other track.

Did you know you can insert silence? If you need to pad a track and make it a little longer or you need to insert a silent gap, first click to mark the point where you want to insert some silence. Then click **Generate** > **Silence**, enter how long you it want to be, and click **OK**. The new silent portion will be inserted to the right of your mark. Figure 3-3 shows how to create a two-second silence. Note that it contains a drop-down menu just like the Selection toolbar, with all different types of values to use: seconds, hours/minutes/seconds, different frame rates, and so on.

Figure 3-3: Inserting two seconds of silence

Fade In, Fade Out

Fading in and out is done a lot in recordings. In Figure 3-4 I deleted a long boring stretch of applause and left about a three-second gap, and then I used the Envelope tool to gracefully fade out to silence and then back in. The Envelope tool gives you a great deal of control over fades and volume levels. The little white squares are *control nodes*. Create new nodes by clicking wherever you want them, drag them in any direction to raise or lower volume, and drag them beyond the track borders to get rid of them. Envelope tools are standard in nearly all audio-editing applications.

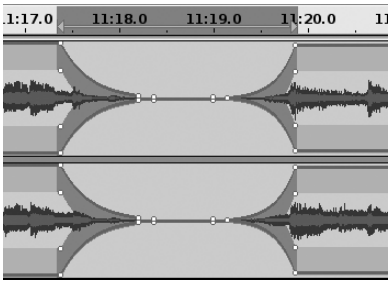

Figure 3-4: Fade to silence, then back to normal using the Envelope tool

Another way to apply fades is with **Effect** > **Fade Out** and **Fade In**. Select the part of your track where you want it to fade, click **Effect** > **Fade Out** or **Fade In**, and it will automatically apply a graceful, uniform fade for you. You control only the length of the fade.

Some CD-writing applications automatically create a two-second gap between audio tracks, so beware. You might not want a gap between songs in a live performance or a gap added to the one that you created in Audacity. Good CD-writing applications let you control this behavior.

Fixing Warps

Audacity won't fix a warped record. A top-quality turntable will track a warped record more accurately than a low-budget turntable. Many how-tos suggest flattening the warp by carefully warming the record to soften it—in an oven, in a sunny window, in a warm vehicle—and then placing it inside a clean paper sleeve and putting it under a heavy weight. I have tried the warm vehicle

method because the idea of using an oven scares me, and sometimes it works well if you are careful and finicky about keeping everything clean. Pressing debris into the soft, warm vinyl won't improve it any.

You can use Audacity to mitigate some of the bad sounds created by a warped record, such as clicks, pops, and hiss; see the next section.

Fixing Skips and Pops

You can find any skips or pops caused by scratches or warps pretty easily by looking at the waveform, as Figure 3-5 shows. They appear as abrupt, slender peaks. **Effect** > **Click Removal** is pretty good at removing clicks in batches without removing music. It looks for spikes in the waveform that are typical of the pops caused by scratches, deletes the scratches, and then does a bit of interpolation to reconstruct the waveform. The Select threshold setting determines the sensitivity for deciding when a spike is a scratch. Smaller Select threshold values are more sensitive, and larger values are less sensitive. Too much sensitivity means something you want to keep might be identified as a click and removed, such as some percussion effects.

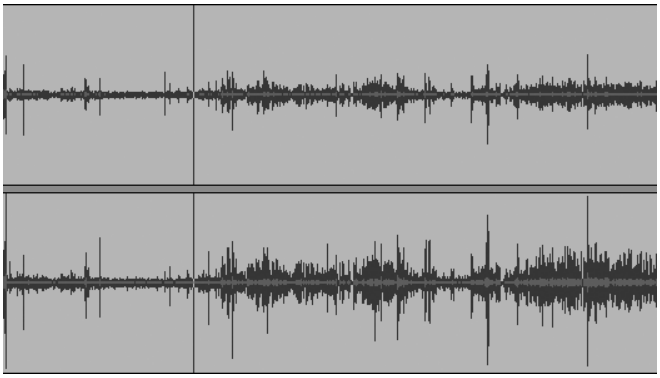

Figure 3-5: The area to the left of the cursor line is between songs and should be relatively flat, but this example is from a record with a lot of little scratches, so you see many sudden, slender peaks instead.

The Max spike width value determines the maximum length of a segment, in milliseconds (ms), that the Click Removal tool will remove. The default is 20 ms, which is longer than most scratches.

Select a small segment of a track that has some scratches on it and try a bit of trial and error, which goes quickly thanks to the Click Removal effect's Preview button. Listen to the preview, and if it doesn't sound right, change the settings and try again. The defaults are pretty good, and once you have the settings tweaked to your satisfaction, go ahead and apply them to the whole track.

NOTE *The default preview length is three seconds. If that is too short, open the **Edit** > **Preferences** > **Playback** > **Length of Preview** dialog and make it longer.*

You may want to repair a click or pop manually, especially if there are only a few of them. It doesn't take long. One way is to select **Effect** > **Amplify** and lower it to −50 dB, which will silence it. Another way is to use the Repair tool, which is more surgical. Zoom in until you can see the individual samples, select a segment to operate on, and click **Effect** > **Repair**. The Repair tool operates on a maximum of 128 samples. Just like the Click Removal tool, it uses interpolation to reduce and smooth out the edges of the repaired segment, so it doesn't leave a gap. (Figure 3-6 shows the before and after.)

