
Precision Powerhouse

MASTERING

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I. About Mastering

Everyone from studios to bedroom operations with a workstation and a CD recorder seems to be offering mastering. What's the difference? How can you tell the pros from the cons?

Why does your recording need to be mastered? You just spent a bunch of money in the studio. Shouldn't they have gotten it right in the first place? Those are common questions. Think about it this way: Mastering a record is like sending a super model to a great make-up artist and hair stylist. The beauty is already there. It just takes the right touch to accentuate the best features. When you're finished, everything seems natural and beautiful. No one notices how much work it took to get to that point. They just enjoy the beautiful result.

Another analogy: Think of a great sports car like a Porsche or Ferrari. Automotive engineers have designed them to be mechanically superior. But even the most advanced design won't run to it's potential until it is properly tuned and adjusted. The same is true of a mix. All the elements are there. The mastering engineer is like a fine mechanic who tunes the fuel injection, sets the timing, optimized each minute detail to get the greatest performance from the machine. The design engineer did his part, now it's up to the mechanic to make it all work together. That's what a mastering engineer does for your product.

The most important difference between a mastering engineer and someone pretending to be a mastering engineer is a dedicated mastering experience. Don't be fooled by buzzword boxes, people telling you they can make your CD louder than anyone else's CD, or even experienced recording or mixing engineers offering to master your project in their studio. The cardinal rule is: never perform mixing and mastering in the same studio with the same engineer. That's just asking for trouble. Ask any reputable mastering engineer or high end mixing engineer and they'll tell you the same. The benefit of a fresh set of ears, a true reference monitoring system, and the expertise of a dedicated mastering engineer is extremely valuable. It's a lot like proof reading your own writing. You know what you want to say, and you understand what you have written, but until you let an objective reader check it out, it may only make sense to you. You may have omitted important information that you think is common knowledge, or a clumsy sentence that looks OK to you may be awkward to a fresh reader. It's always best to get a trained professional opinion. That's exactly what mastering is.

Mastering is not something you can learn in a short while. It requires years of dedicated technical study and practice. As a hypothetical example, let's say you have just finished mixing and you're looking for a mastering facility. If the studio or engineer you contact has been mastering for more than five or six years, that probably shows a dedication to the art and craft of mastering that pre-dates the current crop of desk-top mastering guys.

Most reputable mastering engineers were in the business long before the instant gratification of digital audio workstations was even an option. They have extensive technical knowledge that covers a vast array of audio engineering including signal processing, tape transports, audio monitors, acoustics, amplification systems, signal routing, electronics, replication technology, etc. etc. It is a very technically challenging craft and they have dedicated their careers to it.

If you contact a facility that has been mastering for fewer than five years (in other words, their only experience is with desk-top mastering) or their primary work is recording or mixing with mastering as a part time service, chances are they have little actual day to day mastering experience. Probably not enough to meet your critical needs.

Mastering requires artistry craftsmanship, creative control and technical accuracy. It's a very specialized discipline. Great equipment is an absolute necessity, but that's only the beginning. The most important ingredient is still experience in creating a consistent whole from the individual parts. Mastering skills are very different from recording and mixing skills. Recording and mixing is creating a project from scratch. It's very demanding and requires that complete attention be given to the individual elements of each element as it is being recorded and mixed. Mastering is looking at the big picture. The engineer listens to your music, your voice, etc. in a calibrated reference monitoring environment and finely tunes each element (sometimes even individual verses and choruses within a song) with precise program equalization, compression, leveling and editing. It takes tender loving care to insure the overall balance and consistency of the record. Mastering is the final step in the creative chain, and the first step in manufacturing. Mastering is where everything has to be perfect. Your project depends on it. Once the final delivery master is created, you can be confident that every effort has been made to ensure your complete satisfaction.

II. Mastering Philosophy

One hundred per cent client satisfaction is really all there is. Without your complete satisfaction, we would soon disappear. A mastering engineer's success is based on reputation, and a reputation is a very fragile thing. One mistake and everyone hears it, literally. There is no room for error. There is no room for even one dissatisfied client.

Technology has changed the way artists create their product. Clients have a more active role than ever before in recording, producing, mastering and manufacturing their product. Powerhouse Mastering is here to provide the necessary link between the mix and the finished product. We try to offer the best service available anywhere at any price. We believe our technical expertise and facilities meet that goal for our clients, and they keep coming back again and again for the quality of work they have come to expect. Whatever the problem, we will find the solution.

We also believe in doing things the right way. To us that means tapping into experts in the field. A jack-of-all-trades engineer is fine for running sound at your company picnic, but when it comes to maximizing the potential of your production, you can't afford to compromise on experience or facilities. We've worked hard to build a mastering environment that meets these strict requirements. We believe it's the right way.

