Audio Metering – Measurements, Standards, and Practice (2nd Edition)
Eddy Bøgh Brixen

Some book reviews just about write themselves. Pick the highlights from the table of contents, make a few comments about each, and that's it. Unfortunately, this book isn't one of those. The author recommends reading it cover-to-cover and I did, but it took me more than a month. This isn't a book that you can't put down. There's a lot of technical material packed into its 264 pages and much of it, though it isn't heavy with equations, is about as exciting as reading a math textbook. I know that doesn't sound very encouraging this early in the review, but to be honest, that thought ran through my head all the while I was reading through the book. But stick with me here. It's really better than that.

Audio Metering covers a wide range of topics that range far beyond meters and metering. "Audio Measurements" would be a more descriptive title, but it goes even beyond that. The book is arranged with basic topics in the earliest chapters, with the more descriptive material covered in about the last third of the book. It starts with the fundamentals of sound and its perception, which gives a hint that the measurement of level and loudness will be covered in depth, which indeed it is. While it doesn't have the breadth and depth of Dave Moulton's Total Recording, the two books represent a similar approach to gaining an overall understanding of the basics of sound, hearing, and perception. Ignoring or misunderstanding the fundamental principles of sound can result in incorrect interpretation of measurements, and this, I believe, is the reasoning behind the broad scope of material covered.

The author begins with an introduction to acoustic sound, how electrical signals represent and convey acoustic sounds, and the relationship between frequency, wavelength, and velocity. A brief introduction to the digital representation of audio provides background for the relationship between digital and analog metering, which is covered later in the book.

Because audio measurements are closely tied to what and how we hear, there's a detailed description of the human hearing and vocal mechanisms, We're introduced to the sound characteristics of musical instruments and the human voice, which leads into a discussion of complex waveforms, spectrum, sound power and energy, and how time affects our perception of loudness and pitch. The author does a fairly thorough job of explaining psychoacoustic effects such as masking both by frequency and time relationships, and that we perceive peaks and dips in frequency response differently. While these subjects have little to do directly with audio measurement, understanding the concepts helps to explain why what we measure doesn't always correlate with what we hear.

The first hundred or so pages is basically reference material. It's really dry reading, and honestly, though Audio Metering is well indexed and has a

comprehensive glossary, these days most of us would go to Google or some other on-line search if we sought an explanation of the overtone structure of the sound of a violin or the formula for calculating gain in dB. I feel obligated to point out, though, that on-line information is sometimes incomplete, inaccurate, or just plain wrong. Fortunately, I didn't find any glaring errors in the factual information presented in the book, so you can count on what you read here.

Audio level meters (VU and PPM) are ubiquitous in studios and broadcast facilities. Most of us use and misuse them without really knowing what they're measuring. A solid grounding the characteristics and standards behind these audio level meters is important in understanding how they can best be used and when and how a meter's indication can be misleading.

The VU meter is introduced in its classic form in which an in-line attenuator is used to make the meter read 0 VU, and the line level is read from the attenuator scale. Today's reader might find this confusing since (as the author points out further on) today we use a VU meter differently, not to give us a number that represents a power level, but rather to show us visually when we're in the right ballpark. Today's VU meters no longer indicate power, but rather how close the metered signal is to an ideal system level. The historical background discussion of the VU meter hints at one of the book's flaws – that the theoretical presentations don't always lead to practical applications. I concur that history and underlying theory is important, but that the book would be more valuable to most readers if theory was more clearly related to practice.

By about a third of the way through the book, I got the clue that one of the author's primary goals was to give a solid background to the understanding and measurement of both physical (sound pressure level - SPL) and perceived (often thought of as annoyance) audio loudness. With recently developed standards and some pending legislation, loudness is a hot topic these days with much attention given to abrupt loudness changes in broadcast and theater (including home theater) audio. For the last 75 years or so, we were content to describe loudness in terms of SPL, usually weighted to compensate for the sensitivity of the ear, however today we have more complex measurement techniques and ways of expressing loudness that more closely correlate with how we hear. This appears to me to be where the meat of this book lies, and where it will be most valuable to those who have the need to make or interpret such measurements.

The material covered in the chapter on loudness measurement was mostly new to me and I found it most educational. Here, the author addresses meters developed specifically to make measurements based on recently published standards (ITU-R BS.1771 in 2006 and EBU R 128 in 2010) which are still being argued over and tweaked by the standards organizations. Although the terminology and principles upon which these measurements are based is defined in earlier chapters, I found it to be a pretty tough read for a couple of reasons. First (and this was a common niggle throughout the book), the illustrations aren't

closely coordinated with the text and I was constantly searching for the figure that illustrated the text. Figures are numbered, but the figure numbers aren't always referenced in the text, nor are illustrations, which in this chapter primarily meter scales and displays, located on the same page as their text descriptions. Many of these new loudness meters don't use a pointer on a scale, but rather, display their measurement results graphically on a screen that often employs color as a display parameter. All of the figures, however, are in black and white (probably to reduce publication cost – color printing isn't cheap). More numerical examples relating the input signal to the displayed data would have been welcome in this section, as would annotation of the various sections of the display shown in the figures. In order to fully comprehend this chapter, I had to cheat and look at a copy of the manual for the TC Electronic LM5 loudness meter (one of the examples used in the book) on the web.

