



MASTERING

Part IV: CD MASTERING

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Why are we even talking about CDs?

If you're relatively new to recording your own music, I know what you're thinking. You're probably wondering what the point of making CDs is these days, since most of the music we listen to (and a growing majority, download) is online. I've heard people say that the CD is an "outdated" format, and that doesn't make sense to me for a few reasons.

Before we go further, I would like to ask those of you who feel that CDs are outdated to go back to the first part of this series to review how far recording mediums have come, and if you don't have time for that, let me refresh your memory with at least the second-to-last paragraph on page 10:

The key thing to keep in mind at this point is that with computers and CD-R technology becoming affordable for musicians, this meant that they could now publish their own CDs. The need to have a mastering engineer do the final transfer of the material to publish a CD was no longer a required step.

The CD is still the most playable, cost-effective *tangible* medium available today. You can probably play a CD in more places than MP3s, as they can be played on computers, DVD players, gaming systems and of course, cars. Even most portable DVD players will play audio CDs.

Most of the music that we get online is lower than CD-Quality and to degrade the quality even more, most of the devices that play MP3s have lesser-quality DA converters than most consumer CD players and hi-fi equipment, but this is the least of most peoples' worries because at the end of the day, the current trend is not about quality so much as it is about convenience. Being able to download an album in a couple of minutes is convenient, and it's also true that most people don't mind that a low bit rate-encoded file is like the sonic equivalent of a rice cake; the *attractive* part of it all is that in less than 5 minutes, you can grab a new album from the web, transfer the songs to a player and take with you wherever you go. The truth is that most MP3s don't sound that horrible, and that for the majority of listeners, the difference between a CD and the better DA conversion of more hi-fi gear is still not worth the hassle; I'll argue that most people who don't own CDs, let alone LPs and only have an iPod or similar MP3 player and download audio on the internet as their exclusive source of music wouldn't even care to make the comparison.

But you're not just a listener. Chances are that you've been creating music and have realized that the best way to capture your recordings and mixes is by working in the highest quality resolution possible. You might have already compared one of your 24-bit mixes to an MP3 mix you

bounced from a session and went “wow!” when you heard how much of the definition was lost. To you, making a CD feels like downgrading (that’s because it is!), especially if your recordings and mixes were done in something like 24-bit/88.2kHz, and you have to “shrink” them to 16-bit/44.1kHz in order to playback on a CD, you also know that making even lesser-quality versions is done only for the sake of convenience and fast delivery through the internet, and you know that your original mixes sound better than the MP3 versions you put up on your myspace page.

Let’s forget about quality for a second, and consider something that I feel has gotten lost in this world of convenient web downloads: a more solid connection to the listener through album art. Don’t take it as scientific proof, but there’s certainly something extra when having a tangible product in addition to the music for the listener; having something physical that is sharp in quality and presentation can definitely help make a more solid connection to your listeners (that is of course, assuming you’re trying to take your releases to a more official level than producing tunes for your myspace page’s music player). Have you caught someone’s performance on TV recently? At the end, the host of the show might show the artists’ CD on camera and tell you when it’s being released; I don’t think I’ve ever seen something like that where they don’t show any physical product and instead say “and you can buy the download online!” Showing the physical product has advertising power.

In the days of vinyl (in comparison to a CD), the canvas for artwork was huge. A lot of them had some kind of introduction on the back cover, usually by someone respectfully given the honor to bless the project with some words, giving you some kind of insight about the record. Some albums had four panels, and you opened them like a book and they might have had lyrics you could read along to, or a huge photo spread that you could pin up on your wall (Ohio Players album covers come to mind). Not to over-dramatize vinyl but to be honest, a CD booklet in comparison, even in full color, does not hold the same material value as a nice-looking LP cover you can hold, admire the art and even give it a spin on your finger, throw it up in the air and catch it while you’re playing it.

Cassettes had a much smaller version of the LP art for the cover, and it wasn’t as impressive as the larger LP cover, they usually included all of the text you might find on the vinyl version, except you usually had to unfold the “J-Sleeve” to see all of the panels (they called it this because when you look at a tape’s case from the top, the part where the sleeve goes looks like a “J”). I personally didn’t care much for the J-Sleeves of the cassettes I had; they resembled those little weird folded instructions you get with cheap electronics with tiny print. The sentimental value of cassettes is not as great as LPs; they were good for the intended purpose – portability. They were meant to be kept in things like your glove compartment in your car, so your tape wouldn’t bang around in there and get jacked up.