Every part of the recording chain has it's specific priorities and requirements. In tracking you need great mics and pre-amps, a clean recording desk, big monitors to hear what's going to tape, and a great sounding multi-track recorder. In mixing you need a great desk, lots of effects, monitors that accurately represent the width and depth of the mix, and a high-resolution master recorder. In mastering you need the best playback gear, the cleanest signal path, the highest resolution signal processing, the most accurate reference monitoring to ensure the finished product will sound great across a wide variety of systems, and tons experience with many musical styles and genres.

That only covers the hardware. Each discipline brings with it its own set of skills. Each is very different from the other and, as you go up the ranks in experience and skill level there is virtually no crossover from recording and mixing to mastering. It simply isn't done that way in the big leagues. Check the credits on your favorite recordings. You'll find tracking, mixing, and mastering engineers who have each

brought their own individual talents and skills into the project. That's doing it the right way.

Mastering is where your creativity meets cutting edge technology. There is no room for semi-pro equipment or beginners at this stage of the game. ALL of your production is going through the signal chain. ALL of your production is being evaluated and processed based on the monitoring environment. ALL of your production is being delivered to the pressing plant on one delivery master. There is no room for error in judgment or equipment. ALL of your production is in the hands of the mastering engineer. Only experience, good technique, an extremely high resolution monitoring environment, and the best possible signal processing chain will yield professional results. There is no substitute for doing everything the right way.

Your production deserves it!

III. Loudness And Level Practices

In the early days of analog recording, a 0VU reference was established to work within the physical limitations of the medium. The VU (volume unit) meter represents the average recording level, with peaks reaching into the headroom of the recording tape. As recording level increases, so does distortion, tape saturation, self-erasure and tape compression.

Every engineer has his own method of dealing with the problems that come with putting more level on tape. Since analog tape is not exactly linear at all levels and at all frequencies, changes in recording level affect the sound quality. This coloration is often exploited by experienced engineers to achieve the famed analog sound. The average recording levels (and approximate apparent loudness) are monitored on VU meters, and true peak levels are mostly an educated guess. Utilizing that area in the red above 0VU is part of the fine art of analog recording.

With digital recording technology, a more accurate metering system is needed. Metering the absolute level is necessary to stay within the numeric boundaries of the format. Unlike analog, distortion of the signal actually decreases as signal level increases until 0 dBFS (0 dB Full Scale) is reached. At that point, the system will run out of numbers and clip any wave front trying to exceed the limit. That's why digital clipping is so harsh sounding. There is no rounding of the wave. It is hard clipped and a series of digital 1s is written until the waveform recedes below 0 dBFS. Digital clipping is generally not pleasing to the ear, so the recording level must be accurately monitored to stay below this limit. There is no headroom above an arbitrary average level as with the analog system. The entire signal is represented below 0 dBFS.

The human ear / brain system roughly equates average level to perceived loudness. VU meters were developed with an averaging response roughly equal to how we experience loudness. The standard VU meter averages (integrates) over a 300 mS period. That is to say, whatever the needle of the VU meter reads represents an average of all levels over the past 300 mS, or about 1/3rd of a second. A continuous piano note may read the same as monotone speech if the total energy in that 300 mS window is the same. We would probably experience them as being about the same loudness. But if we were to look at each of them on an

oscilloscope, the held piano note would have a nice smooth envelope, while the speech would be a series of changing waveforms. Certainly not equal in actual level at any given instant, but averaged over time, they measure (and are perceived to be) about the same.

The original idea of level setting in digital recording was to use an analog like reference for average levels and allow the peak information to exist between that arbitrary reference and 0 dBFS. A de facto standard of -18 dBFS was established as that reference point. That's why you will often find DAT tapes that contain a -18 dBFS tone. This level tone is to easily interface the digital tape with an analog mixing desk or recorder. That reference tone is set to 0VU on the desk or recorder to insure proper gain staging.

Exit the seasoned professional with years of experience perfecting the craft; enter the young engineer who has never used an analog deck, but learned to use a DAT recorder in only a few days.

Somewhere along the line radio execs told their engineers to make their station the loudest on the dial. Why? The theory goes that the loudest station will capture the attention of the listener. As a result, radio engineers and equipment designers cooked up a whole genre of compressors and limiters sold exclusively to broadcast facilities designed to maintain a constant level on the radio. Basically, no matter what the input level is, the output level will be fairly constant. That bank of processors will squash even the softest CD into another dynamically lifeless lump of monotony for the sake of ratings.

