AUDIO MASTERING AS MUSICAL PRACTICE

(Spine title: Audio Mastering as Musical Practice)

(Thesis format: Monograph)

By

Matt Shelvock

Graduate Program in Popular Music and Culture

**A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts**

**The School of Graduate and Postdoctoral Studies
The University of Western Ontario
London, Ontario, Canada**

THE UNIVERSITY OF WESTERN ONTARIO
SCHOOL OF GRADUATE AND POSTDOCTORAL STUDIES

CERTIFICATE OF EXAMINATION

Supervisor	Examiners
_____	_____
Dr. Jay Hodgson	Dr. Norma Coates
	_____
Supervisory Committee	Dr. Robert Toft
_____	_____
Dr. Norma Coates	Dr. Samuel E. Trosow
_____	_____
	Dr. Matt Stahl

The thesis by

Matthew Thomas Shelvock

entitled:

Audio Mastering as Musical Practice

is accepted in partial fulfillment of the
requirements for the degree of
Master of Arts

Date_____ _____
Chair of the Thesis Examination Board

ABSTRACT

This thesis examines audio mastering as musical communication. Tasks including loudness management, harmonic balance, denoising, phase alignment, monitoring, effects application, and administrative responsibilities are of central importance to mastering engineers. With the exception of administrative responsibilities, each of these tasks significantly shapes a record's aesthetic character and physical makeup. These contributions – the final creative steps before an album's release – demonstrate the mastering engineer's role as a collaborative *auteur* in recorded musical communications.

KEYWORDS

Mastering, Recording Practice, Perceived Loudness, Signal Processing, Amplitude, Compression

ACKNOWLEDGEMENTS

Recording Practice, although an emerging field, is very near-and-dear to my heart. Despite being a kid who endlessly tinkered with (often haphazard) recording equipment, I would not have believed anyone who told me I would eventually embark on this project. I would like to thank Dr. Jay Hodgson, my advisor, for introducing me to the formal study of Recording Practice and providing me with years of mentorship and instruction. Jay's continued support has taught me that Recording Practice is, in fact, musical communication and that tracking engineers, mix engineers, mastering engineers, and other recordists perform tasks which cannot be omitted from the study of popular music. Recording practice is, in essence, composition. Without Jay's guidance and support this thesis would not have been possible.

I would also like to thank Norma Coates for being a source of knowledge, help, and guidance over a number of years at this institution. Thank-you for entertaining my compulsive need to participate in class.

Thank-you to my defence committee, Dr. Robert Toft, Dr. Norma Coates, and Dr. Samuel Trosow. I am grateful for your contributions and thought provoking questions.

I would finally like to thank my parents, Jill and Tom, for encouraging me to only study that which I am passionate about. Thank-you for saving me from enrolling in the natural sciences, thus preserving my soul. Thank-you, as well, for your ongoing support in numerous ways.

TABLE OF CONTENTS

AUDIO MASTERING AS MUSICAL PRACTICE

**Please note: the reader should listen to accompanying audio examples when prompted.*

-

CHAPTER ONE

INTRODUCTION

Mastering is a crucial recording practice.[1] In fact, everything that occurs during the record-making process is subject to mastering. However, very little is known, let alone written, about mastering as a musical procedure.[2] This is surprising, especially since mastering exerts a total influence on the overall dynamic and spectral balance of recorded musical communications. [3]

So far as I am aware, this thesis is first to seek to rectify this lacuna. In what follows, I will describe the mastering process in concrete musical detail, and situate it vis-a-vis ongoing debates in the field of popular music studies, specifically, concerning the musical functions of signal processing.

This thesis will explain the significance of the mastering process to Recording Practice at large. I will explain where mastering fits within the broader communications paradigm of making and hearing recordings, and in so doing, I will also: (i) historicize the mastering process; (ii) inventory the precise duties associated with audio mastering; (iii) explain these duties vis-à-vis psychoacoustics; and (iv) consider the challenges analytic

---

[1] Consideration of remastering is beyond the scope of this thesis. I intend to research it at a later date.

[2] An in depth explanation of mastering is absent in the following books: Brown, Jake. 2009. *Rick Rubin: In the Studio* ; Doyle, Peter. 2005. *Echo And Reverb: Fabricating Space in Popular Music Recording*, 1900-1960 ; Jones, Steve. 1992. *Rock Formation: Music, Technology, and Mass Communication*. ; Millard, Andre 2005. *America On Record: A History Of Recorded Sound* ; Moorefield, Virgil. 2005. *The Producer as Composer: Shaping Sounds of Popular Music* ; Simons, David. 2004. *Studio Stories: How The Great New York Records Were Made* ; Sterne, Jonathan. 2003 *The Audible Past: Cultural Origins of Sound Reproduction.* ; Thompson, Daniel. 2005. *Understanding Audio ;* Wadhams, Wayne. *2001 Inside the Hits: The Seduction of a Rock and Roll Generation* ; Warner, Timothy. 2003. *Pop Music Technology and Creativity* ; Zak, Albin. 2001, *The Poetics of Rock.*

[3] Readers should consult an audio engineering dictionary or glossary for clarification of terms.

awareness of mastering presents to prevailing concepts of Recording Practice in contemporary popular music studies. This chapter introduces the broad contours of the following study. I intend to examine points (ii) through (iv) in greater detail in the following chapters.

Chapter Two will provide a detailed inventory of musical procedures intrinsic to the mastering process. In *Understanding Records*, Jay Hodgson (2010) delineates the following as responsibilities of the mastering engineer:

- "tuning" the mastering environment (managing sound reflections, absorption, diffusion, and low-end frequency content);
- engaging in appropriate monitoring practice (calibrating and managing frequency and dynamic levels, and phase coherence);
- sequencing, spacing, and fading (referring to the order of tracks on an album, the space between each track, and fade-outs during song endings, respectively);
- equalization ("surgical," which focus on specific EQ bands, and "global," which apply to large regions and, sometimes, entire tracks);
- managing perceived "loudness"; and, finally,
- optimizing masters for various formats (24-bit to 16-bit concerns in digital recording, etc.).

I intend to examine each of these "responsibilities" in greater detail. To do this, I will report on findings from a survey of manuals written by professional mastering engineers like Bob Katz and Bob Ludwig, interviews personally conducted with professional mastering engineers, and observation of numerous mastering sessions.

Once I have established the technique of mastering, I will then situate that technique vis-à-vis ongoing debates within the field of popular music studies at large, specifically, concerning the musical functions of signal processing and related debates

concerning musical authorship. In Chapter Three, then, I will explain mastering as a creative practice, one which is equally communicative as, say, songwriting or performance. This view runs counter to the established conception of mastering as a mere "quality control," designed to ensure optimal average amplitude. Doing this, in turn, will allow me to establish the mastering engineer as an important creative partner in record-making, one who enjoys equal communicative agency with songwriters, performers, producers, and mix–and audio–engineers.

Finally, in Chapter Four, I will summarise my findings, and consider future directions for continuing research. I intend for my research to provide a sound academic basis for later studies of record–making, undertaken from both technical and cultural–analytic perspectives. Current popular music studies lack a detailed account of the mastering process; in fact, most research on Recording Practice fails to mention mastering at all. My study will thus rectify this gap in knowledge and, in so doing, begin a long overdue conversation about what mastering is and what it achieves on a fundamentally musical level. It is my ultimate hope that this will provide concrete data for future studies of Recording Practice slanted toward understanding what mastering —and, thus, what mastering engineers —contribute to modern musical communications at large.

Literature Review

Before continuing, I should first briefly address my proposed study to broader ongoing debates concerning Recording Practice. As noted, as the final stage of recording–making, all recording practices are subject to mastering. However, mastering

has failed to substantially register in academic research on record-making and record reception.[4] As such, it makes sense to examine a few representative studies of Recording Practice at large in this review, to generate a clear view of this lacuna. I will focus on work by Simon Zagorski-Thomas (2010), Albin Zak (2001), Peter Doyle (2006) and Theodore Gracyk (1995).

In "The Musicology of Record Production" (2010), Simon Zagorski-Thomas proposes that record production itself should be studied as a subset of musicology, where interaction with other musical categories must occur. He argues that a musicological approach to studying the recording process must include a discussion of instrumental performances and arrangement, for instance. What may be most pertinent for the current study, however, is Zagorski-Thomas' assertion that recording technology should be discussed from both historical and practical points-of-view. In other words, Zagorski-Thomas argues that developments in recording technology have had meaningful aesthetic ramifications on the sound characteristics of recorded music, and, thus, that technology deserves scrutiny as a communicative agent in Recording Practice. However, he ultimately fails to consider developments in mastering technology and practice. This is an especially glaring absence given that all uses of recording technology during record making are filtered through the mastering process before they are ever heard by fans, and that mastering is now perhaps the most significant shaping factor in the final dynamic and spectral balance of recorded musical communications.

Like Zagorski-Thomas, Albin Zak (2001) is clearly interested in establishing the musical ramifications of recording technology and technique. Zak (2001, 12) explains

[4] In the past decade, only Jay Hodgson (2010) has examined mastering in a substantive manner.

that "presenting a transparent representation of some natural acoustic reality was never the point" of recording practice, as a recorded album is intended to be a musical event in-and-of itself (of course, one might wonder how this assertion would hold up next to 'live' records). As such, record reception now follows numerous evaluative criteria developed specifically for listening to music via sound reproduction (Zak: 2001, 22). Zak contends that recordists carefully construct each element of a record to interpolate various generic and semiotic associations. He delineates five categories of these "associations": (i) musical performance; (ii) timbre; (iii) echo; (iv) ambience; and (v) texture (Zak: 2001, 49).

Zak ultimately neglects the mastering process in his study of "making records" and "cutting tracks", and the profound influence it exerts over the final sound of records. Each of his five categories are indeed mediated through audio mastering, which makes its absence from *The Poetics of Rock* all the more curious. Mastering arguably uses material shaped through tracking and mixing to create all of the timbres, ambiences and textures heard on a record. Zak (2001, 85) defines "timbre," for instance, as the "sonic colour" produced by a track's arrangement, instrumentation, and equipment choices. He separates timbre from texture insofar as texture refers to the way a track's disparate timbral elements combine. Timbres have clear generic references, and choosing timbres can be understood as a means for record producers to market songs to particular demographics. In this way, Zak continues, recorded music can be understood to engage listeners through both physical and rhetorical associations. "Physical associations" refer to the physical components of sound, including frequency, envelope configuration (ADSR) and overtone

structure. “Rhetorical associations,” on the other hand, relate those physical associations to broader cultural schema for decoding musical communications (Zak 2001, 62).

Audio mastering shapes both the rhetorical and physical properties of recorded music. My study will thus complicate far more than negate Zak’s model. For example, early mastering engineers often reduced the low frequency content before transferring a mix to vinyl, to prevent the record needle from “skipping-the-groove” on home record players (Hodgson 2010). In this case, mastering engineers transformed the physical properties of records even as, in so doing, they completely altered their rhetorical implications (consider what Tricia Rose (1994) has to say about the significance of low frequency content on late-1980s and early-1990s hip hop records, for instance). Music released during this “early” era sounds completely different from modern releases, in large part due to this meagre low-end.

