

Metallica, Music & Mead:

Interview with Mead Killion PhD Oct, 2008
Founder, Etymotic Research, Inc.
<http://www.etymotic.com>

By: Douglas L. Beck, AuD
Board Certified in Audiology
Web Content Editor
American Academy of Audiology

Beck: Good Morning Mead. Thanks for meeting with me.

Killion: Hi Doug. No problem. Glad to spend some time together.

Beck: Mead, several weeks ago, I was reading the Wall Street Journal (September 25, 2008) and on the front page, just below the crease, was an article titled "Even Heavy Metal Fans Complain That Today's Music Is Too Loud!!!" and the Wall Street Journal actually used three exclamation points. I started to read the article and it was quite interesting. The first thing that struck me was that Metallica sold 827 thousand albums in two weeks and I immediately thought "I'm in the wrong business." But then I thought, OK, so why on earth would Metallica fans complain about the recording being too loud? I thought, "I need to ask Mead about this." So let's start with - When did you buy your first Metallica album?

Killion: Well, actually, Doug, I'm a little more interested in jazz and classical.

Beck: Aaah, that's right. Sorry. Well then, please tell me what's happened to audio recordings with respect to loudness and dynamic range?

Killion: OK, well, that's a much better question. Of course there are many types of compression, and the compression circuits used in hearing aids represent only some of those. Much more can be done in audio recordings, where real-time operation is not required: A fast mains-operated computer can crunch away for quite a while on each minute of recorded music if necessary.

Compression was first used by advertisers in radio and television in the 1940s and 1950s. After the program, the announcer or the commercial would start, and those commercials could sometimes be twice as loud as the program. There were a variety of tricks employed to make the commercials stand out. In fact, the advertisers were very clever as they created techniques that could increase the perception of loudness while staying inside the overload limit of the transmitter, thus avoiding peak clipping and distortion. So these electronic tricks do increase loudness, and in fairly creative ways.

Beck: And I am quite sure that's still done in 2008 across the world. For instance, it seems that if I watch a program on cable TV or listen to radio, when the commercials come along, they almost always appear louder than the program itself. Is that just my aversion to commercials, or is that accurate?

Killion: Yes, it's really occurring. The audio signal is intentionally boosted. Some of the broadcast material itself is also processed, so the news cast itself may have a greater punch, too. Too be fair, there are now rules to limit the amount of extra boost

you can put in commercials, but they are hard to enforce.

Beck: You mean like baseball broadcasts? I know there are some idiosyncrasies there.

Killion: That's a great example. Baseball broadcasts use a distinctive very-fast-acting compression limiting that keeps the loudness near maximum and also quickly increases the gain each time the announcer pauses so the excitement of the crowd noise is brought up almost instantly to fill that void. This is presumably done to keep it interesting and to keep pulling the audience into the event.
In essence, the broadcaster and the crowd are presented to the listeners at the same loudness. And none of that is done to enhance sound quality!

Beck: Do some stations use special audio treatment all the time?

Killion: Absolutely. In fact, I recall an Audio Engineering Society paper many years ago that reported it was possible to identify various Chicago radio stations from the "spectral signature" of their sound. Each used a different combination of bass boost, midband "presence" boost and and/or treble boost.

Beck: So basically, the signal of interest, whether it be Metallica, the news or sports broadcast, or the commercial is often actually highly compressed, which ruins the overall dynamics, but the overall RMS playback perception and physical reality is overall increased loudness, i.e., the extra "punch" ?

Killion: Yes, that's a good way to think about it. If we take a vowel such as the /ee/ sound, it can have a "peak factor" of some 12 to 14 dB, depending on who speaks the vowel. If you broadcast that sound, or you're making a recording of that sound on an old vinyl record or a new CD, you can make the vowel twice as loud before the needle jumps out of the groove by shifting the phase of each harmonic so they don't pile up on top of each other. That is only one of the tricks that can be used.

Beck: The peak factor: Is that the difference between the instantaneous amplitude peak and the long term, or average root mean square (RMS) amplitude?

Killion: Yes. If you monitor the output of a microphone on both an rms meter and an oscilloscope, a meter reading of 10 mV rms overall could appear on the oscilloscope as a 50 mV peak on each glottal pulse, using our example of the /ee/ vowel. So if the goal is to make the recording louder while not distorting the sound of the original, appropriate phase shifting can be your friend.