Then the CD came and it was roughly 15% the size of an LP. At first, record companies released CDs in a “long box” package but soon stopped because of complaints from various environmental and consumer groups who said the packaging was excessive. I think the smaller product size might have something to do with people not having the same connection with cassettes and CDs they way they did with LPs, and if this is definitely a factor, that means your

listeners aren't connecting with your music as much if all they're looking at for your album's artwork is a tiny little square on their computer or MP3 player screen. If you're a Windows user, this typically means the same old yellow folder icon on your screen and the only thing different between your album and the next is the name of the folder at the bottom of it. Do you know who the artists thanked on the last album you downloaded?

CDs can also hold non-audio data, something I feel has definitely not been explored to the fullest. In the mid to late 90s, this was an idea that some artists & labels explored (remember Wu Tang Forever?) The "Enhanced CD" probably didn't take off because computers weren't as fast as they are now and Flash was in its infancy, with not nearly as many people making Flash content as there are today and so for most people who tried accessing the data portion of these CDs, it was more of a hassle. As I noted in the first part of this series, the first generation AD converters and overall CD authoring methods were also in their infancies and most people making the switch didn't like the new "cold" sound of digital. These days, AD/DA conversion is a lot more accurate, computers are much more powerful, and Flash has become a sophisticated authoring platform for delivering multimedia content (at slim file sizes) that I really can't imagine why the music industry isn't working towards making more sophisticated CD releases. It's probably in part, because the music industry in general has given up on CDs as a delivery medium because they can be easily copied, who knows?

So what am I saying? The CD still has a lot of potential, shit; VINYL has a lot of potential still. The CD is still the cheapest way to mass-produce a project giving the artist complete control and the ability to publish and distribute their works on a physical medium without the need for a major record label or distributor (today, most independent artists send their CD "premasters" in for professional replication directly). It also gives the listener the ability to make copies of the disc for backup and rip MP3 files for portability, just like how back in the day you bought an LP and could make a copy on cassette tape (except now you can do this faster than real-time with a couple of clicks on your favorite software media player). These days, the recording industry wants to restrain the number of copies you can make off a file that you've purchased via download, including putting limits on the number of devices that you can play them in; it's up to you to decide if that's going to fly or not.

Until the day comes where it's typical to see an artist selling their CDs with enhanced content (videos, remixes, etc.) and creative booklets, for \$10 or less, I'll refuse to call CDs "outdated" as their full potential, in my opinion, has yet to be achieved.

To end my rant on why I think CDs are still relevant, I also want to add that the reason why CDs sound harsh and thin these days is not because of the limitations of what the Compact Disc offers, now THAT is an outdated topic, as said earlier, digital conversion has come a long way. It's somehow become acceptable to abuse the range that is available on the platform, so the answer is to fall back a bit and learn how to best make use of what we have available. For you that already know this and have gone through great lengths to make sure your audio is optimized (not necessarily "maximized"), ready to be put on a CD-R to send to a replicator/duplicator for mass production, the next step is to make sure that you hand over a properly burned pre-master disc to replicate/duplicate CDs from.

Technical terms for those that still wanna know

Having an understanding of common CD Mastering terminology and where they fall into the world of making CDs is important; let's cover what the most relevant terms mean:

Replication – This is the process of making CDs (not CD-Rs). A CD plant takes your source, creates a master disc (also known as the Glass Master, because glass is used in the process of making it). The process of making this master is sophisticated; strict requirements are in place to prevent any sort of contamination to the glass master, which might affect the transfer of data. Out of this “father” master, a “mother” is produced from which “sons” can be created and these are the actual stampers that are used to stamp the image of the (father) glass master on to a layer of aluminum, which is then protected by other layers of plastic. Each “son” stamper can produce roughly 30,000 discs. From each “father” glass master, 3 “mothers” can be produced and each of these can produce 3 “son” stampers. You can leave a replicated disc in direct sunlight for quite some time (so long as it doesn't warp) and this won't have any effect on it because there's an aluminum layer in the disc that has been stamped with the data.

Duplication – This process is the same as making a copy of a CD on your laptop's burner, it refers to making copies of a CD to a CD-R disc. CD-Rs use a layer of vegetable dye that the burner's laser burns pits on, which are then playable on most CD players (earlier CD players didn't support CD-Rs but over the years, most manufacturers have incorporated support for CD-R and other various non-red book formats). Making one copy at a time for a large number of copies is obviously not efficient, so there are commercial duplicators available with multiple drives that can create copies of your CD, with models that also offer inkjet printing that is done on the same machine, provided that you use the required printable CD-Rs that are compatible. You should not leave duplicated CD-Rs in your car in direct sunlight for even a half-hour, as the layer of dye can then be damaged; CD-Rs cannot handle nearly the same kind of abuse as replicated discs.