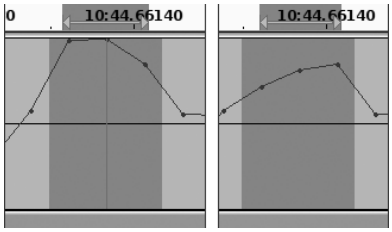

Figure 3-6: Using the Repair tool, before and after, to repair some clipping

NOTE *Remember the Zoom tool—you can magnify your waveform enough to see the individual samples and give yourself plenty of room to make precise edits. To keep your place when you're zooming in and out, click to mark your location on the track, and the Zoom tool will automatically center on your mark.*

Finding and Repairing Clipping

Use **View** > **Show Clipping** to quickly find any clipped segments. Clipping is caused when the volume of your recording goes over 0 dB. Clipping is nasty in digital audio because it causes distortion. An easy way to fix a brief clipped segment is with the Amplify effect. Zoom in and carefully select the clipped segment, and then select **Effect** > **Amplify** to bring it down a notch or two. Use a negative value for the Amplification setting, such as −3.0. One decibel is about the smallest level of change we can perceive, and every 3 decibels doubles or, when reducing amplitude, halves the volume level. So −3 dB is half as loud as 0 dB, and −6 dB is half as loud as −3 dB. Clipped passages over a few seconds long should be rerecorded.

Noise Removal

Vinyl LPs, on even the finest systems, are never completely silent. There is always some sort of background noise: hiss, turntable rumble, tiny scratchy noises from static electricity or pressing defects in the vinyl. Open the **Effect** > **Noise Removal** effect to get rid of this unwanted noise. It's not perfect, and there is always a trade-off between removing noise without causing too much damage to the music. It works best when you have a good noise profile and the noise is distinctly different from what you want to keep.

First you need to build a profile of the noise you want to remove, so select a few seconds of your track that has only noise, such as the very beginning or very end where the stylus is traveling over the record but not over

the music. The longer your noise sample, the better, from 5 seconds up to 30 seconds or so. Select your noise sample, and then in the **Effect** > **Noise Removal** dialog, click the **Get Noise Profile** button. Next, select the segment that you want to apply noise removal to and click **OK**. You can use the Preview button to make sure it's doing it right before hitting OK. Apply Noise Removal as precisely as you can to minimize side effects. Hiss, wow and flutter, hum, and low-level scratchiness are all common defects, and the Noise Removal tool works well if you have a good clean noise sample.

If you don't like the results, press CTRL-Z to undo, change some settings, and try it again. The default noise reduction level is −24 dB, which means segments identified as noise are attenuated by −24 dB. If this removes too much of the recording, reduce this and try it again. A similar tactic that often works well is to go back to your noise sample, reduce its amplitude a few dB, create a new profile, and try again. You don't want to erase the noise completely because this may erase things you want to keep, just lower it to where it's not bothersome.

The Frequency smoothing and Attack/decay time sliders are more aggressive when you move them left and less aggressive on the right sides of the scales. A larger value for frequency smoothing means it treats a wider range of frequencies as the same, so it makes larger changes. *Attack* is how hard a note is hit, and *decay* is how long it takes to fade away. Since there is only one Attack/decay time slider, the attack and decay times will always be the same. Smaller values are more abrupt, and larger values are more gradual.

Another slick trick is to use the Equalization effect (see Chapter 11 to learn more) to reduce hiss or rumble by reducing the amplitude of frequencies below 500 Hz and above 15,000 Hz. Of course, this will also affect any sounds in this range that you want to keep, so it's not always the best solution, but it is one more thing to try. You can try this in any part of the frequency range that contains unwanted noise.

Another way to limit a range of frequencies is to use a *high-pass* or *low-pass* filter. A high-pass filter blocks low frequencies and allows high frequencies to pass, while a low-pass filter blocks high frequencies. You may need to install some plug-ins to get high- and low-pass filters for Audacity; look in your Effects menu to see what is installed on your system. (Chapter 11 tells where to find and how to install plug-ins.)

Customizing Dynamic Range Compression

You may want to tailor the dynamic range of your recording for more comfortable listening in different environments. Because listening to a recording with a wide dynamic range in a noisy environment like a vehicle or at work means it's always too loud or too soft, you can change this with a *dynamic range compressor*. Compressors are used all the time in audio production. I think they're overused, but the neat thing with Audacity is you can

adjust it to please yourself. A compressor usually attenuates the louder frequencies, reducing the difference between the soft and loud passages. Some compressors also boost the quieter frequencies. “Compress Dynamic Range” on page 240 tells all about how to apply compression to your recordings.

Normalization

Now that you are finished with repairs, it is time to normalize the volume for the whole album. If you copied everything to a single Audacity track, select the entire track and apply **Effect** > **Normalize**. This won’t affect the dynamic range or change audio quality; all it does is raise the overall volume level. Set your maximum amplitude no higher than 0.0, which is the maximum for digital audio, and make sure that “Remove any DC offset” is checked. DC offset refers to the mean amplitude. If this is not zero, then normalization won’t be applied correctly because the amplitude levels will be unbalanced, and it might even create a bit of distortion. When this is finished, you’re ready to go on to the next section.

If you put each song into a separate Audacity track, press CTRL-A to select all tracks and then apply normalization. Then skip ahead to “Exporting to CD-Ready Files, Multiple Audacity Tracks” on page 64.