One example where the book could better address a common misunderstanding is with the relationshio between analog and digital meter scales. There's a chapter that touches on this subject that frequently confuses newcomers to digital recording – what "zero" on each meter represents. The author addresses the fact that zero on a VU meter is a nominal operating level while zero on a digital meter represents the maximum possible level, but he skips over the concept of headroom, though the word is found in the glossary. Most people quickly "get it" when they understand that in the analog world, you have a certain amount of headroom over 0, while in the digital world, you can make as much headroom as you want, but that amount is subtracted from 0. The author would have my undying gratitude if he saved me from making that explanation a few more times. (OK, I have an article about it on my own web page). There are tables comparing some of the more common analog and digital meter scales and their nominal reference levels, but the novice is less concerned with the 2 dB difference between SMPTE and EBU reference levels than between 0 on his mixer's meter and –16 or –20 on the DAW's meter.

Phase and polarity are often misunderstood, and the author doesn't clearly differentiate between the two, that polarity is absolute but phase is time related. His description of the audio vector oscilloscope is useful since DAW programs often include such a display, however figure numbers in this section are erroneously referenced in the following section about the spectral phase display. The illustrations for spectral phase measurement are explained only in their captions, not in the paragraph text, and the lack of color makes their interpretation nearly impossible. That's a pity because several DAWs offer this type of display and it's value is often overlooked simply because interpretation of the display can be confusing.

The chapter on surround metering follows in the same vein – there are details about various surround encoding methods, some screen shots of the DK "jellyfish" display, but the text offers little guidance in interpreting the display to recognize problems. I could go on with specific criticisms, but I'll stop here. I think

you get the idea. Most of the pictures associated with metering and meters are neither worth, nor are supplemented by, the proverbial thousand words. More words or better pictures are really needed to tell the whole story.

The author devotes a chapter to the practical subject of where and how to connect a meter, but he takes a lengthy side trip to discuss measurements where balanced and unbalanced inputs and outputs are interconnected. He makes the common error of using the term “balanced” when he’s describing a bipolar source or differential input, but this mis-usage has become so common that I’ll give him a pass. The discussion of connecting a digital meter is similarly obscure. It’s not clear what instruments the author is talking about or why an AES/EBU router, master word clock, sample rate conversion, or digital audio networking discussed in this section has any relevance. There’s an excellent reference, however, to the complete word structure of the AES 3 digital audio format.

The author makes a few profound (and I mean this in a good way) statements. This one is perhaps the most quote-worthy one in the book, so I’ll quote it (which will also give you an example of his writing style):

“Monitoring audio is of course not only a question of using visual displays. Listening is just as important – at least! So it is very practical to establish a relation between reading and the listening level. Further, it is important that the monitoring levels of speakers or headphones are well defined in order to mix for the right balance and keep levels from damaging hearing.

“Regardless the type of signal distributed, analog or digital, a monitor controller with a built-in meter that is set to a reference listening level is an excellent device in all installations. Experience shows that less attention has to be paid to the visual meter when the engineer or editor is confident with the listening level.”

I’ve often expressed a similar sentiment in my writings.

When considered as a reference source, the book is nicely conceived. Each chapter begins with topic headings in outline format, making it easy to scan a chapter to see if what you’re seeking can be found there. There’s a good index and a useful glossary, about half of which is acronyms.

If I was the managing editor for this book, I would ask the author to scale back the scope and enhance the theoretical details with practical examples of related measurement tools, procedures, calculations, and data interpretation, to give the reader a better understanding of what a particular measurement can offer in terms of improving sound, diagnosing a problem, or avoiding a pitfall. Since Audio Metering is strong on theory and background, I think it would make an excellent companion to a course in audio measurements where practical applications could be covered by lecture and demonstration in a classroom and lab.

When I review a book, I try to figure out just what kind of person would get the most benefit from reading it. This one is more about definitions and theory than what a practicing studio engineer normally needs, or even could be expected to remember. I found myself, when reading a chapter, recalling that I had learned that many years ago, but had forgotten it because I hadn't needed to apply the information. Since the scope is so broad, there's bound to be something useful here for nearly anyone working in the audio field, but also much that simply won't be absorbed from a single reading.

There are plenty of other books and web resources (including others from the publisher, Focal Press) that offer as good a background in the fundamentals as Brixen's, but for those of us looking for what's behind generic terms such as "loudness," the answers are here. I can't really recommend reading this book cover to cover, but rather to skim through it, pick out and read topics that are of particular interest, and keep it handy for when Google doesn't quite tell you what you need to know about an audio parameter or measurement.

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