Peter Doyle’s *Echo and Reverb: Fabricating Space in Popular Music Recording 1900-1960* discusses homologies between: (i) sounds treated with echo/reverb in mono productions released before 1960; and (ii) various culturally situated physical territories. In other words, Doyle (2006, 31) investigates the “spatial semiotics operating in popular music recordings” released before 1960. As noted with Zak above, an album’s ambience (both natural and artificial) is finalized during mastering. Doyle, however, provides only a very a cursory consideration of the role signal processing, and microphone practice, play in establishing the “acoustic territories” he ultimately examines records as entry to, and, the mastering process fails to register in his analysis at all.

While Doyle does glancingly consider differences between artificial and natural ambience, for instance, and simulated echo effects, he fails to explain how those

techniques sound, nor does he explain how they are produced. Put differently, the discussion of technology which Zagorski-Thomas (2010) insists is crucial to understanding the aesthetics of recorded musical communications is notably absent in Doyle's (2006) account. After all, if echo and reverb produce semiotic associations with culturally situated physical spaces — or if echo and reverb play a role in situating those spaces — it follows that audible differences in echo and reverb, as instantiated through different technologies and techniques, should play a crucial role in establishing those associations.

In *Rhythm and Noise: An Aesthetics of Rock* (1995), Theodore Gracyk establishes the recording process as an integral formal element of rock aesthetics. For Gracyk, rock records embody the art and craft of popular music, and he advocates that the art of production should be a central concern in the study of rock. He acknowledges the complexities of the recording process, and works to describe recorded sounds as well as how they are crafted in the studio. The subject of mastering again fails to register in Gracyk's work, however. He does acknowledge the mastering process in a discussion on John Fogerty, though. Upon listening to Duan Eddy's "Movin' and Groovin'" (1958), Fogerty claims to have been drawn to the overall "big" sound of the record rather than the specifics of the composition. Fogerty claims that there is a certain "edge" to the album which causes "Movin' and Groovin'" to stand out amongst other albums of the period. This "edge," as Gracyk defines it, is the result of tape saturation emphasised during transfer of the album from tape to disc. However, this remains the only substantive discussion of mastering in the book, and it is clearly lacking in concrete detail. It follows, then, that if mastering causes a recording to sound unique (or display an "edge") our

conceptions of popular musical authorship must also be interrogated both legally and philosophically. [5]

[5] Issues of rights allocation are beyond the scope of this thesis. For further reading see, for instance: McLeod, Kembrew. 2001. *Owning Culture.* Peter Lang Publishing; and McLeod, Kembrew & DiCola, Peter. 2011. *Creative License: The Law and Culture of Digital Sampling*. Durham: Duke University Press.

Mastering: A Brief Historical Summary

Audio mastering, in its current form as a post production practice, was far from conception in the days when 78 rpm records were the standard recording media. Records were printed directly from prototype to a master stamper which was used for duplication. Current studio techniques such as EQ or other types of processing were not yet common practice during the days of early recording media. These early mono records were tracked by diligently placing a microphone so as to produce the highest 'fidelity' reproduction.

An early pseudo-mastering engineer, known as the "transfer engineer", became necessary with the widespread introduction of the analog tape in 1948. The tape engineer is responsible for, quite simply, transferring recorded audio from tape to vinyl. Once a vinyl master was created, it could be sent away for duplication. The transfer engineer's duties expanded with the inception of stereo sound. No longer were they only responsible for transferring recorded audio, they were also tasked with improving *fidelity*. Transfer engineers engaged in minor global equalizations and other processing during the transfer process. Specialized consoles were built during the 1950s to aid the transfer engineer in producing high quality work. It became crucial for transfer engineers to make decisions which were both technical and aesthetic in nature, and the designation "transfer engineer" was eventually replaced with "mastering engineer." If the source tape was too heavy in bass frequencies, for example, the low end would have to be attenuated to ensure that the end user's record player needle did not "jump the groove" of a vinyl disc.

Throughout the 1980s, with numerous advances in sound technology the mastering engineer's responsibilities increased further. Today, mastering engineers continue to be responsible for transferring recorded material onto a final medium from which duplicates are created. I have already summarized the most fundamental mastering duties, and I will examine them in detail in the following chapter. For now, it will suffice to note that each of these duties – tuning, monitoring practice, sequencing, equalization, loudness management, and format optimization – are areas which concern musical taste. For instance sequencing, spacing, and fading; equalization; and subjective loudness management are three areas which concern musical taste directly. If one was to use a normalization algorithm on each song individually on a rock album the resultant sound would have both slow ballads and high energy songs at the same perceived loudness.[6] Listeners would understand this as a transgressive artistic choice. Alternatively, if an entire album is normalized at once, each song will increase by the same number of dBs and the resulting effect has quiet songs relationally more quiet than loud songs. Loudness management and equalization are also significant determinants in producing sonic effects which are subjectively described as "punchy," "bright/dark," "crushed," etc.
Human perception of sound differs from sound as it exists in its physical state. Our ears do not translate direct acoustic energy into nerve impulses for the brain to decipher.

Loudness management is a crucial task for mastering engineers. Different types of songs, genres, and other taste formations within recorded music demand specific practices concerning loudness management. Given that psychoacoustic phenomena are impacted greatly through perceived loudness, especially pitch, timbre, and duration, it is

[6] Normalization refers to the practice of adding a uniform amount of gain across a waveform, where signal-to-noise ratio and general dynamics levels remain unchanged.

necessary to understand the mastering engineer's role in record production.[7] Indeed, the art of record production cannot be understood without considering the mastering process.

Audio mastering is shrouded with mystery in both the professional music world and academia. As it stands, mastering is understood to be the "dark art" within the realm of Recording Practice. This fact is strange given the importance of mastering as the final creative and technical step before an album is duplicated or distributed. In a personally conducted interview with Russ Hepworth Sawyer, a celebrated mastering engineer based in Northern England, he explains:

> *I do believe people face [mastering] with questions such as:*
> *"Do [mastering engineers] really do that much?"*
> *"How important is it?"*
> *From my perspective, I don't really see mastering as a dark art. If Ray Staff was here, he may have a different perspective because he has, for example, learned how to cut vinyl from scratch and is the only person to have cut 2.5 sides from one piece of vinyl as far as I'm aware. That takes utter skill, and he is a true craftsman. To me, that's where the "dark art" of mastering lies: trying to make things as loud as possible on vinyl without breaking the head and without breaking people's needles.*
>
> *Over the last 20 or 30 years mastering has become a craft of a different kind. It's now a creative practice rather than a process of simply changing from one format to another. Originally, the mastering engineer oversaw the process of transferring audio from tape to vinyl, and was expected to make sure that nothing went wrong. They did, however, have to change the tonality of the recording in order to transfer effectively. Now, one goes to a mastering engineer for different purposes, which encompass a wide array of things we have to do now in order to make sure the album sounds good.*

Mastering technique is even intrinsic in establishing genre. French electro-house music, for example, is compressed via the mastering process in order to maximize average amplitude and reduce dynamic range on purpose. Furthermore, this music will be

---

[7] Further research concerning psychoacoustics can be found in the following: Cook, Perry. 2001. *Music, cognition, and computerized sound: an introduction to psychoacoustics*; Deva, Chaitanya. 1967. *Psychoacoustics of music and speech*; Clynes, M. 1982. *Music, mind, and brain: The neuropsychology of music*; Moylan, William. 2007. *Understanding and Crafting the Mix: The Art of Recording.*

mastered with an ideal listening environment in mind: the club. The mastering engineer will maximize the bass frequencies, for which large club-venue subwoofer speakers are ideally suited. Alternatively, mastering engineer Nancy Matter contends that mid-range is more important for punk music, due to the inherent harshness this frequency range tends to evoke in listeners (in Gallagher 2008, 34). Audio mastering technique, as it concerns loudness, compression, equalization, sequencing, and format optimization, is of primary concern in the realm of taste and genre, and can only be fruitfully understood as a creative practice.

Clearly much more research needs to be done on mastering, if only to clarify to analysts of popular music that it is, indeed, an integral component of that communications paradigm. In the following study I will establish that all recording practice is subject to mastering, and that mastering plays the crucial role of determining the audible character of recorded musical communications. How exactly does it do this, though? And, once I have established this, what challenges will awareness of the process present to ongoing debates concerning the musical functions of signal processing? It is my ultimate hope that my thesis will answer these two questions, or, at least, that it begins the process of producing an academically meaningful answer.

CHAPTER TWO

MASTERING: BEGINNING TO END

In this chapter I will identify the tasks performed by mastering engineers. These include administrative tasks, phase alignment, denoising, harmonic balancing, loudness/compression, monitoring practice, and the application of effects.

Administrative Tasks

During mastering, professional mastering engineers perform a number of administrative tasks. These tasks are mostly intended to ensure satisfactory reproduction of the source material, as well as logging/tracking for royalty purposes. Project-based mastering, however, may not require the same level of administrative rigour (Gallagher 2008, 286). Professional engineers are responsible for comprehensive logging of equipment/plug-ins and appropriate setting-values, PQ codes, managing output formats (CD-DA/DDP, digital release), quality control and error management, and sometimes coding ISRC data.

A mastering engineer's logs are important should a project need to be revisted at a later date. A client may, for example, ask for revisions to be made to a master years after its initial release. At Bob Katz's Digital Domain mastering house, each log contains "monitor gain, mastering engineer's comments, and the settings of the processors" (2007, 23). Comments may include client requests, comparative notes to a reference track, notes on instrumentation (insofar as instrumentation affects the engineer's approach to the

tracks), notes on how the resultant master sounds (*bright*, *punchy*, *fat*, *loud*), and other pertinent information.

Where a mastering engineer's logs are intended to be used for his/herself at a later date, PQ logging is intended for the CD duplication plant. The designation "P" indicates the beginning of tracks, where the "Q" subcode designates length of the track (and album timing).

Mastering engineers are also responsible for output formats. A master may be delivered to the CD duplication plant as either a CD-DA hard copy or a DDP file. CD-DA masters should be vacuum sealed and delivered with the utmost care as damage to the disc can result in duplication errors. If the master is damaged, all duplicated copies will contain the same error. Even a single fingerprint may cause unwanted results. Disc Description Protocol (DDP) image files, on the other hand, are a more reliable means of delivering a master for duplication. DDP files are usually sent via an ftp server to the duplication plant, containing a subset of four different files: image.dat, ddpid, ddpms, and sd. The image.dat file carries the audio "image" to be written onto disc via laser. The other 3 files carry "administrative" information such as PQ codes and other data (Katz 2007, 32).