Beck: Interesting engineering; does it mean anything?

Killion: Yes indeed.
Using phase shift alone (which does not audibly change the sound quality), you might be able reduce the peak factor by 10 dB in an extreme example. This means you could increase the recorded rms level by 10 dB (twice as loud) without "hitting the rails" (the limits of the recording and playback equipment). In the case of juke boxes, your CD will cut through the background noise much better than an unprocessed recording. And it will sound louder on the radio if the engineer doesn't turn it down.

Beck: Listeners can hear the two Metallica recordings for themselves?

Killion: Yes <http://online.wsj.com/article/SB122228767729272339.html> contains Ethan Smiths

complete Wall Street Journal article and you can click on the recordings to hear them.

Just for fun, I asked Gary Khan of Pegasus Recording in Chicago to process one of my favorite George Shearing and Mel Torme passages to increase loudness.

Accompanying this interview are short examples of "Loud" processing:

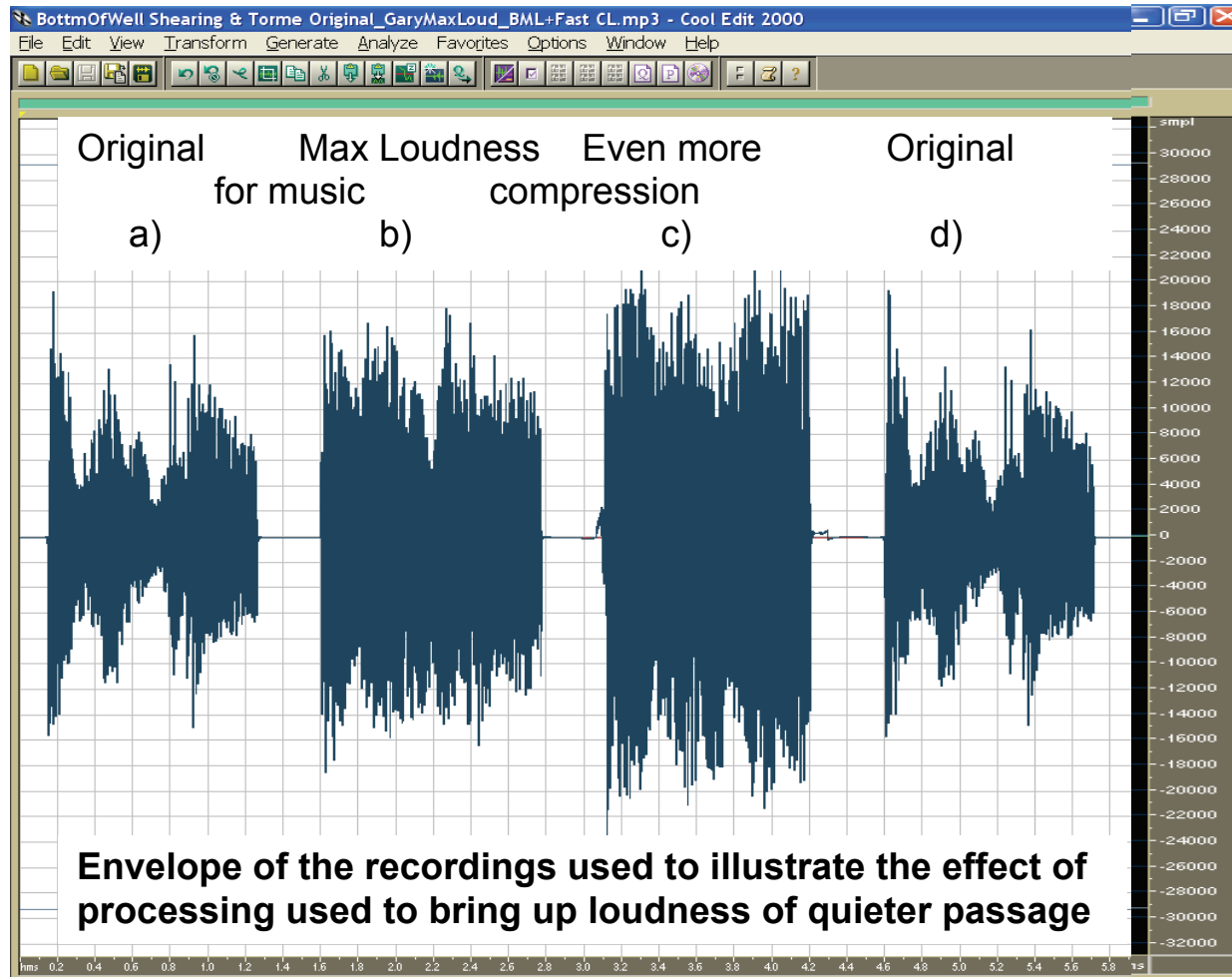
==>These can be played by clicking on the button at rights (**or whatever works**).