Master – The Glass Master used in the Replication process. There can be some confusion when talking to a replicator when the subject of the “master” comes into play, as in the world of Pro Audio, a Master can mean the final collection of songs after the audio mastering process. Mastering engineers refer to the final disc they produce for their clients as the “pre-master” for this reason.

Pre-Master – The CD-R (or other digital source) that is ready to be delivered to a replication plant to serve as the source for the Glass Master (or source to be used by a duplicator). There are several error-checking steps that can be done to a pre-master disc by the mastering engineer to ensure the best transfer of data, which we will cover shortly.

Red Book & other Book Standards – Sony and Phillips (the inventors of the CD) created a series of standards, officially called “The Rainbow Books” for developers to follow when creating platforms for the creation of CDs. Rumor has it that they came up with the names for each of the standards based on the color of the binders used for storing the paper docs for each of them. Below is a list of what they represent:

Compact Disc Book Standards

Red	CD-DA – Digital Audio extended by CD Text
Yellow	CD-ROM – Read-Only Memory and CD-ROM XA
Orange	CD-MO – Magneto-Optical CD-R alias CD-WO or CD-WORM – Recordable, Write Once or Write Once, Read Many, CD-RW alias CD-E – ReWritable or Erasable
White	VCD – Video and CD-Bridge - Hybrid discs, e.g. CD-Ready
Blue	E-CD – Enhanced, CD+ – plus and CD+G – plus Graphics (karaoke) extended by CD+EG / CD+XG
Beige	PCD – Photo (not Picture)
Green	CD-i – interactive
Purple	DDCD – Double Density
Scarlet	SACD – Super Audio

There are software packages available that allow you to author CDs for one or more of the Rainbow Books standards. They range from the basic wizard-type programs that will burn a disc with a few clicks of the mouse that cost about \$50 to sophisticated platforms that produce professional-quality discs with advanced tools for hundreds of dollars.

The Red Book standard applies specifically to audio. The basic set of standards for Red Book CDs is:

- Maximum playing time is 74 minutes (including pauses)
- Minimum duration for a track is 2 seconds
- Maximum number of tracks is 99
- Maximum number of index points (subdivisions of a track) is 99 with no maximum time limit
- International Standard Recording Code (ISRC) should be included

In order for audio CDs to be Red Book compliant (meaning that they're guaranteed to playback on any player that supports audio CDs), they need to follow the above standards. This isn't an issue now because as mentioned earlier most of the newer CD players can also play discs that are Orange Book (and other standards) encoded, which allow you to do things like burn an 80-minute CD-R and play it back, but if you were authoring CDs in the early '90s, chances were that you would be running into issues getting an 80-minute CD-R to play back on most players. Mastering Engineers, when mastering projects intended for audio CD release, will adhere to these guidelines as much as possible, to ensure that the CDs that are produced will have the best chances of playing back over any player.

Information Wars

In 1996 the Red Book standard was updated to include text data (CD-TEXT). This allows you to encode the album title, artist name and song titles while still maintaining the strict Red Book standard. Most players found in cars these days support CD-TEXT, but where the support for this feature lacks most is in software players & CD drives for computers. Often times, artists find that their properly encoded discs don't display the CD-TEXT information when inserting their CD in the computer, and there are two main reasons why. First, the firmware of the CD drive on your computer must support CD-TEXT (most newer drives do) and second, the software player on your computer must also support CD-TEXT.

On the software side, it almost seems as though software developers purposely don't support it. Typically, when you insert a CD into a software media player, the program attempts to download its content's graphical information from a database known as the Cddb by Gracenote. In the early years of the Cddb, independent artists couldn't get their discs' information stored in the database unless they purchased a license from Gracenote, and software players that weren't licensed could also not make use of the database. As a result of this, a free database called "freedb" was launched and developers created software patches that could be installed to work with the unsupported applications. At the time of this writing, Gracenote allows users to enter their CDs' text information directly on certain applications that are licensed to use the database, iTunes being the most popular. You can't however, upload album art and other metadata to the database as this feature is something that is reserved for paying licensees.

iTunes lets users store album art in their hard drives, so if the user wishes to also see album art for their own CD releases, they would need to store the album art on their own computers. Other

popular media players such as Windows Media Player don't use the CDDB to display a CD's information, instead it uses a similar database service called Windows Media Database that is maintained by Microsoft, so in short, there isn't one standard way to get graphic and text data information delivered to all of the software media players out there.