Critical quality control listening should be performed on the final master before duplication occurs. Ideally, this will be done by a separate engineer to ensure that the primary engineer has not *adjusted* his/her listening to suit disfigured balances. Quality control listening should be done with headphones in order to closely scrutinize the final product for clicks, pops, and other intermittent distortions. Moreover, on loudspeakers small dropouts in either the left or right channel are sometimes masked, hence the

requirement for playback over headphones. If unacceptable clicks or pops are present on the master, or if such "dropouts" occur, it may be necessary to revisit the original mix and create a new master before duplication can occur.

Phase Alignment

Mastering engineers are responsible for ensuring balance within the stereo image of a project. The left and right channels must play back audio through monitors at the same level of perceived loudness. If this criterion is not met, the mastering session will proceed with a distorted stereo image and the resultant master will be faulty. It is important that the engineer uses his/her ears to scrutinize the phase coherence of a given project rather than metering implements, as Bob Katz explains:

> Music feels much better when the stereo balance is 'locked in,' which can be as small as a 0.2 dB level adjustment in one channel. It is generally unhelpful to use meters to judge channel balance because at any moment in time, one channel will likely measure higher than the other. I've seen songs where one channel's meter (peak or VU) is consistently a dB or so higher than the other, but the balance sounds exactly correct. Since lead vocals are usually centered, this is a good guide, but there are always exceptions. Proper balance should be determined by ear. (Katz 2007, 205)

To ensure acceptable phase alignment, many engineers begin mastering sessions using mono playback. If the stereo image drifts left or right there is a phase issue between the speakers (Hodgson 2010, 203) (see Example 1).

Example 1: Improper Phase Alignment Simulation
Example 1 simulates the sound of an inaccurate stereo field. When played on any standard listening device the resultant sound will feature a noticeable volume boost in the right channel. This is intended to simulate unbalanced phase alignment. As demonstrated, an unbalanced stereo field can be disorienting. At 55 seconds, when the speed fade occurs, the phase issue is corrected.

Example 2: Phase Cancellation
Example 2 demonstrates phase cancellation. Approximately 8 second into the track there is a sudden drop in the lead vocal. This issue cannot be corrected through mastering, and has to be sent back to the mix engineer.

De-noising

De-noising is the process by which mastering engineers remove unwanted noise from a final mix. Some noises (crackles, hiss, hum, etc) are simply overlooked by the mix engineer and should be removed, where others may be crucial to the aesthetic of the album. Bob Katz surveys two categories under which noises fall in mastering: continuous and impulsive (Katz 2007, 139). Impulsive noise refers to intermittent noises, such as crackles, pops, and other auditory ticks. Continuous noise can be further broken down into tonal and broadband noises. Tonal noise carries a fundamental frequency, and often manifests as buzz (higher harmonics) or hum (lower harmonics) as an effect of electromagnetic interference during tracking. Broadband noises, on the other hand, refer to white noise, pink noise, rumble, and hiss (Katz 2007, 139). The recent prominence of the project studio paradigm requires mastering engineers to especially attentive to unwanted noise as Katz explains:

> Project studio mixing rooms are not as quiet as professional studios. Air conditioners rumble, airflow noise, and fans in computers, cover up noises in the mix. Regardless, the mix engineer should be concentrating on other things besides whether the singer produced a mouth tic. Consequently, when the mix arrives at the quiet mastering suite, we notice problems that escaped the mix engineer - click track leakage, electrical noises, guitar amp buzz, preamp hiss or noises made by the musicians during the decay of the song. We use our experience to decide if these are tolerable problems or if they need to be fixed. (Katz 2007, 140)

Surgical EQ (see Figure 2.01) manipulations can either help remove unwanted noise or at least attenuate its volume. Surgical equalization refers to the practice of carefully boosting or cutting narrow frequency bands in order to remove offensive noise (Hodgson 2010, 210). Often times, however, important musical information may be contained on the same frequency band as an offending noise. In this case engineers

employ the use of downward expansion, which effectively works in the opposite way of a compressor. Compression used during mixing and mastering can inadvertently increase the volume of unwanted noise, hence why expansion is employed. Katz explains that if compression caused the issue, un-compressing via expansion can be a viable solution, and "as little as 1 to 4 dB of reduction in a narrow band centered around 3-5 kHz can be very effective" (Katz 2007, 142). Expanders work via a similar principle to compression, but to the opposite effect. When input signal gain is lower than a user-defined threshold, the expander causes audio to become quieter (Hodgson 2010, 212). In this way quiet segments become quieter and loud sections become louder, thus increasing the overall dynamic range. When applying expansion, it is important to work in small increments. If one does not slowly adjust expander settings, there is a risk of introducing artefacts or reducing ambience.

Figure 2.1 UAD's Cambridge EQ can be used to notch out offensive frequencies

Apart from manually removing noise via EQ and downward expansion, there are automatic tools available to engineers as well. Declickers (see Figure 2.02) and distortion removal software both do exactly what their names imply: remove clicks and distortion, respectively. If a declicker is applied too generously, the resulting sound may be distorted. This is particularly common in high frequency instruments such as the trumpet (Katz 2007, 143). Distortion removal software (sometimes called a decrackler or descratcher) works by replacing audible distortion with a fragment of the original sound in its non-distorted form.

Figure 2.02 The Weiss DNA-1 is a denoiser, declicker, and decrackler. It works without a fingerprint, and in real time.

De-noising solutions are not perfect, and must be used with caution. It is unlikely that any single noise-reduction approach will result in a satisfactory master. Rather, a combination of approaches is usually the most plausible solution. Engineers must be aware that de-noising can introduce new undesirable noises into a track. Such artefacts can include "comb-filtering, swishing or phasing noises (known semi-affectionately as *space monkeys*), [and] low level thumps and pops" (Katz 2007, 144). It is also common to lose important track information through de-noising. For example, reverb often slowly decays into that which may be interpreted as "noise" by a de-noising algorithm. De-noising also may potentially reduce high-end frequency response of a track (Katz 2007, 144). The presence of certain noises, especially high-end continuous noise such as hiss, can be perceived by the listener as intrinsic to the track's high-end frequency content. If this noise is removed, the overall psychoacoustic effect can be a diminution of perceived volume within the track. As managing loudness is an integral part of a mastering engineer's work, a drop in perceived volume could be undesirable. In this case it may be appropriate to use EQ to restore the lost frequency information. It must be stated, however, that certain tonal information will be lost and the overall sound character may change for better or worse.

Example 3: Denoising (resonance)
Example 3 features a track with an offensive resonance which must be removed. Notch filtering was employed to target the offending frequency at 600 Hz. The accompanying track contains, first, the audio with the offending resonance. At approximately 1 second into the track, I have isolated the noise in order to make it distinct. At approximately 5 seconds into the track I have applied notch filtering which entails utilizing single band equalization cuts.

Example 4: Denoising (crackle)
Example 4 demonstrates the sound of unwanted crackling within an audio track. An automatic decrackler was used, which employs a “thumbprint” of the undesirable noise in order to cancel the crackle via “spectral subtraction.” The noise has been removed approximately 15 seconds into the track, at the speed fade.

Bob Katz suggests the following order of operations when attempting to de-noise a track:

- First [treat] any tonal artefacts that stand out (eg. Hum, buzz) using a **simple or complex filter**, followed by
- **Declicking, first automatic, then manual** to deal with any remnants not caught by automatic declicking
- **Decrackling** (which can also remove some remnant clicks)
- **"de-distortioning"** [which may be the same as decrackling, depending on processors used]
- **broadband** denoising.
- Finally, overall program equalization, filtering, other processing if needed (Katz 2007, 146)

Harmonic Balance

EQ may be applied in a surgical manner, as explained in the previous section, or with a more global approach. Global equalizations refer those EQ manipulations which are intended to improve a track's spectral balance. Jay Hodgson (2010, 212) explains that many commercial masters feature a similar spectral balance:

> Specifically, most commercial records feature a flat, or almost flat, midrange from about 60 Hz to 2-8 kHz, which can be flanked on either side by surprisingly steep roll-offs. Rock, pop, jazz, and folk records, for instance, almost always feature what engineers call a "symphonic tonal balance." Tracks mastered for these markets typically present a more-or-less neutral (flat) midrange, flanked, on either side, by steep roll-offs, beginning at about 40-60 Hz and 3-7 kHz respectively.

It is up to the mastering engineer to decide how to treat an album's spectral balance, and must be approached in such a way that considers genre, listening formats, and listening

environment. Furthermore, global equalizations must be employed with the utmost care as certain elements may lose aesthetic appeal through engaging various cuts and boosts.

Example 5: Example of Symphonic Tonal Balance
Example 5 demonstrates what engineers refer to as a “symphonic tonal balance” versus a more neutral tonal balance. The first audio clip has been manipulated via EQ to achieve this neutral balance. The second clip has been manipulated via EQ to feature a flat or “neutral” mid-range with gain reductions at 60 Hz (and below) and 7kHz (and above). This captures the roll-off effect discussed above.

Bernie Grundman (in Owsinski 2008, 43) offers the following advice pertaining to spectral balance:

> *One of the things that is really hard is when the recording isn't uniform. What I mean by uniform is that all of the elements don't have a similar character in the frequency spectrum. In other words, if a whole bunch of elements are dull and then just a couple of elements are bright, then it's not uniform. And that's the hardest thing to EQ because sometimes you'll have just one element, like a hi-hat, that's nice and bright and crisp and clean, and everything else is muffled. That is a terrible situation because it's very hard to do anything with the rest of the recording without affecting the hi-hat.*

As most mastering efforts are global in scope, as opposed to the specificity and directness allowed by mixing, subtle adjustments to equipment tends to yield more aesthetically pleasing results.

To begin the equalization process, some engineers prefer to begin by examining a track's midrange frequency content in order to emphasize vocals. The 500 Hz-1kHz range is where most of the vocal's "thickness" resides, and around 3.5 kHz is where one can enhance vocal intelligibility (Gallagher 2008, 200). Engineers must be cautious when tampering with midrange frequencies as other important elements, such as guitars and snare drums, also reside in this range. Too much gain in the 2.5 kHz range may afford too much "harshness" to a track, for example.

Example 6: Harmonic Balance ("Muddiness")
Example 6 demonstrates how low end frequency content can be reduced to increase both perceived loudness and clarity. At approximately 29 seconds in, muddiness is reduced through the application of EQ to attenuate low end frequencies within the track.

High-end frequency content must also be addressed by the engineer. High frequencies demonstrate the highest propensity towards subjective loudness, in terms of psychoacoustic perception. For this reason, modern masters tend to sound very bright in order to maximize perceived volume. If a track does not sound sufficiently "bright," one can employ a harmonic exciter. Where EQ increases the gain of a particular frequency band, a harmonic exciter "boosts the harmonics of fundamental tones in the input spectrum, adding emphasis to only consonant high-frequencies" (Hodgson 2010, 215).

