



BOOK REVIEW

Katz "The Master's Class"

By David J. Weinberg

Regardless of music genre, creating an album involves several technical steps—recording, mixing, and mastering. Renowned mastering engineer Bob Katz (Digital Domain; www.digido.com) has written a book for audio professionals that should be mandatory for all who will ever do any or all of these things; those who design and build hardware and software for music's creation and playback.

Katz maintains that "the mastering studio is the place where experience in the musical art is combined with the science of audio, but the dividing line between art and science is nebulous, so my book constantly tries to integrate the art and the science. [It] is designed to help you learn to make informed decisions on your own; how audio equipment works, and what happens when you turn the knobs."

His book, *Mastering Audio: The Art and the Science* (Focal Press; www.FocalPress.com; 2002; ISBN 0-240-80545-3; \$40) is a masterful tutorial in using science to create and support art.

Of the three steps I mentioned at the beginning, Katz concentrates on mastering, which includes many of the same considerations, techniques, and technologies used in mixing, with added emphasis on assuring optimum performance from the final product.

Roger Nichols says it best in the Foreword: "What places this book head and shoulders above the rest is the attention to useful detail. Instead of hyperbole, the reader can actually put these methods to good use. The descriptions of how to perform a task are augmented with the reason that you should perform the task. [For example:] Not just how downward compressors work, but when and why you would want to use them. Science is meaningless without art."

Nichols suggests that "limiters and compressors should be treated just like firearms. There should be guides for proper use, and classes you must take before you can own one. That class is here in this book. After you read this "audio firearms manual" you will have a much better understanding of the mastering process. You will know when and how to use these tools yourself and when to leave it to the professional."

Katz sprinkles the text with maxims, for example: "Mastering is the art of compromise. . . the first principle of mastering is: Every action affects everything else" and "making good sound is like preparing good food. If you overcook, it loses its taste." A bit facile, perhaps, but the catchy phrases will help novices keep the concepts in mind.

He quotes Glenn Meadows, another mastering expert, who emphasizes the greater importance of the operator than the equipment: "There is no magic silver bullet. There is no one magic anything that will be "best" in all situations. The ability of the operator to determine what it is that needs to be done and pick the best combination of tools is more important than what tools are used."

Katz elaborates: "The truth is that in a typical mastering session, each tool makes only an incremental improvement, and the final result comes from the synergistic totality of the tools working together. In these days of mass-gear-marketing by competitive manufacturers there is too much emphasis on the glitz, fashion and style of the gear rather than on its sound quality and principles of operation. While this book is definitely for gearheads, serious engineers who want to improve their techniques will also find out how their devices function. Audio principles never go out of style, but models of gear will always

fade away."

This text clearly teaches the complexity involved in mastering and how this process can substantially affect an album's musical impact.

Chapter 3. "An Earientation Session: Ear training is really mind training because the appreciation of sound is a learned experience." Katz provides a frequency chart on which he has marked the scale with terms describing various sound affectations, such as "muddy" (~160-225Hz), "nasal" (~750-1.3kHz), "sibilant" (~3-9kHz). He describes a series of ear-training exercises that can be performed easily with minimal equipment, reminding the reader to "take the opportunity to experience the sound of live unamplified music... Surprisingly, some engineer/artists don't know what uncompressed, natural-sounding audio sounds like. While more and more music is created in the control room, I think it's good to learn how to capture natural sound before moving into the abstract. Picasso was a creative genius, but he approached his art systematically, first mastering the natural plastic arts before moving into his cubist period. Similarly, it's good practice to know the real sound of instruments."

A foldout is enclosed of E.J. Quinby's famous 1941 Carnegie Hall "Musical Pitch Relation Chart—Showing Compass of Fundamentals." Over an axis of 109 piano keys (from nine notes below A1 to 12 notes above C8), the frequency of each key is listed, as are the approximate frequency ranges covered by the fundamental notes of singers and orchestral instruments. At the bottom of the chart are musical notation staves, with each C drawn in. There is much more information in this chart; its study is well worth your time.

Chapter 4. Wordlengths and Dither: This chapter presents the best all-around

explanation I've read on dither: what it is, why it is important, and how to use it properly and effectively to maximize sonic quality. Katz tells why it is necessary for DSP used in mixing, editing, and mastering to work with many more bits than the wordlength used in the original recording and the final product. "Each individual decimal place may seem insignificant, but DSPs require repeated precision calculations to perform filtering, equalization, and compression, and the end number may not resemble the right product at all unless adequate precision is maintained. Remember, the more precision, the cleaner your digital audio will sound in the end (up to a reasonable limit)." The spectral graphics in the color plate section show clearly why higher-precision math is required for intermediate signal processing.

Chapter 18. High Sample Rates: Katz considers the requirements and advantages of higher sampling rates, particularly as they benefit the sound of a lower-sample-rate final product, like the CD. Though not placed adjacent to Chapter 4, the subjects of these two chapters are related.