Over the past 15 years as CDs have been getting progressively louder, a huge number of hits have been recorded and released. Go back 10 years or so and listen to a CD from that era. I've pulled the Police Synchronicity CD out of a hat. This is a CD full of hits. I'll bet you've heard those songs on the radio hundreds of times right next to songs recorded this year at today's increased loudness. Do you see where I'm going with this? The fact that you never noticed a problem proves my point. **IT MAKES NO DIFFERENCE ON THE RADIO!** The Police CD is at least 6 dB softer than, say, a Garbage CD, but on the radio played one after the next, they sound exactly the same. That famed rack of processors at the broadcast facility has made sure of it. In the realm of FM broadcasting, there's no room for dynamic range.

Why is this still happening?

We are stuck in a loudness war. There seems to be a crazy ego-driven desire to have the loudest CD, but there is no justifiable reason for it. It is a self-defeating endeavor. Since everyone can not be the loudest, and they keep getting louder every day, all you wind up with is an over compressed and limited CD. A CD that sounded loud enough today but is not loud enough tomorrow. The sound has been permanently crippled by the elimination of its original dynamic range. It won't sound as good as it could even on the finest home system since its dynamic character has been squashed. That's one huge step backwards in quality. Hopefully future digital consumer formats will be better understood and this sort of sonic torture will be a thing of the past. Unfortunately, the likelihood of inexperienced mastering engineers understanding this paragraph is extremely low.

Let that be the last time you let anyone tell you your CD must be louder than anyone else's to sound good on the radio. Now you know the facts.

The moral of the story is simply: Don't ruin the dynamics of your record by over compressing because of the current loudness fad.

If you're still not convinced, this test will prove my point and erase any doubt. Take any song of your choice and make two versions of it. One with no dynamic processing and one compressed for loudness. Adjust the gain so that they match in perceived loudness and compare for detail and clarity. It may seem obvious that the levels must be matched for this comparison, but it is rarely done correctly. There have been tests performed that prove raising a song's gain as little as .5 dB with no other processing will be perceived as sounding better than the exact same song at the normal level. That's why people are fooled into thinking the compressed sound is better. When a fair comparison is made, the uncompressed version usually wins this test. The peaks are louder. The valley's are deeper. The transients are all there is just like in live sound. The pumping and breathing artifacts of compression are gone. The natural dynamics of the actual event are preserved. It just sounds more real. In fact, the uncompressed version has **LOUDER** peaks. Think about that! The peaks were not squashed, so they can rise above the average level and be much more dramatic than if they were compressed. Compression for the sake of increased loudness hurts your sound!

Armed with all of this information, loudness is no longer an issue. Besides, that's what volume knobs were invented for. Granted, there are times and genres when compressing and limiting are necessary to control dynamic problems, but when it

comes to a final mix, dominant stereo compression will go down in history as a failed attempt by uninformed engineers to compensate for poor mixes with a hotter recording level. Loud and over compressed program will represent that sound of the mid to late nineties. Picture hairstyles of the 70s and 80s and that's what over compressed will seem like.

Don't get me wrong. I CAN increase perceived volume a great deal with very few artifacts. The final listener often can't tell the difference. But that's no argument for doing it.

It's like this, someone just purchased your latest record and is listening to it right now. That person can't hear all the vocal takes or the different mixes you tried before getting it just right. They only hear the result of the final mixes and mastering. If a guitar solo was supposed to be in the intro to a song but it got lost in the mix, they would never miss it. But you would. You'd raise hell until it was right. The same applies to dynamics. You can't miss what you never had, but given the choice, a more natural and lifelike recording will always be preferred, all other things being equal.

Educate your listeners. Let them realize that their own volume control makes sounds louder and softer. They don't need to suffer the ill affects of this volume war.

IV. Mastering Equipment, DAT And Requirements

A. Few Words About Delivery Masters.

Your delivery master is the most important link in the long chain leading from the recording studio to the finished product. An extremely reliable and error free delivery master is essential for getting the results you expect. Reputable mastering facilities have good working relationships with Replicators and have the equipment and skill necessary to create extremely high quality delivery masters. The most common formats are pre-master CD (PMCD), U-matic 1630, and Exabyte DDP. The merits of each have been argued for years, but these formats continue to be the overwhelming choice of professionals.

B. What About DAT?

Nope! DAT is not an acceptable professional delivery format. In fact, reputable mastering engineers agree that DAT is below professional consideration for delivering a final master and is considered by many to be of too low quality for mixing.

Replicators will accept DATs simply because it makes them money. The fact is, most DAT or CD masters sent to a replication facility are run through the process of creating an Exabyte DDP master before the glass master is created. The reason is simple; most customer supplied DAT and CD masters are not of high enough quality to create a glass master directly. The error rates from consumer CD recorders, sub code errors and drop-outs on DATs have made this a real problem for replicators.