While engineers may, at times, accentuate midrange frequencies, there are times when a small attenuation in this area (ie. roughly 200 Hz to 2 kHz) may increase perceived loudness. The "smile-curve" approach to EQ is one example of this phenomenon. Human hearing tends to afford an emphasis to mid-range frequency content, even when this range is subdued. At louder volumes, however, midrange frequency content becomes less prominent to the human ear, and low and high frequencies become more prominent. Paul White (2003) explains, "our perceptual frequency curve changes at different levels…Low and high frequencies predominate over the midrange at high SPLs." This application of the smile curve is intended to simulate human hearing at a high volume (Hodgson 2010, 215).

Example 7: The smile curve
Example 7 demonstrates the equalization technique of applying a "smile curve." This smile curve was achieved by reducing gain in the 900 Hz to 1.7 kHz region, and applying slight boosts to both low end and high end frequencies. This change in EQ occurs approximately 3 seconds into the track.

Loudness/Compression

Mastering engineers are responsible for managing the perceived loudness of a recording. Integral to this process is dynamics processing (i.e. compression/limiting). Throughout the years records have progressively become louder, giving rise to what is referred to as the "loudness wars." Engineers are expected to treat commercial records in such a way that favours loudness over musical dynamics. This is due largely to the fact that, as Bob Katz explains, the louder of two records tends to sound "better" (Katz 2007, 168). The competitive practice of manufacturing loud albums, however, dates back to the 1950s (Owsinski 2008, 24). This practice continues today as current records are much louder than in the past. Records now, on average, are about +18 dbFS louder than in 1980 (Katz 2007, 168). As Ray Staff has pointed out, 0 dB has become a target rather than a warning on modern peak meters during mastering (Hepworth-Sawyer 2009, 251). Digital recording allows for peak normalization which makes the "target" of 0 dB easier to achieve. Utilizing a fuller peak in this way allows for a better signal-to-noise ratio, but also dramatically increases volume. In comparison to analog, Katz (2007, 169). explains,

> In the days of the LP, the variation in intrinsic loudness of pop recordings was much more consistent, perhaps within as little as 4 dB. Even at the peak of the vinyl loudness race, I could put on a Simon and Garfunkel LP, or even a Led Zeppelin, and follow that with an audiophile direct-to-disc recording, barely having to adjust the monitor control to satisfy my ears

The switch to digital recording, however, did not immediately result in frenzied experiments in loudness. The loudness of compact discs was initially more comparable to vinyl. Katz (2007, 169) continues,

> In the earliest days of compact disc, before the digital loudness race began, many mastering engineers would dub analog tapes with 0 VU set to -20 dBFS, and leave the headroom to the natural crest factor of the recording. It was not thought necessary to peak to full scale, and so the intrinsic loudness of early pop CDs was

> much more consistent. However, the inventors of the digital system abandoned the VU meter, which opened Pandora's Box. And so the average level began to move up and up.

Greg Milner identifies 1994 as the year in which "there was no turning back" concerning loudness wars, which hit fever-pitch in 1999. Some professionals called this "the year of the square wave," insinuating that albums are now mastered at such high volume that all dynamics are lost (Milner 2009, 280-81).

If digital recording systems all peak at full-scale (0 dBFS), the question must be asked: how does one make a recording sound louder? After all, certain genres require loud masters in order to be competitive. Mastering engineers increase loudness through compression techniques which increase average amplitude. Compression must be applied in such a way that a recording's peaks are reduced, allowing for extra "make-up" gain to be applied. This increase of the overall average amplitude translates to louder sounding records.

> To do this, [engineers] compress what they master, and then apply a generous amount of "make-up" gain. If engineers want to boost a track which already peaks at full scale (0 dBFS) for three more decibels of loudness, for instance, they must first compress its dynamic range by - 3 dBFS. Only then can they apply +3 dBFS of make-up gain and, in the process, raise its average amplitude by +3 dBFS. (Hodgson 2010, 218)

Example 8: Inboard compression, moderate
Example 8 has been treated with compression and "make-up" gain on an inboard application. Dynamics have not been lost as a result of using only moderate compression.

Example 9: Outboard compression, moderate
Example 9 has been treated with compression and “make-up” gain on an outboard application. Dynamics have not been lost as a result of using only moderate compression.

Example 10: Inboard compression, strong
Example 10 has been treated with compression and “make-up” gain on an inboard application. Perceived loudness is noticeably higher on this track.

Example 11: Outboard compression, strong
Example 11 has been treated with compression and “make-up” gain on an outboard application. Dynamics have not been lost as a result of using only moderate compression.

An engineer may be given a mix which, for example, features a loud snare drum. If the snare drum peaks too far above the rest of the waveform, and barring any Mid-Side work, a compressor will have to be applied in order to raise the average amplitude of the entire track. One viable approach to compression in this situation is to use fast "attack" and "release" times. This ensures that the compressor will attenuate the signal quickly, then "let go" of the signal quickly as well, allowing it to return to its normal state. Using a moderate compression ratio, such as 3:1, will cause the compressor (see Figure 2.03) to change the level of the signal 1 dB for every 3 dB of level change.[8] The overall effect of the compressed signal should be very subtle when auditioned against the original signal, due to the fast attack/release times and moderate compression ratio used. At this point, the mastering engineer is free to increase the gain on the compressor by +3 dB to make up for the 3 dB of lost dynamic range of the track. This will ensure that there is no clipping, as the peaks will have been reduced.

[8] To be clear, when concerning ratio settings, compression can both attenuate and increase signal level. Given this example, if we knew a track dropped by 3 dB at a given point, the compressor would increase the level by 1 dB. When using compression for the purpose of increasing average amplitude, as per the given example, engineers intend to attenuate the peaks of a signal.

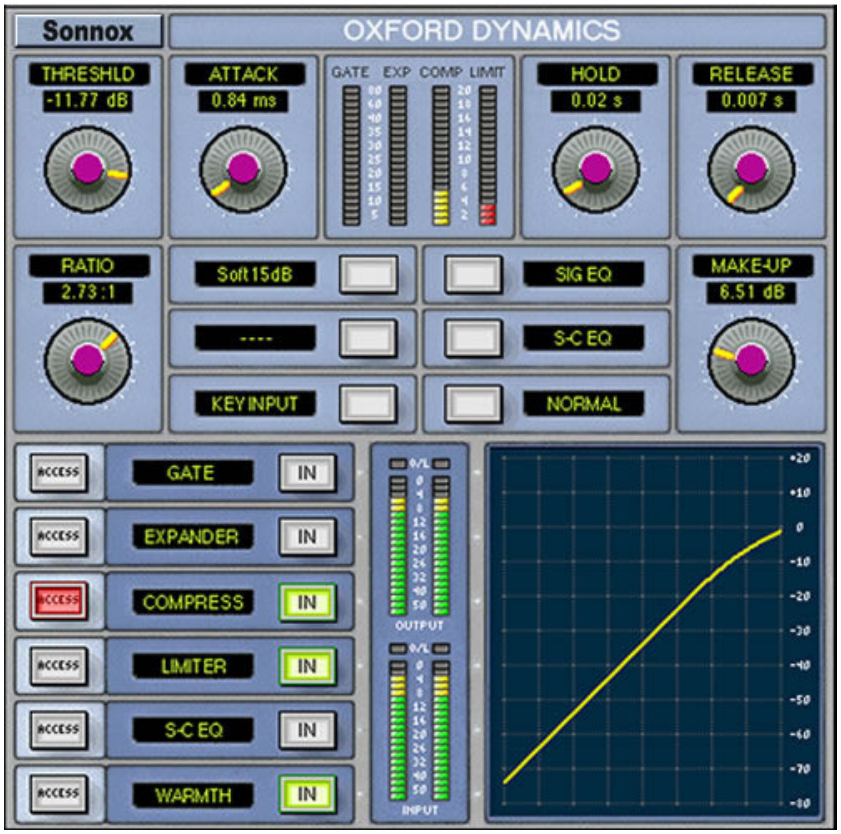

Figure 2.03. *Oxford Dynamics by Sonnox, a popular choice for in-the-box compression and limiting*

Another alternative for managing peaks is to use automation. By simply using a DAW's (Digital Audio Workspace) built-in volume automation, peaks can be controlled via reducing level at desired points. This could prove to be an arduous task for an entire album (or track) worth of material, especially if the offending element is a snare drum as per the previous example. In that particular case, an engineer would have to automate the track's level downwards every time the snare was present on the recording. Automation can, however, still be useful within a track or album which features a few prominent peaks. The engineer then has the option to apply compression in order to take care of any remaining peaks contained within the source material (Gallagher 2008, 211). Once peaks have been manually tamed, the engineer is free to increase the overall level of the track.

Clipping, while often avoided, is another technique which can increase the loudness of a track. Clipping must be used with discretion and is often genre specific. Most mastering engineers agree that clipping for less than 26 ms will not produce discernable distortion. That said, it is not uncommon in hip hop or house music to have clipping audible throughout. The album *Californication*, for example, by Red Hot Chili Peppers provides us with an example of audio clipping in the rock context. On clipping, Paul White (2003) explains:

> The final weapon in the guerrilla mastering arsenal is that of good old-fashioned clipping. Conventional wisdom has it that digital clipping should never be allowed, as it usually sounds awful, but it is equally true that short bursts of clipping can be tolerated without doing the audio any noticeable damage, simply because the events are too short for our ears to register as distortion. As a very general rule of even more general thumb, periods of clipping should be kept to under one millisecond (around 44 samples maximum at 44.1kHz sample rate) and if two or more periods of clipping follow each other in quick succession then the maximum period of clipping needs to be made shorter to prevent audible side effects. The only way to tell how much clipping you can get away with is to listen — and if you're lucky, your audio software will also warn you of clipping and tell you how many consecutive samples were clipped (White 2003).

Clipping must be used cautiously. Careless usage may result in records which are unlistenable due to over-distorting.

Example 12: Clipping
Example 12 features short sections of clipping in order to increase perceived loudness of the track. Clipping was induced through gain boosts used in tandem with compression (used to apply “make-up” gain).