Dividing a Long Track into Individual Songs

If you copied everything into one long track, you can export this to a 16-bit WAV file and then copy it to a CD. But you won’t have individual songs; instead, you’ll have one long track with no way to skip between songs. So here is how to divide it into individual songs. Start at the very beginning; make sure you are exactly at the beginning of the track by pressing the HOME key. Then press CTRL-B. This will create a new label track under your album track, and the cursor will be inside a little text box. Type the name of the first song into this little box and press ENTER. Then click wherever you want the break to go between the first and second songs, press CTRL-B, and type in the name of the second song. Keep going until all the songs have their name labels (Figure 3-7).

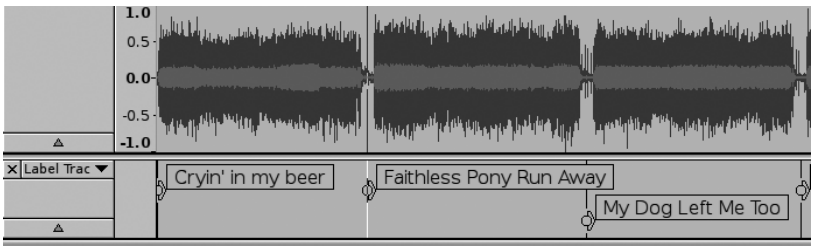

Figure 3-7: Dividing one big track into individual song tracks and labeling them

Exporting to CD-Ready Files, One Long Audacity Track

If you have copied all your songs into one long Audacity track, this is how you export them to individual CD-ready audio files. First open **File** > **Open Metadata Editor** and enter the album title and artist's name, as well as any other information that you want to preserve in the track metadata. Leave the Track Title and Track Number fields blank, because Audacity will fill those in for you.

Next, go to **File** > **Export Multiple** and choose Export Format: WAV (Microsoft) signed 16 bit PCM. You'll see a window like Figure 3-8. I recommend exporting to a separate directory and not mixing your exports with your Audacity project files. Select the "Split files based on: Labels" and "Name files: Using Label/Track Name" radio buttons. Check the "Overwrite existing files" box only if you are sure you want newly exported files to replace old files with the same name. Click **OK**, and you're on your way.

Figure 3-8: Exporting each song into an individual, CD-ready audio file using the label names as the filenames

If you enabled "Show Metadata Editor prior to export" in the **Edit** > **Preferences** > **Import/Export** dialog as I suggested, the Metadata Editor will appear for every song as it exports. It is okay to turn it off if you don't need to review the metadata for every song.

Exporting to CD-Ready Files, Multiple Audacity Tracks

If you copied each song to an individual Audacity track, this is how you export them to individual CD-ready audio files. First open **File** > **Open Metadata Editor** and enter any information common to all the tracks, such as date, genre, or artist's name. Leave the Track Title and Track Number fields blank, because Audacity will fill those in for you.

Next, go to **File** > **Export Multiple** and choose Export Format: WAV (Microsoft) signed 16 bit PCM. You'll see a window like Figure 3-9. I recommend using a separate directory and not mixing your exports with your

Audacity project files. Select the "Split files based on: Labels" and "Name files: Using Label/Track Name" radio buttons. Check the "Overwrite existing files" box only if you are sure you want newly exported files to replace old files with the same name. Click **OK**, and you're on your way. You will end up with each song in a separate file, and the track names you created will become the filenames.

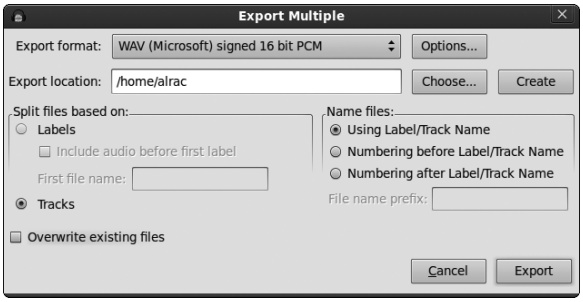

Figure 3-9: Exporting each track into an individual CD-ready audio file, using the track names as the filenames.

Writing Songs to a CD

Now you have a batch of nice individual WAV files, one file per song. Write your songs to a CD with your favorite CD writer application, and you're done. Don't burn at the maximum speed, but throttle down to half speed to make sure you get a good disk. Be sure to select "New Audio Project," or whatever your particular application calls making a music CD, because this creates a CD in the proper Red Book Audio format. Don't make an ordinary data CD because then it won't work in standard CD players, like in your vehicle or hi-fi system. Standard CD players can't play WAV files. (Computer CD players will handle just about anything, because it is all done in software media players.)

Watch the order of your song tracks—your CD-writing application may put your songs in alphabetical order, rather than track order. A quick way to sort them is by date, if your CD-writing software supports this, since the first song exported will always be the oldest and the last one the newest.

If you have an inkjet printer that supports printing on CDs and DVDs, you can get special CD blanks that are made to be printed on. These have either a white or silver side that is designed to hold ink and not smear. Another newfangled printable CD/DVD requires a special thermal printer, which can be purchased for about $100. A third printable disk type is called *LightScribe*, which requires a special CD/DVD writer. These are in the same price range as ordinary CD/DVD writers, about $50.

"Do I need to buy a special audio CD?"

The answer to this commonly asked question is no. All CDs are exactly the same type. Some countries charge a tax on "audio" CDs that supposedly gets paid to musicians to compensate for lost income from illegal copying. (If they actually receive a fair share of this tax, I will eat my favorite vinyl LP.) The other special thing about them is a pressed data flag that is part of the Serial Copy Management System (SCMS) to control copying protected material. The SCMS encoding controls three states: copy allowed (00), copy once (11), and copy prohibited (10). It won't stop you from making copies of an original CD. If the "copy once" flag is set, it might interfere with putting a copy on a CD writer that attaches to your hi-fi system. Computer hardware and media are exempt from the laws that mandate SCMS. I use ordinary nonaudio CD blanks, and they work fine in all CD players.