In all fairness to the CDDB, it predates the extension of CD-TEXT for the Red Book standard by about 3 years and it's unfortunate that the CD-TEXT extension didn't include the ability to store metadata such album art and other useful information on the disc itself, rather than require users to access the internet to download it and because the recording industry in general has declared the CD dead, I doubt they (Sony & Philips) will extend the standard again. If you would like to have your CDs information displayed on computers, the workaround is to learn what database the software players you think are most relevant use and find out how to submit your disc's information to them. Then again, the easiest way is to distribute an MP3 version of your album on a compressed folder that contains album and other data; for this purpose, MP3 files are great because of their ability to store metadata that is compatible with practically all software players.

ISRC codes are distributed by the RIAA (they used to be free, now there's a fee involved). These codes are unique track codes that can help you track spins at radio stations that have a system in place that pulls these codes directly off your disc for reporting royalties to ASCAP/BMI. Ironically, most people I do work for have no knowledge of what these codes are for (probably because most people aren't concerned with getting spins on the radio these days).

Making the Pre-Master

So now we know that when speaking about your final mixes in the world of mastering, they are considered your "pre-master source", since the "master" is the actual stamper that makes your CDs. Once all of the tracks in your project are mastered, you'll need to decide who is going to layout your project in terms of track IDs, space between tracks, ISRC Codes, UPC code (should you want to have this information also encoded on the CDs themselves); these bits of information are referred to as "PQ" codes and sub-codes on the Red Book Standard. What does "PQ" mean? Good question, they call it that after the expression "Mind your P's and Q's" and it's so old that it's debatable as to what "P's" and "Q's" mean. Apparently, it goes way back to 16th century English pubs where the barkeep would be told to mind his "Pints" and "Quarts" when pouring for clients. For our purposes, this means to make sure you place your track IDs where they need to be, for example.

Your Mastering Engineer should have a platform for encoding all of this information on your pre-master source. Expect to pay a little more for this service from some studios, but there are others who do this part of the mastering process at no additional cost. Replication plants can also do this for you, but they will charge you extra. If you're doing your own mastering, it may be a benefit to you to have the replication plant do this process for you, and send them your audio files instead, as it would guarantee an error-free pre-master source for making CDs, if all you have is an average CD burner and burning software that doesn't do precise Red Book encoding and if you don't have the means to check for BLER.

Burning the Pre-Master

Part of a solid mastering chain also involves the tools needed to burn a properly-encoded pre-master with as little errors as possible. There's always going to be a small amount of data errors (due to the CD technology as well as the Red Book Standard for audio CDs) that are acceptable, these errors in the transfer of data are known as "recoverable errors" which means that any CD player will be able to compensate for them during playback and "fill in the gaps". Over the years, Mastering Engineers have found out what combination of drives and media work best for making pre-masters with as little errors as possible (Plextor drives and Taiyo Yuden media being the one of the most common combinations), as well as running systems with the least amount of background processes (as opposed to burning on a computer that's also running the internet and other software at the same time, which can lead to more errors on your pre-masters). The speeds at which to burn can also be a factor, although not as much as it used to be in the past, when drives, media, and operating systems were not as efficient and reliable as they are now. It is not about burning at the slowest speed possible, but a combination of what works best for the drive and media being used (I find that these days I get the least amount of C1 errors on Taiyo Yuden discs burned at 16x on my system).

Error-checking the Pre-Master

The last step in a professional mastering service is error-checking a pre-master CD before delivery to the client or replication plant. As said above, there's always going to be a degree of recoverable errors on the media, and when checking the Block Error Rate (BLER), Mastering Engineers will check for unrecoverable errors (E32) that will cause problems when CDs are replicated. If the replication plant catches the error and makes you aware, this is where a BLER report can come in handy so that the problem can be pinpointed. In many cases, replication plants will simply assume you've checked the pre-master source and skip any error-checking mechanism, so if your discs have unrecoverable errors and the plant is not checking for these errors, you can end up with a bunch of replicated discs that will have issues on playback, so this is definitely one service you want to make sure your mastering engineer is performing on your pre-master.

The process of checking for BLER takes on an average (for me) about 15 minutes and I don't automatically print out the reports, but do provide them on request, so if this is something you would like to have for your records, ask your Mastering Engineer to send you the BLER report(s) when he mails off your pre-master(s). Keep in mind that BLER checking happens almost immediately after the burning of the pre-master disc, which is free of dust or any scratches, so always treat the pre-master discs that you get from your mastering engineer with care. Avoid getting any dust on them, or exposing them to direct sunlight as this may damage the layer of dye.

In part V, we'll explore how we have somehow screwed up a good thing; how audio is typically maximized for loudness these days - so much that some of it literally hurts to listen to, and hopefully offer some thoughts that will help us work towards an optimal sound.