Chapter 5. Decibels for Dummies: Katz is clear in his conviction, well-supported by rational explanations and experiments, that many measurements of equipment performance do not correlate with sonic performance. Level meters with dB scales have been misused since they were invented, especially in the migration from average-reading meters for analog recordings to peak-reading meters for digital recordings. Meters have changed from having a limited, though inaccurate, relationship to loudness, to merely ensuring the recording medium isn't overdriven. One example: "Some mastering engineers deliberately severely clip the signal, and then drop the level slightly, so that the meters will not show any OVERs. This practice, known as SHRED, produces very fatiguing (and potentially boringly similar) recordings." Katz advises that when interconnecting studio equipment, nominal level, clip level, and noise floor need to be balanced to prevent unnecessary loss of sound quality.

Chapter 6. Monitoring: "The major goal of a professional mastering studio is to make subjective judgments as objectively as possible. [A key to this accomplishment is] the intelligent use of an accurate, high-resolution monitoring system. . . The mastering engineer's monitor system is an

audio microscope."

*****Katz's theme: Make the master sound as good as possible on a high quality home audio system, and it will almost always also sound fine in a car, on radio, from boomboxes, and even over the Internet. This is an improvement over an older, mass-market practice, in which some recordings would have their dynamics deliberately altered to optimize the listening experience in a noisy, frequency-limited environment such as a car. With the passing of AM radio as a music source and marketing engine, the older practice is not as useful as it once was.

Chapters 9, 10, and 11. How to Manipulate Dynamic Range for Fun and Profit: "It's not how loud you make it. It's how you make it loud." He explains the effect of various compressors and limiters typically used in attempts to make the recording sound louder, pointing out that the result is often not as effective as intended, and results in unwanted side effects.

At the other end of the level spectrum, "What distinguishes a good noise-reduction job from a bad one?—Good taste. The engineer must continually retain perspective, because the more noise removed, the more noise revealed (noise itself masks other noise below it)! It's like peeling the layers of an onion. If you remove some crackle from the right channel, suddenly you may hear some tics which were not previously audible in the left. In all cases, careful comparison between the source and the processed product is necessary to ensure that the music has not been damaged."

Katz has found that the differences among monitoring systems and their setup have been instrumental in the sound quality disparity found among today's CDs. He is also of the opinion that those recording, mixing, and mastering these CDs have been paying far too much attention to the technology, and not enough to the music: "In the 20th century we concentrated on the medium. In the 21st century, we should concentrate on the message."

Chapters 14 and 15. How to Make Better Recordings in the 21st Century: "Calibrated monitors are the critical tools of the 21st century audio engineer." Katz makes his case for calibrating the mixing and mastering engineers' monitoring systems to a standard level, recommending SMPTE RP 200 ("Relative and Absolute

Sound Pressure Levels for Motion-Picture Multi-channel Sound Systems—Applicable for Analog Photographic Film Audio, Digital Photographic Film Audio and D-Cinema") as the guide. Experiments he and other respected practitioners have conducted, in which level adjustments were made without looking at the meters, consistently resulted in levels that are consistent with the specifications in RP 200. This will temper the widely diverse levels found on recent releases, and help alleviate the variations in bass response that come from mixing/mastering at different levels, since human sensitivity to bass changes dramatically with monitoring level, resulting in different EQ.

The ideal monitoring level is the orthotelephonic reference condition: the playback level is identical to that which would be heard by the listener in the selected location at the "live" event, such as Boston's Symphony Hall seat N22 for a BSO concert, if that is what the producer and recordist want to reproduce or create. To provide an obvious example, a harpsichord is much quieter than a brass band, and each should be monitored, mixed, and EQ'd at its respective orthotelephonic level if the result is to sound the way it does "live." This will aid in maintaining lifelike perceived frequency balance across disparate recordings.

Humans also suffer from listener fatigue, especially at high levels, that results in changes in our perception as we work on a project. This will lead to a change in the sound from the beginning to the end of the album, or possibly even the song. Katz points out that no meters accurately correlate with our hearing, so meter value changes do not match how much we perceive the sound to have changed. "Because of the big difference between typical metering systems and our perception, two pieces of music that measure the same on an SPL or VU meter can have drastically different loudness, depending on many factors including transient and frequency response, and the duration of the sound."

Katz presents his K-system metering and monitoring proposal "that integrates the best concepts of the past with current psychoacoustic knowledge in order to avoid the chaos of the last twenty years." It is based on a metering system calibrated such that 0dB with a mid-frequency sine wave yields a reference loudness from the

monitoring system, and provides a predictable amount of headroom. Using his system should make recording levels and quality more consistent and predictable.