Copying Vintage 78s

Vintage 78s is shorthand for old monophonic phonograph records made from about the 1890s to the late 1950s. These are also called *short-play* records and *wide-groove* records. There were no real industry standards until the early 1930s, so older records played at a variety of speeds, from 60 to 130 rpm. Vintage 78s are made of shellac mixed with dyes, fillers, and other materials, and they come in a range of sizes all the way up to 16" in diameter. Some are laminated and will come apart if they get wet. Alcohol will dissolve shellac, and even too much humidity will hurt it.

Vinyl LPs, whether mono or stereo, play at 33 1/3 rpm, and singles play at 45 rpm or 78 rpm. Yes, way back in the olden days there were 78 rpm singles; for example, these were favored by Disney in the early 1960s. You might also find some 45 rpm LPs. Two main differences between these and vintage 78s is they are made of vinyl rather than shellac and they are cut in microgrooves rather than wide grooves. The coarse-groove records require a 3 mm stylus, while microgroove records use a 1 mm stylus. You can play old monophonic LPs and singles with a modern stereo cartridge and stylus, but not vintage records. There are modern cartridges and styli that are made for playing these old records, such as the popular Shure M78S.

I'm no expert on vintage 78s, but if you need more information on the correct ways to store, handle, and play these old-timers, there are a lot of great resources both online and in the real world. There are many vintage phonograph record experts, aficionados, and traders, so it's not hard to find some expert guidance.

Once you have all the hardware and safe handling sorted out, there are a few things you need to do differently in Audacity. Open the **Edit** > **Preferences** > **Devices** dialog and set the number of recording channels to 1 (mono). Then go to **Edit** > **Preferences** > **Import/Export** and select "Use custom mix." The reason for doing this is to mix down to two channels from your mono track so you'll hear music in both speakers on your stereo system. If you don't do this, you'll get playback from only one speaker. Figure 3-10 shows you what Audacity's mixer panel should look like: Move the slider at the bottom to create two output channels, and then click "Audio Track" (or whatever name you gave your track) and "Channel: 2" to link them together.

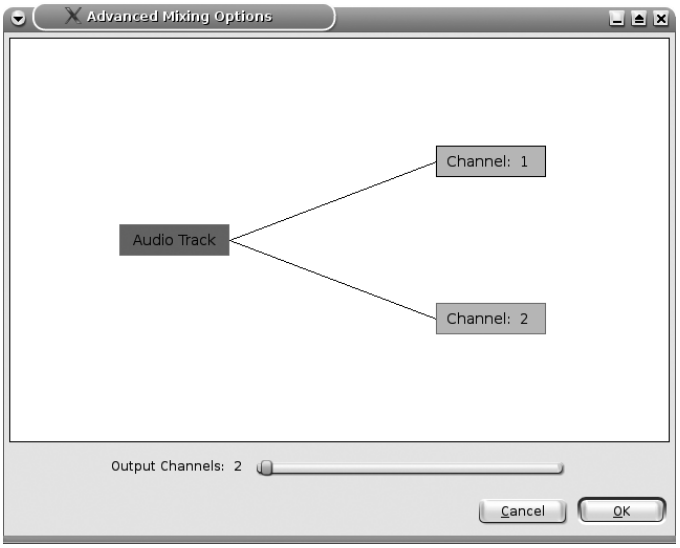

Figure 3-10: Mixing down a mono recording to two channels for playback on stereo systems

Connecting Legacy Devices to Your Computer

There are several ways to connect turntables and other legacy components to your computer. First let's talk about connectors. The terms *plug*, *port*, *socket*, and *jack* are thrown around willy-nilly these days. Just to keep it clear and simple, I shall call the connecters on cables and adapters *plugs*, and the things they plug into (like the RCA and TRS sockets on amplifiers) are *jacks*. Also, in the interest of honoring standard terminology, I shall refer to plugs and jacks according to gender, male and female. This is especially important with gender changers, which are adapters for changing from one connection type to another.

In the olden days everyone used 1/4″ (6.3 mm) TRS plugs, and life was easy. Then manufacturers started making 1/8″ (3.5 mm) mini-jacks and plugs and the even dinkier 3/32″ (2.5 mm) micro-minis. It doesn't matter what your devices have because there are adapters to fit any situation. In fact, it's common for devices with mini-plugs to include 1/4″ adapters, and you can also get adapters to fit 1/4″ plugs into mini-jacks. Just make sure you have a correctly matched adapter, either mono or stereo. Mono TRS plugs have one black insulator ring, and stereo plugs have two.

RCA audio connectors, fortunately, are still the same as they have always been. RCA plugs come in a rainbow of colors, and each color has a meaning: Red means right channel, white means left channel or mono channel, and the other colors are for different surround sound channels. They're all the same, so it doesn't matter if you use the "wrong" colors. There is only one size. They are also called *phono* plugs. Figure 2-7 on page 37 shows an assortment of TRS jacks, adapters, male and female RCA connectors, and a dual-RCA-to-single-stereo-plug adapter. Adapters are inexpensive, and you always need them, so get a grab bag for all occasions.