Where clipping and peak limiting are undesirable due to the propensity for each technique to "colour" an audio track, parallel compression may be a valuable tool. Parallel compression works on the psychoacoustic principle that the ear is more forgiving of the upward compression of quiet passages than downward compression of loud passages (Katz 2007, 133). The basic approach of parallel compression is to mix a compressed signal with the original uncompressed signal. Katz identifies two types of parallel compression: transparent parallel compression and attitude parallel compression. The overall effect of transparent parallel compression can sound similar to using automation to manage loudness peaks. It also causes fewer tonal shifts and little-to-no loss of transient detail (Katz 2007, 134). Katz (2007, 133-4) recommends the following compressor settings for transparent parallel compression:

- Threshold: -50 dBFS
- Attack time: 1ms (less if possible)
- Ratio: 2:1 or 2.5:1
- Release time: 250-350 ms
- Crest factor: set to "peak"
- Output level/make-up gain: adjusted taste (subtle compression can be achieved between -15 through -5 dB)

Attitude parallel compression uses compressor settings which add "punch without damaging the loud peaks" (Katz 2007, 134). Mid-range frequency content tends to be accentuated through this compression style, which can be useful when mastering rock music. To achieve the extra punch that attitude parallel compression can produce, Katz (2007, 134) recommends the following compressor settings:

- Threshold: set to between 1-7 dB of gain reduction[9]
- Attack time: medium (start with 125 ms and adjust as necessary)
- Ratio: to taste
- Release time: set to work in tandem with the attack time
- Output level/make-up gain: to taste, rarely past -6 dB

Russ Hepworth-Sawyer also employs the parallel compression method as a staple in his practice. Interestingly, he avoids the use of outboard gear in the signal chain. He explains,

> *"I work completely in parallel. I begin by putting up two copies of the stereo file, and then phase-locking them. Multi band compression, and compression, just doesn't quite do what I need it to do, especially as the Loudness Wars become increasingly a nightmare. Using this parallel limiting technique is my way of trying to sneak loudness in through the back door. This way, I'm not interjecting compression into the music, but rather effecting only one of the channels. One channel will either be left alone, or in the case where I'll receive a track with only 2-3 dB of room between RMS and peak – which actually does happen- I'll use a decompressor which works sort of like an expander within Pyramix.*
> *The 4 total tracks, coming from 2 stereo tracks, are each merged into a left and right channel. From here I can effect or EQ each channel as required. Recently I worked on a project featuring a sax/guitar jazz duo. The sax was bleeding out of the right hand side -far too loud for the left channel- and I was able to EQ one instrument and not the other, adjust levels, etc in order to fix the balance.*
> *Next in the signal chain is an MS-encoder which is crucial for making the center image really pump or de-pump as required. You can also add sort of ethereal air to the sides, if you want to. From here, I have the option to send the signal out to other gear, but I don't tend to use a lot of analog kit. The ability to be able to recall presets easily makes digital equipment more crucial to how I work. I can work on more sessions in a day and go back and forth between different projects given the ability to store presets. As I mentioned earlier, it's nice to be able to go back to a project with a fresh set of ears."*

[9] This will be dependant on the track itself, and its intrinsic volume levels

Monitoring Practice

Each of the previously mentioned (non-administrative) tasks rely on the use of monitors. The most important criteria in monitor selection are frequency width and neutrality. If an engineer attempts to use a monitoring system which yields neither a flat nor wide frequency response, the resultant master may yield an unwanted frequency bias. Engineers such as Bob Katz explain the analogous relationship of monitors to microscopes as follows (2007, 83):

> The major goal of a professional mastering studio is to make subjective judgements as objectively as possible. What enables this to be done most successfully is the intelligent use of an accurate, high resolution monitoring system. A high resolution monitor system is the mastering engineer's audio microscope, the scientific tool which enables the subtle processing decisions required by the art.

Inaccurate speakers, or speakers which deliver a biased frequency response, will result in masters which compensate for said bias. If an inaccurate monitor set enacts a sharp peak at 1 kHz, for example, an engineer might use equalization to needlessly reduce this false midrange boost.

Inaccurate monitors (see Figure 2.04) do serve a purpose, however. It is common practice for engineers to use smaller speakers, or speakers with a limited frequency response, as a reference for "real world" listeners. Audiophiles with high quality stereo systems account for a small percentage of music listeners, therefore it is often crucial to reference with sub par speakers. Some engineers, such as Bob Ludwig (in Owsinski 2008, 19), forgo this practice explaining,

Figure 2.04. Yamaha NS10s are used for "real world" simulation

> One reason I've always tried to get the very best speaker I can is I've found that when something sounds really right on an accurate speaker, it tends to sound right on a wide variety of speakers. I've never been a big fan of trying to get things to sound right only on an NS-10M.

Katz agrees, conceding that real-world monitors should be used now-and-again to "double check" masters, rather than as a benchmark (Katz 2007, 86). Those engineers who use high resolution monitors (see Figure 2.05) exclusively (or nearly exclusively) argue that high resolution monitors provide balanced, neutral audio replication, thus providing a reference experience which is somewhat "average."[10] Many engineers, however, still prefer a system where both high resolution monitors and "real world" monitors are employed.

Figure 2.05. B&W 801D: an example of high end monitors for mastering

[10] I use "average" in a more colloquial sense here. Consumer music playback seems to occur primarily through headphones, clubs, cars, and home stereos, and neutral-calibrated monitors are believed to reference these diverse listening experiences in the most effective way.

Some mastering engineers have also begun to monitor with an additional subwoofer (see Figure 2.06), employing either a single or stereo pair. Subwoofers have become increasingly common in both audiophile and casual home-listening environments, as well as at live events. Using a stereo pair of subwoofers is said to replicate the ambience of a live event, where subwoofers are always placed on either side of a stage, thought it is rare for a mastering studio to have more than one subwoofer in operation at any given time (Owsinski 2008, 20).[11] It is common practice, after all, for engineers to place low end frequency content in mono, making stereo separation unnecessary in many cases.

Figure 2.06 The Wilson Watch Dog is an example of a high quality subwoofer.

[11] This is true of both rock and electronic/club venues.

Bobby Owskinski (2008, 20) gives the following advice concerning subwoofer placement:

- Place the subwoofer in the engineer's listening position behind the console
- Feed pink noise only into the subwoofer at the desired reference level. (Eight-five dB SPL should do it, but the level isn't critical)
- Walk around the room near your main monitor speakers until you find the spot where the bass is the loudest. That's the spot to place the sub. For more level, move it toward the back wall or corner, but be careful because this could provide a peak at only one frequency. You're looking for the smoothest response possible (which may not be possible without the aid of a qualified acoustic consultant).

Effects

Occasionally, mastering engineers will be called upon to add "effects," or non-transparent processing, to a track. A client may feel, for example, that there is less reverb present than necessary on the final copy of a master. Bob Ludwig explains that reverb can also assist in covering up difficult edits in order to make an engineer's touch more *invisible* (Owsinski 2008, 47). Another use for reverb is to give coherence to the imagined space of a track. The subtle application of reverb (see Figure 2.07) to an entir track can have a unifying effect (Gallagher 2008, 212).

Figure 2.07 This UAD reverb plug-in emulates the EMT-140, a plate reverb.

Mastering engineers occasionally take advantage of the Haas effect (see Example 9), which states that echoes which occur between 10-40 milliseconds after the original source are perceived to be fused with the source sound (Katz 2007, 234). If a recording was captured in a dead room with poor early reflections, the Haas effect can create an illusion of space which seems less artificial than longer reverb/echoes (past 40 milliseconds). If useful early reflections already exist within a track, units such as the TC Electronics VSS_4 feature a "decrease" function which minimizes the creation of synthetic early reflections (Katz 2007, 235).

Example 13: Haas Effect
Example 13 has been treated in order to simulate the Haas effect.

Reverb, if used at all, is applied late in the mastering process (post compression/limiting). It is generally undesirable to apply reverb before compression as compression can increase the volume of reverb dramatically.

Example 14: Reverb
Example 14 features the application of reverb. At 18 seconds into the track there is a speed fade followed by a passage with added reverb.

Stereo widening plug-ins may also be employed during the mastering process, such as the Waves S1 Imager (see Figure 2.08). These types of plug-ins work psycho-acoustically to affect one's sense of space within the stereo field. Engineers must be judicious with the application of stereo-widening plug-ins, or the resultant sound may cause unwanted phase-cancellation effects (Gallagher 2008, 214). Furthermore, hobbyists on online forums have found that stereo-widening can cause one's mix or master to sound accurate only in ideal listening environments. An ideal listening environment, in this case, would be any listening environment wherein equidistance between both the speakers and the listener is achieved, forming an equilateral triangle.

Figure 2.08. Waves S1 Stereo Image

Stereo-imaging effects can also work in tandem with EQ, compression and reverb. Mid-Side (MS) effects (see Figure 2.08) work by allowing engineers to alter the amplitude, equalization and dynamic range of either the center of the stereo image or the sides of a stereo image. In other words, MS effects allow engineers to apply EQ, compression, and reverb spatially through effecting the middle or side(s) stereo images *separately*. A mastering engineer could, for example, cause a vocal to sound more distinct within a mix by boosting the lower mid frequencies (or presence) in the M channel only. According to Bob Katz, this should cause the center vocal to be louder with less detriment to other instruments (Katz 2007, 212).

Example 16: Mid-Side Encoding
Example 16 demonstrates Mid-Side equalization through boosting all frequencies over 1 kHz in the side channels. The overall effect is greater perceived loudness due to increased mid and high frequencies. This change in MS EQ occurs approximately 3 seconds into the track.

Figure 2.09. iZotope's Ozone features both EQ and compression with Mid-Side capabilities

MS Compression (see Example 12) can be used judiciously to tame peaks within a mix. If instruments are competing with the lead vocal volume, an engineer could use MS compression to combat instrument levels at the sides of the stereo field. Similarly, MS Reverb (see Example 13) can satisfy clients who require more reverb added to the final master. If one was to apply more reverb to the M channel, for example, a song's

lead vocal would sound more reverberant. Alternatively, applying more reverb to the S channel would cause more reverb to be present on the instruments.

Example 17: MS Compression
Example 17 uses Mid-Side encoding to compress the side channels. The change occurs approximately 3 seconds in. The overall effect is less dramatic than applying direct compression.

Example 18: MS EQ
Example 18 features the application of Mid-Side EQ in order to bring out transient detail in the side channels. The application of MS EQ occurs at approximately 3 seconds.

Case Study

"Get Ready" by Domsky

Example 19: Original Mix
Example 19 is an "unmastered" mix Domsky's track entitled "Get Ready." There is a noticeable lack of volume, punch, transient detail, and low end frequency content in this example. The proceeding examples attempt to shape "Get Ready" into a genre-competitive master.

Example 20: Master 1
Example 20 features 1 of 4 "in-the-box" masters of "Get Ready." While noticeably louder than the original mix, this master is the quietest of the 4. Increased transient detail can be heard, especially in the side channels. Mid-side compression and EQ were used almost exclusively, with the addition of an Oxford Limiter.

Example 21: Master 2
Example 21 was mastered via the same method as Master 1 with increased midrange and slightly less low end.

Example 22: Master 3
Example 22 is an “unmastered” mix of Domsky’s track entitled “Get Ready.” There is a noticeable lack of volume, punch, transient detail, and low end in this version of the track. Each of the following audio examples feature strategies which intend to make the track genre competitive.

Example 23: Master 4
Example 23 is the loudest of the 4 masters. This was achieved by using extra compression and “make-up” volume.

Example 24: Outboard Master 1
Example 24 was mastered using a nickel based transformer on an outboard preamp. The nickel preamp results in a sound which is both punchy and abundant with low end frequency content.

Example 25: Outboard Master 2
Example 25 was mastered using a steel based transformer. The resultant sound is less aggressive than the nickel master.

Example 26: Outboard Master 3
Example 26 was mastered using the discrete op-amp setting. The resultant master is slightly quieter than the others, and exhibits a more even harmonic balance.