Chapter 16. Analog and Digital Processing: Katz explains “the fallacy of typical weighting curves” such as A or C weighting, which when used for measurements “do not correlate with what our ears tell us.” He suggests considering the F-curve, “a 9th-order curve used by some of the best-sounding dithers.”

“Cheap digital equipment is subject to edgy sounding distortion which can be caused by sharp filters, low sample rates, poor conversion technology, low resolution (short wordlength), poor analog stages, jitter, improper dither, clock leakage in analog stages due to bad circuit board design and many others, such as placing A/D and D/A converters inside the same chassis with motors and spinning heads. It takes superior power supply and shielding design to make an integrated digital tape recorder that sounds good.”

This book points out that while bits are bits, there are great, sound-altering variations among digital-audio hardware and software used in recording, mixing, mastering, and playback. Katz explains these differences, citing why they exist, and how they affect sound.

Chapter 17. How to Achieve Depth and Dimension in Recording, Mixing and Mastering: Katz addresses acoustics, psychoacoustics, plus microphone selection and technique. “I placed this acoustics lesson in the middle of a book on mastering because the creation of wonderful audio masters requires that some basic acoustic principles be understood. As we enter the era of surround recording and reproduction, many mix engineers are repeating their mistakes from two-channel work—panpotting mono instruments to discrete locations, and then adding multiple layers of uncorrelated stereophonic reverb “wash” in a vain and misguided attempt to create space and depth. . . I’ve been making “naturalistic” two-channel recordings for many years taking advantage of room acoustics, but it is also possible to use artificial means to simulate depth. . .”

He prefers to use instrument placement in a room, combined with specific mike techniques, to put the instrument in its proper space, but will also artificially employ the “Haas effect, delays and alteration

of phase, more naturalistic reverberators, and understanding how to unmask via placement.” Another technique is to adjust frequency response to simulate depth, taking advantage of the apparent attenuation of an instrument’s high frequencies with increasing distance.

Microphone placement will have a substantial effect on perception of orchestra depth. For example, if the mike is placed over the orchestra, the sound will have less depth than if it is close to the front of the orchestra. As the mike is moved back in the hall, the sense of depth decreases, as the ratio of distance from the mike to the front versus the back of the orchestra decreases. Katz discusses directivity of instruments, the influence of hall characteristics, various mike techniques including multi-miking, even the influence of the control room. He recommends several commercial recordings to demonstrate various effects.

Chapter 19. Jitter—Separating the Myths from the Mysteries: Katz presents a clear explanation of jitter and its effect on sound quality, including a special section, “Jitter, When it Matters, and When it Doesn’t.”

“There is no jitter on a storage medium.” There is also no jitter in digital processing, since the data is not being clocked, each data value is being arithmetically manipulated irrespective of time.

Katz provides several real-world examples in support of his conclusions, which include the need for careful selection of A/D and D/A converters, the importance of the clock controlling the converters, and how it impacts the sound: “Remember: audio processors process data, not clock. If they hear a difference, it is because a cleaner clock is passed to the D/A converter; but there is no difference in the data being processed;” and “Jitter usually becomes meaningful in a digital mix only during monitoring, when the data is clocked out of a D/A converter.” He also describes various digital audio interfaces, along with several clock systems’ strengths and weaknesses.

He explains why and how measurements conflict with perception; for example: “Traditional audio signal-to-noise ratio measurements have (almost) no relationship to the sound of a converter when it is receiving signal. . . Most signal-to-noise measurements quoted in manuals are therefore irrelevant, and most people have

never heard true 20-bit performance, let alone 24.”

Chapter 21. Education, Education, Education: This is perhaps the most important chapter, as it emphasizes the need for both formal and experiential continuing education—always work toward improving your knowledge, understanding, and skills. Sources of additional information are in **Appendix 10.** Recommended Reading, CDs for Equipment Testing and Ear Training.

CONCLUSION

Mastering Audio’s contents are substantively dense, and of exceptional pragmatic value. Throughout the book Katz explains why some audio truths are self-evident, while others are pure myth. It is important to read the footnotes as an addition to the text, because they contain information that is just as valuable.

Katz’s writing style is direct, with little superfluous content, which results in an engaging read—I didn’t want to stop, except when I felt I had ingested so much that I needed time to process it, within his, and my, context of trying to produce recordings that sound, as much as possible, like live performances (without unwarranted amplification).

His working process and techniques are representative of the best in his profession. We can hope that more individuals involved in recording, mixing, and mastering will adopt and adhere to the principles and procedures that guide his work, so we can enjoy an increasing number of great recordings that sound natural and musical on high quality playback systems, rather than abusively processed for maximum sales to boombox listeners and iPod users.

I could write much more about this book, and still not do it justice. Everyone—those who create music and albums, design music-related hardware and software, and audiophiles—will learn from reading Katz’s *Mastering Audio*, gaining an understanding of the difficulties involved in the task, and the decisions behind the sounds we like and don’t like. **aX**

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