My favorite way to digitize legacy media is to connect a stereo amplifier or receiver to an analog-to-digital/digital-to-analog converter (ADC/DAC), which then connects to the computer. Then every component that connects to the amp—turntable, tape deck, radio tuner, VCR, CD, DVD—is available to record in Audacity. (CDs and DVDs can be played and copied directly on your computer; see Chapter 5 to learn how to do this.)

You probably already have an ADC/DAC on your computer—your computer's sound card. If it has a Line In port, you should use that. These are light blue 1/8″ stereo jacks. Depending on your amp or receiver, you should have a pair of standard RCA outputs you can connect to your sound card, usually called *record out* or *line out*. Flip back to Figure 2-2 on page 34 to see the back of my treasured old Pioneer amplifier.

So, connecting my amp to an internal computer sound card requires a two-RCA-to-1/8″ stereo mini-plug adapter, as in Figure 3-11.

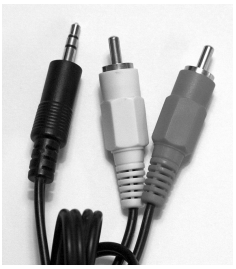

Figure 3-11: Because of the proliferation of 1/8″ mini-plugs, this is the workhorse of many a conversion studio.

On surround-sound home theater receivers, consult your manual to figure out the best recording outputs. For example, I have an Onkyo 5.1 system with a pair of RCA tape outputs, just like my old Pioneer amp. You have to use the remote control to select the correct output channels, and then it records whatever is currently playing.

My favorite recording interface is an M-Audio MobilePre USB, which is a combination microphone preamp and ADC/DAC. This replaces an internal computer sound card. The MobilePre supports a number of different connectors, so I could use the two-RCA-to-1/8″ adapter or a two-RCA-to-two-1/4″ TRS adapter, as in Figure 3-12.

Figure 3-12: A two-RCA-to-two-1/4″ TRS adapter. Note that the Y-adapter (bottom right) is not needed for connecting the MobilePre to the Record outputs on the amplifier. The Y-adapter comes in handy when I need to use a headphone jack for my recording source.

Connecting a Turntable to Your Computer

There are several ways to connect a turntable to your computer in addition to connecting through your amplifier connected to your computer. A popular method is to use a USB phono preamp that lets you connect any turntable, even cherished old ones, directly to your computer. In fact, you might want to look for a good old turntable instead of a modern one, because it's hard to match the quality of those old turntables without spending a mint. You can pick up decent USB phono preamps for cheap, such as the ART USB Phono Plus V2 for around $100. It includes a gain control, a clipping indicator, a monitor port, a USB port, RCA inputs and outputs, optical ports, and an S/PDIF port. The ADC/DAC operates at 16/44.1 and 16/48. It even includes a phono ground connector, which is a must-have for turntables that have ground wires. If you don't ground them, you'll get an annoying hum.

You need a phono preamp and not just any old preamp, because phono preamps apply the RIAA equalization curve correction. This is very important. The *RIAA equalization curve* is an industry standard for attenuating bass frequencies (below 500 Hz) on a vinyl LP and boosting frequencies above 2,120 Hz. Vinyl LPs have to be recorded this way or the bass grooves would take up most of the album, resulting in short playing time, and the higher frequencies would barely be audible. When you play a vinyl record, your integrated amplifier or receiver corrects this imbalance with a built-in phono preamp that reverses the RIAA curve. It sounds tinny with hardly any bass, and you can hear this by turning off your speakers and placing your ear close to the cartridge while a record is playing.

NOTE *Amplifiers and receivers are called* integrated *because the preamp is built in. Amps and receivers that accept separate preamps often still have integrated preamps. In the wacky world of audio components, you may spend more for a bare amplifier that doesn't have an integrated preamp or radio tuner. The most expensive stereo amp I ever saw had a completely blank faceplate with only a power switch, power LED, and volume knob.*

The RIAA equalization curve became widely adopted starting around 1955, so records from before then may have different equalization curves. If you want to fuss with making your own handcrafted equalization corrections, you can do this in Audacity. Audacity also has a number of prefab equalization curves, such as Columbia LP, AES, Decca, and RCA. Use an ordinary preamp instead of a phono preamp to get an uncorrected signal, copy your album into Audacity, and then apply your own equalization. Figure 3-13 shows what the RIAA curve equalizer looks like in Audacity.

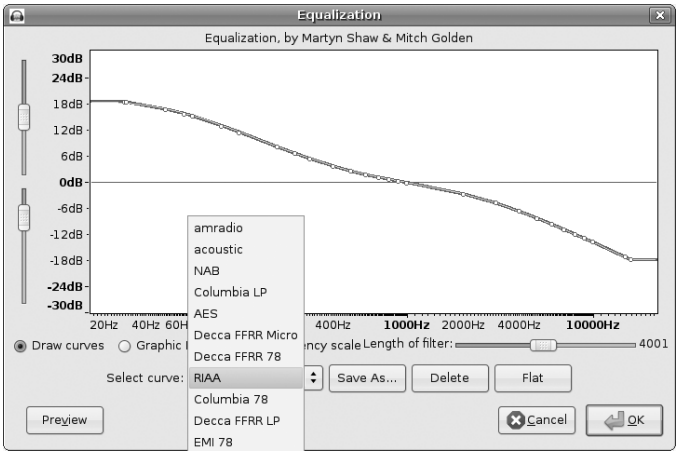

Figure 3-13: The Equalization effect allows you to fine-tune equalization any way you want, and it supports creating custom presets.

A good way to connect a turntable to your recording interface, as mentioned earlier, is to connect your turntable to your stereo receiver or amplifier in the usual manner and then connect your receiver to your computer's recording interface.