CHAPTER THREE

MASTERING AND AUTHORSHIP

An understanding of the mastering process can enrich current viewpoints concerning authorship in popular music. The record-making process is integral to the aesthetic of popular music, and constitutes much of its creative labour (Gracyk 1995, xiv). However, even the most fundamental recording techniques are absent from most musicological research. Recording practice is, in fact, musical technique. It is a mastering engineer's duty to apply his or her final authorial input before a CD undergoes duplication.[12] In this chapter, I intend to explore the authorial role of the mastering engineer by (a) first demonstrating how recording practice constitutes musical communication, (b) briefly exploring the role of the author drawing from interdisciplinary criticism, and (c) positing some of the creative actions of the mastering engineer as co-authorial in scope.

In fact, detailed studies on recording practice may be scarce within musicological research due to a confusion of text versus context. Brackett (1995, 18) explains, in the past, musicologists were understood to study "texts," where sociologists were thought to study "contexts". This divide between musicology and sociology became less clear as some musicologists began to consider how context may shape, and shape our understanding of, text. Even still, text (musical score) is most often afforded separate consideration from its contextual situation.

[12] Barthes might argue that the listener is the final author, but in this case I am simply referring to the mastering engineer as the final authorial input on a project before duplication occurs.

As Recording Practice begins to figure more prominently in musicological study, researchers are faced with a challenging question: do the particulars of recording practice constitute text or something other than text?[13] A great deal of research examines contextual elements of recording in popular music,[14] and yet others examine only notatable elements of a recording (i.e., pitch relations, song forms, etc), but the processes and aesthetic regimes employed by recordists themselves are either absent or treated in a cursory manor in the vast majority of research.

For pop music, given its implicit connection to recording media, "notation-centric" approaches to textual analysis are incomplete. Analytic frameworks built around standard notational practice tend to favour complex pitch relations over other musical qualities such as timbre (Brackett 1995, 28). When applied to popular music, this type of analytic model often fails to account for the idiom's complexities. Part of the reason for this deficiency is a difference in compositional intent and creative media: axiomatically, classical composers write scores, and pop musicians make records. Moreover, recorded classical performances are designed to communicate transparency, creating the illusion of an unmediated document of a performance. Thus, notation-based analytic frameworks are

---

[13] Brackett's study does not propose an answer to this question. The particulars of recording practice are noticeably absent from his proposed analytic frameworks.

[14] Doyle, Peter. 2005. *Echo And Reverb: Fabricating Space in Popular Music Recording, 1900-1960* ; Frith, Simon. 1996. *Performing Rites: On the Value of Popular Music*.; Barker and Taylor. 2007. *Faking it: The Quest for Authenticity in Popular Music*; Walser, Robert. 1993. *Running with the Devil: Power, Gender, and Madness in Heavy Metal;* Waksman, Steve. 2009. *This Ain't the Summer of Love :Conflict and Crossover in Heavy Metal and Punk*; Szatmary, David P. 1996. *Rockin' in Time: A Social History of Rock and Roll*; Frith, Simon, et al. 1993. *Sound and Vision*; Purcell, Natalie J. 2003. *Death Metal Music :The Passion and Politics of a Subculture*; Weinstein, Deena. 2000. *Heavy Metal :The Music and its Culture*; Frith, Simon. 1978. *The Sociology of Rock;* Brackett, David. 1995. *Interpreting Popular Music*; Sterne, Jonathan. 2003. *The Audible Past: Cultural Origins of Sound Reproduction*; Jones, Steve. 1992. *Rock Formation: Music, Technology, and Mass Communication*; McRobbie and Frith. 1978. *Rock and Sexuality*; Waksman, Steve. 2001. *The Instruments of Desire: The Electric Guitar and the Shaping of Musical Experience.* 2009. *This Ain't the Summer of Love: Conflict and Crossover in Heavy Metal and Punk*; Brackett, David. 2005. *The Pop, Rock and Soul Reader*: *Histories and Debates*; Moore, Allan. 2001. *Rock: The Primary Text. Developing a Musicology of Rock*

of more use in studying classical music, as the score is often intended as the principal musical product to be interpreted throughout time by different performers. Furthermore, classical music favours harmonic complexity, lending itself to analysis by notational means. While analyses of popular music which favour musical notation are certainly not useless, they do lack sufficient depth to deal with the genre's complexities. Bracket explains, "modern popular music, which circulates primarily in recorded form, seems unsuited to analytical methods that stress spatial metaphors rather than temporal ones, and that favour visual methods as opposed to aural ones" (Brackett 1995, 24). Analyses which allow for the consideration of the intricacies of the aesthetics of Recording Practice fulfill both of these requirements.[15]

Analysis which considers the aesthetics of recording practice effectively expands the definition of pop music's "texts" to include timbral detail as it exists within temporal space via recording media. Examining popular songs through this lens allows one to rightly consider recording practice as a musical practice. While analysts commonly agree that timbre –as affected via recording technique- is a crucial component of popular music, it is rarely afforded sufficient importance and attention by researchers.[16]

---

[16] Newer pop timbral studies are beginning to emerge, as seen in the following: Brown, Jake. 2009. *Rick Rubin: In the Studio* ; Doyle, Peter. 2005. *Echo And Reverb: Fabricating Space in Popular Music Recording*, 1900-1960 ; Jones, Steve. 1992. *Rock Formation: Music, Technology, and Mass Communication.* ; Millard,Andre 2005. *America On Record: A History Of Recorded Sound* ; Moorefield, Virgil. 2005. *The Produceras Composer: Shaping Sounds of Popular Music* ; Simons, David. 2004. *Studio Stories: How The GreatNew York Records Were Made* ; Sterne, Jonathan. 2003 *The Audible Past: Cultural Origins of SoundReproduction.* ; Thompson, Daniel. 2005. *Understanding Audio ;* Wadhams, Wayne. *2001 Inside the Hits:The Seduction of a Rock and Roll Generation* ; Warner, Timothy. 2003. *Pop Music Technology andCreativity* ; Zak, Albin. 2001, *The Poetics of Rock.*

The Renaissance Ideal and Auteur Theory

An understanding of recording technique as a form of musical/creative communication complicates current beliefs concerning the authorship of popular music. Conventional conceptions of authorship and artistry are now linked closely with Renaissance era ideals, where artists are afforded an elevated status due to perceived superior intellect or divine inspiration (Wolff 1993, 26). Marketing often works to ensure that *the artist* (or occasionally the producer) remains an album's focal point, elevating *the artist* (or producer) as a "genius". Other creative labourers involved in record-making are typically relegated to the status of "hired-hand" technician, and are not afforded any entitlement to the "authorship" of a recording both in law and in popular discourse.

This Renaissance tendency to assign genius status to "serious" artists exists not only in popular music, but also in cinema. Francois Truffaut's 1954 article, "A Certain Tendency of the French Cinema" reads as a manifesto for what is colloquially known as the *auteur* theory.[17] Film criticism based on this theory usually posits a film's director at the helm of meaning and importance, and intends to elevate his or her work above both society and other films. It is also an exclusive framework, allowing only for the discussion of directors decided upon by other film critics. This type of criticism was also an attempt to elevate film aesthetics towards being a "serious" art, worthy of critical attention (Grant 2008, 1). During the peak years of *auteur* criticism, a director's personal style was believed to take precedent over a film's content. A bad or trivial plot, for example, can be overlooked in favour of an *auteur*'s overall style and technique (Grant

[17] Some seminal articles concerning *auteur* theory include: Truffaut, Francois. 1954. "A Certain Tendency of the French Cinema;" Bazin, Andre. 1957. "De la Politique des Auteurs;" Cameron, Ian. 1962 "Films, Directors and Critics;" Sarris, Andrew. 1962. "Notes on the Auteur Theory;" Kael, Pauline. 1963. "Circles and Squares." Wollen, Peter. 1969. "The Auteur Theory." Wood, Robin. 1977. "Ideology, genre, Auteur."

2008, 3). Furthermore, it was often insinuated that a "bad" *auteur* film is better than a good film by a non-*auteur*.

This all said, auteur theory remains controversial in film criticism. Critic Pauline Kael's (in Grant 2008, 47) objections to *auteur* criticism were many, for instance, but the most applicable of these to the current topic runs as follows: films are collaborative projects, and no single "author" deserves full credit for a film's success or failure. Kael's contribution to film criticism in opposing auteur theory is important, however Barry Keith Grant (2008, 5) writes,

> Because of its usefulness in understanding and appreciating the role and function of artistic expression in contemporary mass media, the auteur approach has also been applied convincingly to artists in other forms of popular culture such as television and popular music, and it has become one of the paradigms for how consumers think about works of popular culture in all media.

In other words, while *auteur* criticism may be limited in scope, its popular resonance is far-reaching. Music criticism is guilty of frequently placing producers at the locus of a work's creative genius. Much has been written about Phil Spector, George Martin, Phil Ramone, Sam Phillips, Berry Gordy, and other "legendary" producers. Applying Kael's influential assertion that collaborative works have multiple authors to music analysis, however, allows for a model which can include the consideration and criticism of recordists as well as artists and producers. After all, recordists are largely responsible for album's timbre insofar as recording practice constitutes musical technique.

The creative contributions of the mastering engineer's authorial input do not go unnoticed by listeners. However, few people are trained to discern exactly what mastering engineers contribute to a recording. As outlined in Chapter 2, some tasks are purely administrative (logging, PQ codes, quality control), others are creative (managing

loudness, spectral balancing), and some are technical (de-noising, phase alignment). Mastering engineers often work closely with artists to ensure their aesthetic goals are achieved. Russ Hepworth Sawyer explains,

> *In the first phase of my approach, I can get a pretty good master fairly quick. I send this preliminary master to the client and say "This is what we have so far, what do you think?" I take their comments into consideration, because I don't want to be miles away from what the client intends. This allows me to correct my approach before wasting loads of money and time down the road.*

The goal of such an approach is to satisfy the artistic needs of the client. A mastering engineer's artistic responsibilities are crucial for analysis as they constitute the last authorial step prior to an album's release, especially insofar as his or her contributions work vis-à-vis genre considerations.

Frequency balance must be adjusted by mastering engineers to suit both an employer's needs and genre norms. Midrange frequencies tend to pose difficulty due to their complexity in relation to human hearing. Scooping midrange towards 3.5 kHz, for example, may cause a track to lose vocal intelligibility. Given that most popular music is vocal centric, this may be a poor aesthetic choice. There are cases however, such as second wave black metal, which prefer a lack of energy in the vocal intelligibility range. Dramatic boosts in a mix's midrange, on the other hand, may result in inappropriately loud electric guitars and snare drum. Furthermore, the resultant sound may be louder from a psychoacoustic perspective as humans tend to privilege midrange sounds over low and high frequency sounds. This effect is employed on punk records to enhance the aggressive aesthetic of the genre (Hodgson 2010, 213). High frequencies, when enhanced either via EQ or excitation, can dramatically alter a track's perceived loudness (2010, 214). In doing so, however, engineers must be careful insofar as this frequency range can

contain a number of harsh sounding objects. Transient detail, for example, is located in the high frequency range and has a high potential for damaging hearing if exacerbated. Bright-sounding masters, however, are commonly released and are prevalent in a number of genres, including Nashville-style releases (including rock, country, contemporary Christian). Reductions in brightness, on the other hand, are commonly found in trip-hop and reggae masters, as well as in dub and underground hip hop.[18] Interestingly, in genres where roll-offs are prevalent in higher frequencies, bass boosts are also common (Hodgson 2010, 213). This occurs in many EDM genres and is *de rigueur* in dub-step and electro house.