You will hear a short excerpt of music (Torme singing "...bottom of the well...)

- a) In the original,
- b) After maximum loudness boost retaining reasonable quality (+5 dB rms)
- c) After the further addition of unreasonable amounts of fast compression limiting (+ 7 dB rms from a)
- d) The original repeated

The waveforms are shown below. Note that I choose a relatively quiet passage which illustrated the most loudness boost (just as compression boost quiet sounds in hearing aids).

The audible loudness differences are more dramatic if you listen at a high level such as you would be using driving in a car.



The progressive increase in loudness is accompanied by progressively greater degradation in quality.

(Note: I did not include an intermediate “louder” version created by Mr. Khan, because it succeeded in being somewhat louder but without appreciable degradation in quality.)

Beck: You said this started out with AM broadcasting?

Killion: Yes, for good reason.
In the case of AM radio broadcasting, increasing the average audio level by 10 dB is equivalent to increasing the transmitted RF power by a factor of ten, so the coverage distance from increases by a factor of 3. Our listener quotient goes from 1 million to 10 million, perhaps. Certainly helps pull in advertising dollars. Even a 5 dB loudness increase would increase the effective coverage distance by 1.8 times and the number of potential listeners by 3.2 times.

Just as important as coverage is the fact that many AM radio listeners are in a car and the radio is turned up about as much as they want. The typical 70 dBA noise level inside a new car driving 70 mph on an expressway produces a roughly 50 dB HL masked threshold (i.e., you have the noise-masked equivalent of a 50 dB

hearing loss). So an announcer or interviewee who dropped their voice might well become *inaudible* to many travelers when they did. Early on, AM broadcasters used not only phase shifting, but often heavy compression to keep the signal level up.

Beck: So they used compression in radio for the same reason we use compression in hearing aids: To keep sounds audible without being uncomfortably loud, and without requiring constant readjustments of the volume control!!

Killion Exactly

Beck: How about FM?

Killion: Chicago's WFMT classical FM station appears to use very little if any processing. Listening to WFMT at home, it sounds like a concert. Listening in a car, however, I sometimes find a quiet section of a classical selection masked by the car noise. (The same thing is true when listening in a car to a "purist" classical CD, for that matter.) Switching from WFMT to another FM or AM radio station sometimes causes me to quickly reach for the volume because it is too loud. WFMT has apparently made the decision to make use of much of the full FM dynamic range. No one else in the Chicago area does, to my knowledge.

**Under the "more than you may want to know" category:
I first heard the recent Rachel Barton Pine recording of the Beethoven Violin concerto over WFMT, and noticed that it is a nice example of a large-dynamic range broadcast of a wide-dynamic-range recording, and her original new Cadenzas are wonderful, but I had to turn up the volume for the second movement. Analyzing the CD with Adobe Audition, the quietest rms level is 45 dB below the maximum rms level (A-weighted or C-weighted). The maximum unweighted rms level was 9 dB below the peak level, which was 1 dB safely below the peak clipping level on the CD.)**

Beck: May we return to the main topic?
So now that we have outstanding real-world ability with respect to modern audio recordings, playback systems and hearing aids, factors such as extended bandwidths and new compression circuits that provide audibility while maintaining more true-to-life sound and spatiality cues, and we have amazing headphones and ear-inserts with electronic and physical noise reduction (I personally use Etymotic ER-6s) and we can achieve a wealth of sound reproduction and playback, now that these tools are available to the public - the recording industry provides head-banger music with virtually no dynamic range, just to make it louder?