One more option to consider is buying a USB turntable with its own built-in phono preamp. These are becoming popular as more people want to try converting their own albums to CD. It's a great concept and convenience, but a lot of them are not very good quality, so shop carefully.

My own personal turntable is an Audio-Technica AT-PL120. This is not a sweet decades-old turntable but a shiny new direct-drive three-speed with its own internal phono preamp. That's right, 33 1/3, 45, and 78. It's designed to be a DJ turntable, so it comes with an elliptical stylus for playing records both frontward and backward. (The horror! As if I would do that to a perfectly good LP!) It has adjustable speed, pitch, antiskate, and feet

levelers, and it's weighty and solid as a good turntable should be. The internal preamp is switchable, so you can either connect it directly to a recording interface or switch off the internal preamp and connect to an external phono preamp. If you want to play vintage 78s, you need to purchase a special cartridge and stylus, such as the Shure M78S wide-groove monophonic cartridge.

NOTE *Our excellent technical consultant Alvin notes that radio DJs used direct-drive turntables so they could rotate them backward: "You manually adjust the record so that you know where the song begins, then turn the record back one quarter of a turn. When you hit "play" on those record players, the turntable is at full speed in the one quarter turn."*

Figure 3-14 shows my own setup at home. I have both recording and playback routed through my M-Audio MobilePre USB.

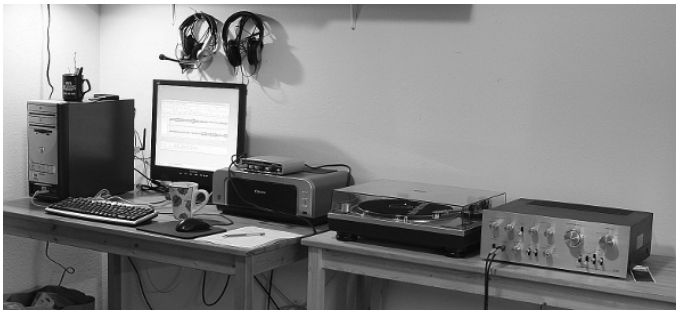

Figure 3-14: From the right to left: nice old Pioneer stereo amp, Audio Technica three-speed turntable, color printer, M-Audio MobilePre, screen, headsets, three-core CPU wedged into salvaged E-Machine case

Connecting a Tape Deck

Tape decks can connect directly to your computer. Just connect their RCA output plugs to your recording interface with the appropriate adapter. Your recording interface might already have RCA inputs.

Which Is Better: Vinyl, Tape, or CDs?

There are endless debates over which has superior sound quality, vinyl LPs or CDs. I've been a serious music fan since I was a wee tot way back in the days of reel-to-reel tapes and vinyl LPs. My dad was a symphony musician and music teacher, and to this day I don't believe he has acknowledged any music made after the 18th century. (Kidding, Dad! Hugs!) I think CDs are the bee's knees.

In the olden days before CDs, a lot of music lovers who wanted to preserve their vinyl played a new LP only once, to copy it to tape. It was no use

purchasing commercially recorded cassettes because of their inferior quality. They used the cheapest tape and were plagued with hiss, narrow dynamic range, and overall cruddy tone. By the early '70s, commercially recorded reel tapes were pretty much gone from the market, so if you wanted good-quality tape recordings, you had to do it yourself.

This might sound like a lot of fussiness to readers who are not familiar with audio tapes and LPs, but there were shortcomings with both media, and neither one provided a completely satisfactory solution. It's easier to skip tracks on an LP and they're easier to handle than reel tapes, but it's nearly impossible to keep them clean and undamaged. Neither one holds very much music. A vinyl LP holds 16 to 24 minutes per side; modern dance music LPs hold 12 minutes or less because of the extreme thumping bass, which creates wider grooves. Don't even suggest using a record changer—those are for people who like having mangled records. A 1,200-foot, 7-inch reel of 1/4″ tape, which was common for home recording, holds 64 minutes per side at 3.75 inches per second (ips) and 32 minutes at 7.5 ips. (In comparison, professional recordings were made at 15 and 30 ips.) Neither one is easily portable, and you can't play them in cars.

Cassette tapes revolutionized home and portable audio. They were good compromises among sound quality, portability, and cost, and they were a lot more rugged than reel tapes or LPs. You can stop a cassette tape at any point and remove it from the machine; you can't do that very easily with reel tapes. Cassettes for the home market travel at 1 7/8 ips, and their tapes are 0.15″ wide. Sound quality isn't equal to that of LPs and reel tapes, but if you have a good recorder and use good-quality Type II or IV tape, it is pretty nice. Whenever I bought a new vehicle (new to me, that is), the first thing I did was put a good sound system in it. I made a lot of long trips because I liked going places, and having a big box of music tapes made those trips even more splendid. Cassette tapes came in a variety of sizes, and I liked 90-minute cassette tapes because I could get two LPs on one tape. A dual-well cassette player with auto-reverse delivered 180 uninterrupted minutes of music. Larger sizes, such as 120-minute cassettes, were too thin and fragile to use. Thinner tapes stretch; 60-minute, high-quality tapes are thickest and suffer the least amount of stretch.