A master's perceived loudness is another creative endeavour undertaken vis-à-vis the consideration of genre. Increasing loudness is achieved via compression/limiting, as explained in Chapter 2, and can severely reduce an album's dynamic range.

Loud masters, despite sounding less dynamic, can be desirable for certain genres. Pop/rock albums released towards the middle and end of the 1990s (and onward) are severely compressed and comparatively louder than records of the past, averaging 4 dBFS less in dynamic range than noticeably compressed masters by the likes of the Beatles, Motown, and others. Dance music is notorious for its exorbitant loudness, to the point of distortion. Hip hop shares this tendency as well. A number of other genres, on the other hand, reject this trend. Genres which are still acoustically oriented, such as folk and jazz, tend to favour more dynamic (and thus quiet) masters. Either way, it is the Mastering engineer's task alone to determine dynamic range. Some genres require both loudness and dynamics, such as commercial rock records. It is up to the mastering

[18] Underground hip hop including Jedi Mind Tricks, Hieroglyphics, Del tha Funkee Homosapien, Army of the Pharaohs

engineer to correctly choose an approach to managing loudness which satisfies the aesthetic needs of his or her client.

Summary

A mastering engineer's work is crucial in achieving the aesthetic goals of a recording. Far more than just a technician, the mastering engineer is a creative partner in the creation of recorded musical communications. A master's spectral balance and loudness remain largely the purview of mastering engineers, in fact. As the final step in audio processing, mastering engineers have the ability to completely reshape a mix as they see fit. Kael's admonition against singular *auteur* criticism is particularly insightful here as it encourages the analysis of co-collaborators aesthetic contributions to a given project. In this way, mastering engineers can be afforded authorship status, as well as other creative labourers.

CHAPTER FOUR

FUTURE DIRECTIONS

Having established the authorial significance of the mastering engineer as a creative labourer through examining his/her work processes, I see a number of future directions for continued study of this authorial agency. Those who research issues in digital labour may find the preceding study engaging insofar as it begins to clarify the role of the mastering engineer in creating musical communication. Given the vital importance of mastering to all records, perhaps this study may be useful to those interested in adjusting the compensatory schema, in fact.

The cultural ramifications of re-mastering may also be a worthwhile lacuna for examination. If mastering can be equated with authorship, what exactly might it mean to *re*-author a piece? An interdisciplinary study drawing from available scholarship concerning popular film might be telling here, or perhaps even film re-mastering for enhanced colour and overall fidelity.[19] Furthermore, how might a re-master relate to a remix or cover version of a song? These questions could be addressed through further study, which must include an examination of appropriate musical technique.[20]

On the technical side, mastering for surround sound applications and vinyl are two areas which are increasingly popular amongst mastering engineers. Surround sound masters are particularly susceptible to noise issues and require sensitive ears to ensure audio clarity. Issues concerning frequency and spatial balance are also a delicate matter in

[19] Films are routinely remastered to suit current demands for HD, an example being *Blade Runner* (Scott, 1982)

[20] As suggested in earlier chapters, audile technique as it applies to music embodies *musical* practice rather than simply *technical*.

surround mastering. Given the desired effect of surround sound to create a heightened sense of space, an unbalanced master can ruin the overall aesthetic character of records.

While 5.1 (and above) surround sound is a relatively new format, vinyl is not. Vinyl mastering today, however, combines old processes with new processes. While certain tasks remain unchanged in vinyl masters, considerations must be made for the current *loudness* climate and fidelity demands placed on mastering engineers. A future study of the vinyl master could thus provide an even clearer picture of the cultural and technical issues mastering engineers must negotiate as they apply their trade.

Another consideration for future study is how mixing is informed by the mastering process. Mastering engineers mostly prefer to avoid mixing, Russ Hepworth - Sawyer being exemplary in this case:

> *I try to stay away from mixing music. While I'm very happy to master in-the-box, I prefer not to mix in-the-box. The mix-advice service that I offer helps because I can advise clients to create a mix that translates well to the mastering stage.*

Although mastering must occur after mixing, professional mix engineers remain cognizant of the mastering process while they are mixing. Russ Hepworth-Sawyer's mix advice service demonstrates the need for mix engineers to design mixes which translate to mastering. For example, professional mix engineers will avoid over-compressing audio tracks. Audio which is too compressed is difficult to work with and can interfere with an engineer's ability to craft an aesthetically appropriate master. Mix engineers must also consider harmonic balance. Given a mix in which low-end frequency content is overly dominant, mastering engineers cannot manipulate loudness as effectively without first applying EQ. This issue must also be considered when mastering vinyl, as the presence of overbearing low-end frequencies on a record will cause one's turntable needle to "jump

the groove." If a mastering engineer is forced to attenuate these frequencies, it is possible that important aesthetic programming will be lost. Concerning mixing, another area for consideration might be how stem mastering blurs the lines between mastering and mixing. Many engineers are against stem mixing for this reason. Russ Hepworth-Sawyer explains, "I try to avoid mastering with stems all together, because mastering stems blurs the lines between mixing and mastering."

The aesthetic power of mastering must also be considered in terms of generic convention. The current study features examples of genre-competitive mastering techniques. However, a less cursory examination of how mastering is informed by genre norms is warranted. Encoded within these auditory conventions are important cultural reflections. Some guiding questions might include:

- How does clipping factor aesthetically in Hip Hop? Why must artists insist that their records sound slightly distorted over loud speakers and headphones alike?

- Why, despite a fetishization of power/loudness, do many heavy metal records exhibit less subjectively loud volume levels than electro records?

- How does mastering factor into audiophile culture? Electro and dubstep fan subcultures exhibit elitist tendencies through prioritizing high resolution records with ultra-wide-band frequency content. Examples can be seen of fans comparing masters of their favourite artists on hobbyist forums, where spectral diagrams are posted to verify audio resolution.

The pervasive scope of audio mastering allows, through study of its particulars, research that provides a more comprehensive accounting of musical aesthetics. If mastering is understood to be musically communicative in-and-of-itself, there are a number of generic and cultural avenues that subsequently open up for exploration. The mastering engineer's labour must not go unnoticed if we are to strive towards a

comprehensive understanding of Recording Practice in general and popular music practice in particular.

INTERVIEW

MASTERING ENGINEER RUSS HEPWORTH-SAWYER

Q: How did you begin mastering?

A: *Actually, I've had no formal training to be honest. I used to work part time at London College of Music for around 20 years, and during that time the studio manager acquired a SADiE rig –which was probably running on a 486. The album I was recording at the time clearly needed more treatment, so I sat down and mucked around on this SADiE rig for a few days and got a bit of a flavour for mastering.*

Later on, the studio I was using at the time bought a TC Electronics Finalizer and I spent a lot of time – probably too much – trying to figure out how to make this tiny box do the things I wanted it to do. I started mixing and mastering at the same time – which I certainly would not recommend to anyone these days – running anywhere from 30-70 tracks into the Finalizer. We would find that, for example, the mastering process might make the vocal quieter, so we would alter it from the (analog) board and send it back through the Finalizer. It was certainly an unorthodox way of working, but it taught me a great deal about the interaction between mix and master. Working this way also taught me how the levels coming from a mix interact with primitive outboard [AD] converters – although the TC converters are pretty good despite being 16 bit– where the analog board has the capacity to hold +20dB of head room, and I want the signal to sit around -3dB to make sure that the Finalizer does not distort. Learning this way was sort of a baptism by fire.

After taking a teaching job for 6 years, I decided to found MOTTO (http://www.mottosound.co.uk/). I took the plunge and bought Pyramix, after already having a room and monitors from the recording work I had done.

Q: Why is mastering considered to be a "dark art," and why is it so widely misunderstood?

A: *I don't know that mastering is necessarily misunderstood, but I do believe people face it with questions such as:*

> *"Do [engineers] really do that much?"*
>
> *"How important is it?"*

From my perspective, I don't really see mastering as a dark art. If Ray Staff was here, he may have a different perspective because he has, for example, learned how to cut vinyl from scratch and is the only person to have cut 2.5 sides from one piece of vinyl as far as I'm aware. That takes utter skill, and he is a true craftsman. To me, that's where the "dark art" of mastering lies: trying to make things as loud as possible on vinyl without breaking the head and without breaking people's needles.

Over the last 20 or 30 years mastering has become a craft of a different kind. It's now a creative practice rather than a process of simply changing from one format to another. Originally, the mastering engineer oversaw the process of transferring audio from tape to vinyl, and was expected to make sure that nothing went wrong. They did, however, have

to change the tonality of the recording in order to transfer effectively. Now, one goes to a mastering engineer for different purposes, which encompass a wide array of things we have to do now in order to make sure the album sounds good.

Q: I've had material mastered in the past where, despite being a group of experienced professionals, we had very little understanding of the mastering process. As a result, we were left with a less-than-impressive sounding master. What do you do to work with clients in achieving a master which satisfies their aesthetic needs?

A: *We all have bad days, and we don't always get it right. I made a decision early on with Motto to deal with clients in a very different way. I prefer a cooperative approach using one price structure, which is not based on time. I'll work at the same job until the client is satisfied. Occasionally I'll receive a project with a tight deadline, but I prefer to have the breathing room to revisit a mix or master. Once you go back to a mix with fresh ears, it sometimes takes on a different character. In* <u>*What is Music Production*</u> *we talk about this type of micro-listening, and listening "switches." I recently spent a year mastering one artist's album because it was remixed so frequently. We put the time in, and now it's a really smashing album which is what really matters. I like my clients to feel like they have a partner in my ears.*

Q: What is your general approach to the work flow of mastering audio?

A: *There are two ways of looking at mastering. There is the Bob Katz way of looking at things, where you can never be too careful, and you can never overdo the administrative elements of mastering. I always begin with administrative tasks, and give clients a locked spreadsheet where they fill in necessary information. The client has to acquire the UPC and ISRC codes to being.*

From here, I use a phased approach. I implemented this approach based on a technical limitation of Pyramix. The early version I was using did not allow the use of VST plug-ins. Rather, this version favoured Pyramix native plug-ins which are incredibly expensive. All I could do was add VST software to the end of my signal chain, which is not particularly useful. So I began to use Pyramix at the beginning to work with the master until I thought it was close. And as with mixing, it doesn't take long to craft the audio into something which sounds close to what you want. I call this concept the mix mountain, where towards the end of the mixing stage there is a steep incline which takes a lot of work to overcome. Mastering is the same way. So I would work first in Pyramix, then move to a VST-friendly environment for the next phase.