If a mastering facility tries to send a DAT as a delivery format, you've just uncovered them as amateurs.

C. The point?

Your CD will only sound as good as the master delivered to the replicator. Only trust the creation of your delivery master to a mastering engineer who has intimate knowledge of the replication process and personal relationships with replication engineers. It's really no fun to receive your shipment of finished CDs and find a problem. With a reputable mastering facility, you don't have to worry.

D. Original Master Requirements for CD Mastering

To create the best final master, we need as much information as possible

1. Essential Documentation:

1. Complete and accurate list of Original Master contents, including song list, song times, and information regarding keeper vs. bad/unused takes
2. Final Master song sequence, spacing, edits, cross-fades, etc.
3. Sampling Frequency of digital formats
4. Properly labeled master and box
5. Tape Format, Noise Reduction, Speed, etc. of analog masters
6. Complete alignment tones (reference level, frequency response, azimuth, noise reduction) for analog masters
7. Name and phone number of the mixing studio or engineer
8. Any additional special instructions necessary for the proper completion of mastering.

2. Acceptable Master Formats

In order of preference:

1. Analog reel (1/2' or 1/4' @ 30 - 15 ips) 1/2' 30 ips is still considered by most to be the best sounding master format available.
2. High resolution digital (24 bit) such as a Prism or Paq Rat encoded MDM, Genex, Sony PCM 9000, Sonic Exabyte archive, 24 bit DAT, etc.
3. R-DAT (the original unedited masters, please)
4. CD-R (questionable, but acceptable. Since they are usually generated on consumer grade CD recorders by low resolution editing systems, they I try to avoided them as a source for mastering.)
5. Sony F1 (beta of VHS)
6. Hi Fi VHS
7. Cassette
8. Vinyl (LP, 78 rpm, etc.)
9. Other formats with special arrangements.

*Dolby SR and A, and dbx Type I NR is available for all open reel formats.

It is very important that the master supplied be the original mix master. What better place to use the original than in mastering?

If editing or any other changes to the songs or individual takes are required, our mastering studio is the best place to make these modifications. In our signal chain, all editing, gain changes, fades, EQ and DSP are done at very high resolution in order to preserve the sonic integrity of your music. Edited mix masters, even if they are digital, can suffer from the ill affects of generation losses. Consumer grade digital editors (and even some very popular Pro editors) can actually reduce the resolution of your recording. Much worse, going DAT to DAT via analog WILL result in sonic degradation you can hear. This is not a good way to treat your music. It will also save you time and money to avoid duplication of efforts by doing all post-production in the mastering stage.

V. Precision's Mastering Expert

Greg Reiersen

For the past fifteen years Greg has been hard at it, mastering and editing high quality audio. He brings with him a variety of experience in location recording, studio design, technical support and quality assurance. In the Powerhouse studio, Greg tackles music and dialog editing, restoration and enhancement, and electronic and mechanical calibration and modification. Greg also works with various local artists and dance and theater groups and is on the board of directors of Corning Dances and Company. He provides sound and dialog editing, sound system design and construction, and Consultation. He is also very active in the creative community as the percussionist for the group SEVEN THIEVES. Other interests include cycling, roller-blading, motor sports, photography and fine art.

VI. Client List

- 3M
- Advanced Duplication Services
- Arista Records
- Atomic Theory Records
- Bacon Brothers, The
- Big George Jackson
- Bobby Llama
- Bruce McCabe
- Chopin Society
- Cold Wind/Narnian Records
- Cure, The
- Deepak Chopra
- Dodd
- Doug Kershaw
- Gene Adams
- Gini Dodds
- Grant Heart
- Greater Twin Cities Youth
- Holland Records
- Hot Springs Records
- Indigenous
- Jason Heinrichs
- John Hermanson
- John Kay of Steppenwolf
- John Wright
- Jonny Lang
- KTCA
- K-Tel Records
- Kurt Jorgensen
- Linda Peterson
- Lorie Line
- Marc Anderson
- Marshal Tucker Band, The
- Metacom
- Michael Johnson

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- Moore By Four
 - Mystery Science Theater
 - OarFin Records
 - Pachyderm Records
 - Peppermint
 - Prairie Home Companion, A
 - Red Decibel Records
 - Robayat
 - Ronny Loew
 - Schubert Club
 - Shirley Witherspoon
 - Shrapnel Records
 - Simitar
 - Smooth Composition Records
 - Soulfood Media
 - Sowah Mensah
 - Stephen Bishop
 - Studio M
 - Suburbs, The
 - Symphonies
 - Tommy James
 - University of Minnesota
 - Voice Trek
 - Wain McFarlan
 - Warner Brothers Records
 - Westside
 - Willie Wisely
 - Zomax Optical Media