Cassette recorders were the salvation of music lovers. My friends and I liked to make and exchange mix tapes, because even in my youth oh so long ago commercial radio was pretty horrible, just the same Top 20 dreck played over and over, with more commercials than music and annoying DJs interrupting the music. So, trading mix tapes was a great way to discover new music. Another cool thing was we could copy just the songs we wanted and not suffer through the filler that plagued so much popular music. Given the continual failures of the music industry to deliver what would please its customers, it's amazing that it survives at all. The bosses at the big labels should give thanks every day to determined customers who figure out workarounds that let them enjoy commercially produced music, rather than giving up on it entirely.

A Quick Tip About Tape

Alvin recalls that tape is manufactured very wide and very long: "The outermost edges, and the first and last lengths of the tape, are the poorest and used for the lowest-grade audio tape. The sections that are higher-grade become the higher quality audio tape, and the very best became the digital tape for computing. Because of this you can use most computer tape for audio, which I do. The large quarter-inch cartridge (QIC) tapes that have gone bad are fantastic reel-to-reel tapes. I have an ancient solid-state Ampex home audio recorder, circa 1969 (transistors, point-to-point wired like the old vacuum tubes). With no noise reduction, 1 7/8-, 3 3/4-, and 7 1/2- inch speeds, with RadioShack's cheapest tape and slowest speed, it sounds better than cassette metal tape and Dolby C noise reduction."

Cassette tapes are also given credit for spreading Western pop music, especially punk and rock, in developing nations and Eastern bloc countries.

There isn't much nostalgia for cassette tapes. They served a purpose, and some people still like them. But it's not easy to find good cassettes anymore because manufacturing quality has declined.

Neither tape nor vinyl ages well. Tape is a magnetic medium, so it can be ruined by stray magnetic fields. Tape is less prone to collect dust and scratches than vinyl, but both suffer physical wear and tear. Both will last decades if they are handled and stored carefully, but the sad fact is the more you play and enjoy them, the more they will wear out. They won't suddenly become unplayable; they tend to lose the high frequencies first and fade over time like a garment that is washed too many times.

The Digital Advantage

Lovers of vinyl claim that it sounds warmer, sounds more true to life, and has a wider and more accurate dynamic range. CD fans claim that LP aficionados are nostalgic for all the ambience that goes along with playing a vinyl record: the sounds made by the turntable, the addition of surface noise from dust and scratches, flipping it to hear the other side, and all the fussiness required to keep LPs in good condition. I miss the cover art, posters, and generously sized booklets that came with LPs—you just can't do much with a tiny CD case. But no matter how careful you are with keeping LPs clean, handling them carefully, keeping your stylus clean, and keeping your tonearm optimally balanced and tracked, it is impossible to avoid causing wear or even damage merely by playing them, because you're scraping a diamond stylus with a Mohs' scale hardness rating of 10 over a surface with a Mohs' hardness of 1.

Some LPs survive in better condition than others because they are better engineered. Vinyl LPs begin life as master tapes. These are copied to the master disk, which is made of metal or lacquer. Cutting a record is an exercise in compromise. Quiet passages can't be too quiet or they will be lost in noise, but if they are too loud, the grooves will overlap and create skips. Louder volume also results in less playing time, so there is as much artistry in the engineering as there is the in music itself. Unfortunately, all LPs are not created equal. As the industry matured, a multitude of demands were placed on the master recording engineers, who were often told to make the master tapes also serve as masters for cassettes, and butchered for radio play. The vinyl itself became thinner. In other words, the lowest common denominator reared its mediocre head. Older LPs are beloved because they're better made.

CDs have most of the technical advantages. The biggest advantage of digital audio is that copies are equal to the originals. This is not true of analog audio, which loses something with each generation. By the time you get to a copy of a copy of a copy, you know it's a long way from the original.

A CD offers as much as a 96 dB dynamic range, whereas the best vinyl delivers maybe 75 dB and, more typically, in the 50s. So, the CD offers a superior signal-to-noise ratio, plus something that even the best LP system is hard-pressed to deliver, and that is absolute silence in the silent passages. True, this absolute silence is largely theoretical because some sound will probably be created somewhere in your audio chain—a bit of hum, a touch of electrical interference—but the CD itself is dead silent. Vinyl wins on frequency range, sort of—if you have good enough equipment (which would make you a rare, wealthy, and elite audiophile indeed), it will capture frequencies as high as 70 to 75 kHz, up there where the bats fly. More typically it falls into the 10 Hz to 25 kHz range.

Down here in the real world, most audio hardware is designed with upper limits of 20 to 30 kHz in mind. The human ear can detect frequencies up to 25 kHz, and the range of sensation is 50 kHz. If you have something blasting away at 115 dB sound pressure level at a frequency of 45 kHz, you'll feel the pain but not know why. Some folks believe that very high frequencies are still perceived in some manner and add to the listener's enjoyment. What they might be talking about are the harmonics. If you have a sound at 100 Hz, there are harmonics of that sound at 25 Hz, 50 Hz, 200 Hz, and so on. If you clip the harmonics, the sound tends to sound a little dead on the high end.

I have compared some of my favorite music on both CD and LP, and it's the extra noise on LPs that sets them apart. I can really tell the difference in a symphony—the quiet passages on a CD are unmarred by scratches, hiss, or rumble, and the loud bits are loud and accurate, without distortion. If you want to make your own comparisons, make sure you have LPs and CDs that have been recorded with skill and care. An awful lot of them are junk, and the trend with modern popular music is simply to crank all levels on a CD to the maximum, with no regard for dynamic range, distortion, nuances, or balance. Pianos and organs are great for testing the quality of

Wire Recordings

The original master "tapes" were made on wire recorders, which used spools of steel wire as the recording medium. Wire recorders were in wide use until the 1960s, when they were supplanted by magnetic tape recorders. Old music, like the original Carter Family recordings of the 1920s, were recorded on wire recorders. Wire rusts, and the fidelity is nothing to get excited about, but it is very durable. Even so, most of those old recordings are lost.