In the first phase, I can get a pretty good master fairly quick. I send this preliminary master to the client and say "This is what we have so far, what do you think?" I take their comments into consideration, because I don't want to be miles away from what the client intends. This allows me to correct my approach before wasting loads of money and time down the road.

Assuming that phase one passes, I move to phase 2 and begin to use the appropriate VSTs. It's a little unconventional, but for me it works quite well. From this point I simply do more administrative work: ddp files, cds, etc.

Q: What sort of technical processes do you employ in your own mastering practice?

A: *I work completely in parallel. I begin by putting up two copies of the stereo file, and then phase-locking them. Multi band compression, and compression, just doesn't quite do what I need it to do, especially as the Loudness Wars become increasingly a nightmare. Using this parallel limiting technique is my way of trying to sneak loudness in through the back door. This way, I'm not interjecting compression into the music, but rather effecting only one of the channels. One channel will either be left alone, or in the case where I'll receive a track with only 2-3 dB of room between RMS and peak – which actually does happen – I'll use a decompressor which works sort of like an expander within Pyramix.*

The 4 total tracks, coming from 2 stereo tracks, are each merged into a left and right channel. From here I can effect or EQ each channel as required. Recently I worked on a project featuring a sax/guitar jazz duo. The sax was bleeding out of the right hand side – far too loud for the left channel – and I was able to EQ one instrument and not the other, adjust levels, etc in order to fix the balance.

Next in the signal chain is an MS-encoder which is crucial for making the center image really pump or de-pump as required. You can also add sort of ethereal air to the sides, if you want to. From here, I have the option to send the signal out to other gear, but I don't tend to use a lot of analog kit. The ability to be able to recall presets easily makes digital equipment more crucial to how I work. I can work on more sessions in a day and go back and forth between different projects given the ability to store presets. As I mentioned earlier, it's nice to be able to go back to a project with a fresh set of ears.

Q: It's often difficult to get clients to sign off on one particular level of perceived loudness for a master. What is your approach in dealing with client needs?

A: *With the phased approach that I use, clients have the opportunity to let me know if they want a louder master. Sometimes, clients will get a phase 1 reference track and feel like nothing else needs to be done. Ultimately, the decision is theirs, although sometimes I'll suggest we keep working with it because the master isn't even close to being finished. Occasionally during phase 2 the client might only request a louder master, which is fine by me.*

I've been sent mixes before that are so loud that I can't facilitate lifting during the chorus. I spent days on one particular track and couldn't quite get it where I would have liked it to be, but you can't win them all. At least with my phased approach to mastering,

I can give clients an idea of how much louder a track could be. After phase 1, I can bring in a VST like one of the Oxford plug-ins to increase loudness.

I communicate with clients via email, as I've found it just works. What you might find with other mastering services is that you send them a mix which they master, but then you will never hear from them. For myself, I prefer to communicate with the client via email or phone. I also offer a mix advice service, which I can't claim to have invented. I find that here in the North most of our work comes from mostly from more underground artists who are extremely passionate and want to make their music as good as possible – although I also work with more successful artists as well. The mix advice service exists for those who embrace the DIY process, but want to have certain elements done professionally.

I try to stay away from mixing music. While I'm very happy to master in-the-box, I prefer not to mix in-the-box. The mix-advice service that I offer helps because I can advise clients to create a mix that translates well to the mastering stage. I try to avoid mastering with stems all together, because mastering stems blurs the lines between mixing and mastering.

WORKS CONSULTED AND CITED

Anderton, C., 2004. Audio Mastering In Your Computer. [Online] SOS Publications Group Available at: http://www.soundonsound.com/sos/aug04/articles/computermastering.htm [Accessed April 2011]

Anderton, C., 2009. Speakers Meet Mastering. [Online] New Bay Media, LLC Available at: http://www.eqmag.com/article/speakers-meet-mastering/may-06/19978 [Accessed April 2011]

Auld, R., 2008. Mastering Then and Now. The history of mastering and whether we should pursue it ourselves. [Online] Music Maker Online LLC Available at: http://www.recordingmag.com/resources/resourceDetail/109.html [Accessed April 2011]

Bassal, D., 2005. The Practice of Mastering - 1 : History. [Online] MacMusic Available at: http://www.macmusic.org/articles/view.php/lang/en/id/91/The-Practice-of-Mastering-1-History [Accessed April 2011]

Bassal, D., 2005. The Practice of Mastering - 1 : History. [Online] MacMusic Available at: http://www.macmusic.org/articles/view.php/lang/en/id/91/The-Practice-of-Mastering-1-History [Accessed April 2011]

Bazil, E., 2009. Sound *Equalization Tips And Tricks*. 1st ed. Norfolk: PC Publishing

Bazin, Andre, 1957. "De la Politique des Auteurs." In Auteurs and Authorship, Barry K. Grant, Oxford: Blackwell, 2008.

Brackett, David, 1995. *Interpreting Popular Music*. Cambridge University Press.

Bregitzer, L., 2009. *Secrets of Recording-Professional Tips, Tools & Techniques*. Ist ed. Oxford: Elsevier

Cameron, Ian. 2008 "Films, Directors and Critics." In Auteurs and Authorship, Barry K. Grant, Oxford: Blackwell.

Case, Alexander. 2007. *Sound FX: Unlocking the Creative Potential of Recording Studio* Effects. Oxford: Focal Press.

Chambers, P., 2009. Inside the dark art of mastering. [Online] Resident Advisor Ltd Available at: http://www.residentadvisor.net/feature.aspx?1007 [Accessed April 2011]

Clynes, M. *Music, mind, and brain: The neuropsychology of music*. N.p.: Plenum Pub Corp, 1982.

Cook, Nicholas. 2009. “Methods for Analysing Recordings”. In Cambridge Companion to Recorded Music, eds. Nicholas Cook, Eric Clarke, Daniel Leech-Wilkinson, and

Cook, Perry R. *Music, cognition, and computerized sound: an introduction to psychoacoustics*. N.p.: MIT Press, 2001.

Covach, John. 1997. “We Won’t Get Fooled Again: Rock Music and Musical Analysis”. In Theory Only 13: 119-141.

Cuniberti, J., 2008. Mastering-the last creative process in the chain. [Online] Available at: http://www.johncuniberti.com/mastering/ [Accessed April 2011]

Deva, Chaitanya B. *Psychoacoustics of Music and Speech*. N.p.: Music Academy, 1967.

Domain, D., 2010. Mastering Engineers Discuss Compression and Mixing. [Online] Digital Domain Available at: http://www.digido.com/mastering-engineers-discusscompression-and-mixing.html [Accessed April 2011]

Doyle, Peter. 2005 *Echo and Reverb: Fabricating Space in Popular Music Recording 1900-1960*. Middletown, CT: Wesleyan University Press.

Gallagher, M., 2008. *Mastering Music at Home*. 1st ed. Boston: Thomson Course Technology PTR.

Garvey, C., 2006. Interview with mastering engineer David Else of Digital Media Duplication. [Online] AAA Music ltd Available at: http://www.a3music.co.uk/ Interviews/mastering_interview.html [Accessed April 2011]

Gibson, David. 2005. *The Art of Mixing*, Second Edition. Boston: Artist Pro Publishing.

Gracyk, Theodore. 1996. *Rhythm and Noise: An Aesthetics of Rock*. London: Duke University Press.

Grant, Barry K. 2008. *Auteurs and Authorship*. Oxford: Blackwell Publishing.

Hodgson, J., 2010. *Understanding Records: A Field Guide to Recording Practice*. 1st ed. New York: Continuum International Publishing Group Ltd

Howard, David, and Jamie Angus. 1998. *Acoustics and Psychoacoustics*. New York: Focal Press.

Kael, Pauline. “Circles and Squares.” In Auteurs and Authorship, Barry K. Grant, Oxford: Blackwell, 2008.

Katz, B., 2007. *Mastering Audio: the Art and the Science*. 2nd ed. Oxford: Focus Press

Kealy, Edward R. 2006 “From Craft to Art: The Case of Sound Mixers and Popular Music.” On Record: Rock, Pop and the Written Word. ed. Simon Frith and Andrew Goodwin. London: Routledge.

Levitin, D.J., 2006. *This is Your Brain on Music- The Science of a Human Obsession*. 1st ed. London: Penguin Group. Longhurst, B., 1995. Popular Music & Society. 1st ed. Cambridge: Polity Press

Milner, G., 2009. *Perfecting Sound Forever: The Story of Recorded Music*. 1st ed. London: Granta Publications

Mixing, A.M.a., 2010. Facts, Tips, and Q&A About Us and Our Audio Mastering Process. [Online] Audio Mastering and Mixing Available at: http://www.audio-masteringmixing.com/FAQ___Q_A.html [Accessed April 2011]

Moore, Allan. 2003. *Analyzing Popular Music* . New York: Cambridge University Press.

Moorefield, Virgil. 2005. *The Producer as Composer: Shaping the Sounds of Popular Music* .Cambridge, Mas.: MIT.

Moulton, D., 2008. What's Mastering All About? The basic tools and techniques of the trade. [Online] Music Maker Online LLC Available at: http:// www.recordingmag.com/resources/resourceDetail/112.html [Accessed April 2011]

Moylan, William. 2007. *Understanding and Crafting the Mix: The Art of Recording,* 2nd Edition. Boston: Focal Press.

Mueske, S., 2010. Ten Questions with Mastering Engineer Greg Reierson. [Online] Songstuff Available at: http://recording.songstuff.com/articles.php?selected=154 [Accessed April 2011]

Owsinski, B. 2008. *The Mastering Engineer's Handbook*. 2nd ed. Boston: Thomson Course Technology PTR.

Sarris, Andrew. “Notes on the Auteur Theory.” In Auteurs and Authorship, Barry K. Grant, Oxford: Blackwell, 2008.

Sterne, Jonathan. 2001. *The Audible Past: Cultural Origins of Sound Reproduction*. New York: Routledge.

Truffaut, Francois. "A certain Tendency of the French Cinema." In Auteurs and Authorship, Barry K. Grant, Oxford: Blackwell, 2008.

Wolff, Janet. 1981. *The Social Production of Art*. 2nd ed. New York: New York University Press.

Wollen, Peter. "The Auteur Theory." In Auteurs and Authorship, Barry K. Grant, Oxford: Blackwell, 2008.

Wood, Robin. "Ideology, genre, Auteur." In Auteurs and Authorship, Barry K. Grant, Oxford: Blackwell, 2008.

Zagorski-Thomas, Simon. 2007 "The Musicology of Record Production." Twentieth Century Music . 4 : 189-207.

Zak, Albin. *The Poetics of Rock: Cutting Tracks, Making Records*. Berkeley: University of California Press, 2001.

VITA

Name:	Matt Shelvock
Post-secondary Education and Degrees:	The University of Western Ontario London, Ontario, Canada 2006-2010 B.A. 2010-2012 M.A.
Related Work Experience:	Teaching Assistant The University of Western Ontario

Publications:

Shelvock, Matt. (July 2011). "Interview with Josh Leo". Journal on the Art of Record Production