Killion: Yes, that seems to be what's going on. We go from a 50-70 dB dynamic range in live orchestral concerts (I measured SPLs from 40 dBA up to >100 dBA during a single evening's Chicago Symphony Orchestra concert) and a similar dynamic range in some CD classical recordings. The range between "quiet" and "loud" in some rock music is 5-10 dB.

Beck: It boggles the mind. Of course, the human ear can detect about ten octaves from about 20 to 20 thousand hertz and the dynamic range for normal hearing ears is about 100 dB, or perhaps a little more. If I recall, don't CDs and DVDs have nearly the same

dynamic range ability as human hearing?

Killion: Yes, they are more than adequate for most listening. A 16 bit CD has a dynamic range of 96 dB. Most homes have a background noise level of about 45 dBA with the furnace, refrigerator, or air conditioner running, so anything quieter than about 25 dB HL is masked. In fact, you could certainly argue that a modest amount of compression would improve both the CD and FM broadcast for normal use, because homes don't have the 30 dBA noise level of Orchestra Hall unless there is no wind or traffic and everything is turned off. The limited comparisons I've made between live and recorded concerts leads me to suspect that some such compromise is being made.

Beck: And if you go back and listen to earlier digital recordings, such as early, well-engineered recordings from The Beatles, such as Sgt. Pepper or Abbey Road, or Crosby, Stills, Nash and Young, or Joni Mitchell, James Taylor and more, you'd find dynamic ranges used maximally to maintain the original music dynamics, to allow a vast range between the quietest sounds and the loudest sounds.

Killion: Sure, and the same is true for high quality jazz and classical. The well trained ear wants to hear those dynamics, and the technology is available to capture and provide those dynamics.

Beck: Unless you listen to Metallica!

Killion: Right, that seems to be the issue. But it goes beyond Metallica and recording techniques. I finally went to my first rock concert in 2007 when the Rolling Stones played at Soldier's Field in Chicago. I had my sound level meter with me (as I always do), and even though we were up in the stands the sound was almost a constant 104 dB SPL on the A scale of the sound level meter. So in their live concert, even the Rolling Stones used a limited dynamic range. They presented a fairly uniform loudness level through the entire concert.

Beck: And if you did the same in hearing aids, used very fast compression and heavily compressed signals, it would be tremendously annoying.

Killion: Sure, it would sound terrible. That is not just your and my opinion. We once made KEMAR recordings of live musical groups on a series of well-known third-generation digital hearing aids. One of them used very fast, heavy compression such as you described. It received fidelity ratings of about 30% from hearing aid wearers, 50% lower than the fidelity ratings they gave well-designed aids. The same subjects also required a 4-5 dB greater signal-to-noise ratio to obtain 50% on the QuickSIN test than they did on well-designed aids, so this was clearly bad compression from the standpoint of fidelity and intelligibility.

When you take sound and apply extreme compression, you get more sound into a smaller space (i.e. dynamic range) but you lose lots of the natural acoustic aspects that give the sounds their unique qualities, such as temporal cues, dynamic range, timbre and of course you can mask spectral and amplitude cues, as well.

Beck: So are you suggesting that compression is basically bad?

Killion: Of course not. I guess I got carried away. Etymotic's K-AMP circuit, which I understand is seeing a cult revival among musicians, uses wide-dynamic-range compression. But it doesn't use excessively high compression ratios or nasty fast compression time constants. Done properly, compression can make quiet sounds audible again without making loud sounds too loud, and without degrading sound quality. I believe every digital hearing aid on the market today uses wide dynamic range compression.

So increasing loudness can be a good thing, but it is like the old saying: If taking two aspirin is good, no one suggests that taking the whole bottle would be better!

Beck: Somehow this reminds me of the old Spinal Tap movie and the discussion Nigel offers explaining his amplifiers are special because rather than having the normal 1 through 10 on the loudness dial, his amps go to 11. Thanks Mead. It's been fun chatting with you.

Killion: Thank you, too, Doug. It's been a pleasure for me, too.

For More Information, References and Recommendations:

"Even Heavy Metal Fans Complain That Today's Music is Too Loud." By Ethan Smith. Wall Street Journal. Front Page. Thursday, September 25, 2008.

www.etymotic.com