But not all! *The Live Wire: Woody Guthrie in Performance 1949* won the 2008 Grammy for Best Historical Album. It was restored from wire recordings and is believed to be his only recorded live performance. Like a lot of wire recorders, these recordings were made on a home-built device, which complicates any restoration process. But restored they were, and now you can enjoy Woody Guthrie live on CD.

your audio system because their sounds are difficult to reproduce accurately, they have monster dynamic and frequency ranges, and you can tell pretty easily if they sound right. Try "Toccata and Fugue in D Minor" by Johann Sebastian Bach; this covers the full range of the pipe organ, the big kind you see in cathedrals. At one point, a bass pedal is held so long your speakers may visibly distort. Pink Floyd's "Time" from the *Dark Side of the Moon* exercises the sound separation among left, right, and true center. Jimi Hendrix's *Electric Ladyland*, if you can find the original double LP and not some bad CD remaster, is an amazing piece of studio and artistic wizardry that will exercise your audio system and reward careful listening.

CDs win hands down for convenience. They're sturdy, they don't get damaged from being played, you don't have to continually fuss with them, and they are portable. Most CD players have remote controls, and you can play the tracks in any order or shuffle. You can load multiple CDs in a CD changer without harm and bliss out for hours.

Despite the efforts of the music industry to foil our fair use rights and desire to enjoy music the way we want to, it's as easy to create custom-mix CDs as it was to create our own mix tapes. And for most of the same reasons: to package music the way we want and to discover new artists. (Chapter 5 tells how to make compilation CDs.) However, we now have two marvelous new options that we didn't have back in the olden days, and that is satellite radio and Internet radio. Neither one is high on the audio quality scale, but you can't beat them for variety and discovering new artists. Commercial broadcast radio is worse than ever, which I didn't believe was possible.

CDs also win on cost. A hundred dollars buys a perfectly satisfactory CD player. Even in the olden days, a good-quality turntable, cartridge, and stylus cost several hundred dollars, and they haven't gotten any cheaper. Oh, and

CD Players

You can spend a little or a lot on a CD player. Ideally, you'll be able to test them with your own sound system before making a purchase, especially if you're going for a higher-end model. As with all digital audio, the quality of the digital-to-analog converter determines how good it sounds, so spending more can make a difference. If you are connecting your CD player to a receiver or amplifier that has its own DAC (you'll see optical or coaxial digital inputs), that gives you two DACs to try. Using the digital connector means the CD player sends a digital signal to your receiver and does not use its own DAC. Instead, the receiver performs the conversion to analog. Using your CD player's RCA connectors means your CD player will do the conversion and send an analog signal to your receiver. If you have a high-end CD player, you probably don't want your receiver mucking with its output, so use the analog RCA connectors. Of course, it's not always that simple, because in some modern A/V receivers, the integrated preamp converts all incoming signals with no regard for whether they are analog or digital, which is dumb, but there it is. This is not always documented, so you might have to pester your vendor to find out what you have.

don't forget the dust cover, which was always an overpriced add-on. And a stylus-tracking force gauge, and cartridge alignment tool, and special cleaning accessories, and so on.

So who wins, vinyl or CDs? Easy—whichever one you like better. Don't get hung up on specs; it's the music and your enjoyment that matters.

Longevity

Longevity is still an open question. The current state of digital storage is not encouraging for the long term, so you better plan to periodically transfer your archives to fresh media. There are several problems with long-term digital storage: One, the physical media may not last for more than a few years without deteriorating. Two, think of all the closed, proprietary file formats that have come and gone in the past 10 or 20 years and are no longer readable. Three, if your media survive and the files are still readable, will you have a hardware device that can read your media? If someone handed you a 5.25″ disk, a Zip disk, a 3.5″ diskette, or a super floppy disk, would you have any idea what to do with it? Currently we take CDs, DVDs, USB sticks, and 3.5″ hard drives for granted, but they are all just a few years old, and we do not know what the future holds.

NOTE *There might be a business opportunity in old drives and software. Alvin notes, "There's a market for those who can transfer from the ancient media to current. I have a Viper QIC tape drive for the DC300 tapes, a Bernouli drive, a Questech 40MB drive (it was a favorite of Apple Macintosh's), a TEAC digital audio cassette drive (205MB storage), Zip and Jaz drives, 250MB Colorado QIC, and other floppy tape drives."*

Commercial CDs are pressed rather than burned like home-created CDs and will outlive most home-burned CDs because they are built of sturdier materials and have deeper grooves. CD-Rs will outlive CD-RWs; don't use CD-RWs for anything that you want to last more than a year or two.

There are significant differences in brands. Taiyo Yuden is the top-of-the-line manufacturer of CD and DVD blanks. Taiyo Yuden blanks appear under their own name and under different brand names, but the secondary vendors change their suppliers often, so you can't count on the names to tell you what you're getting. Genuine Taiyo Yuden blanks are made only in Japan. There are fakes, so search online to learn how to identify the real deal.

Verbatim, TDK, and Sony are also considered to be good brands, though they use multiple suppliers. You can read the disk ID after purchase with diskDVD Identifier and DVDInfo for Windows, DVD Media Inspector for Mac, and cdrecord and dvd+rw-mediainfo for Linux.