The life and death of dynamic range: who decides how loud?

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Proceedings of The Art of Record Production Conference, Cardiff, Wales, November 2009

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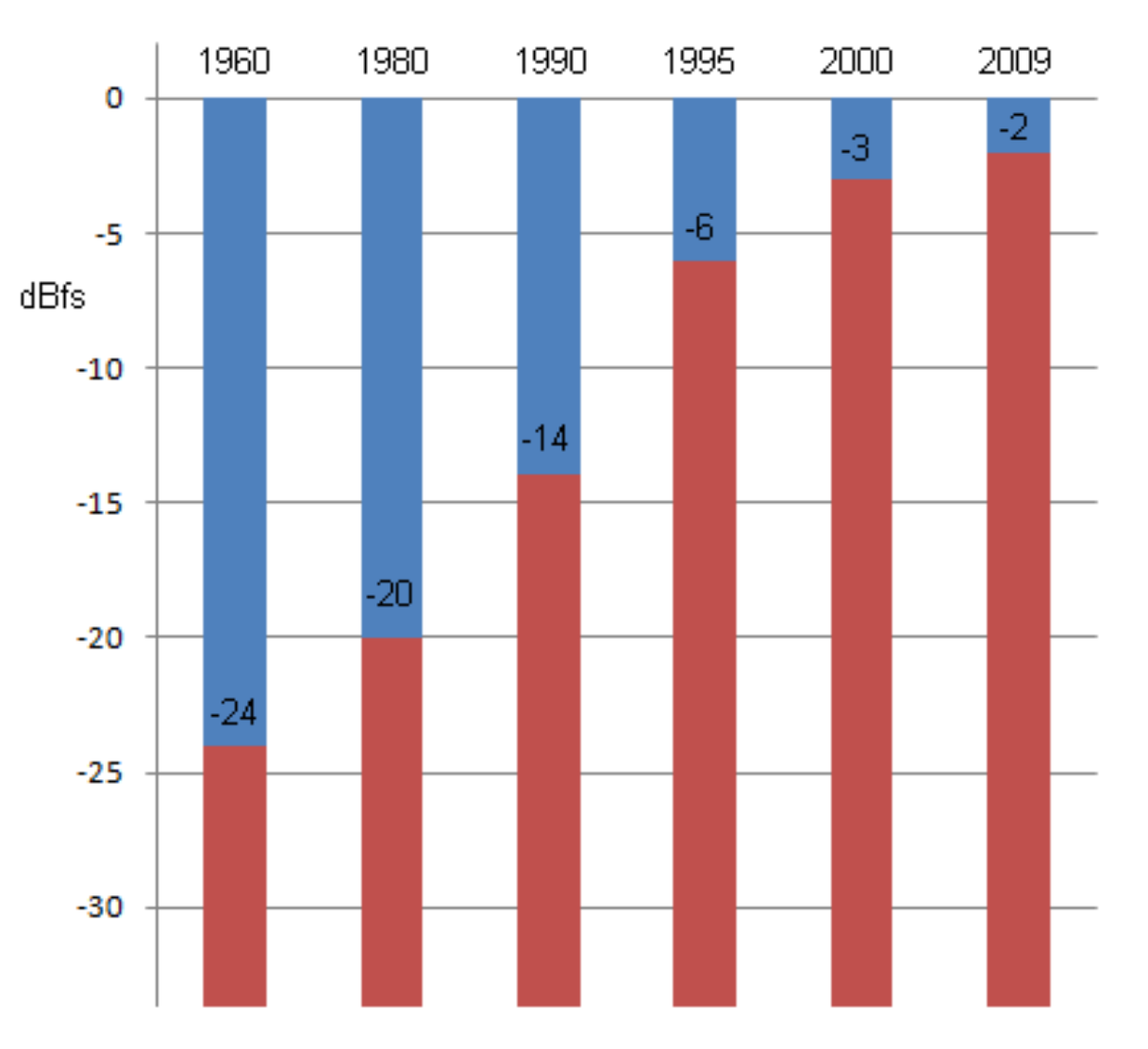
Abstract

It is common practice for produced audio to be mastered with the aim of increasing the perceived loudness for the listener. This can allow one record to stand out from another, by delivering an immediate impact and intensity. But who actually decides how ‘loud’ a piece of reproduced music is or should be? The mastering engineer can control the level of dynamic range of a piece by manipulating the peak and RMS values of the audio stream. And record labels often dictate to the mastering engineer that recordings require an immediate impact for the listener in order to stand out above the competition. A general assumption is that the listener perceives loudness as the RMS value of the audio, with the actual peak levels adding transient quality, but with no major contribution to perceived loudness. So to achieve the greatest possible loudness within a given reproduction headroom, the RMS can be raised if first the peaks are reduced – i.e. through compression or limiting. So there is a trade off between loudness and quality. But who is the listener? Do they have a roll to play in this process? If the listener has a home reproduction system with suitable headroom, they can dictate the loudness by simply turning up the volume. This raises both the peak and RMS – the best of both worlds.

So, is compressed audio really needed? Recent commercial releases have seen passages of audio with a dynamic range (the peak-to-RMS ratio) of just 2 dB. And the methods of limiting to this extent generally result in the distortion and reduction of transients. Therefore, conversely, a loudness enhanced piece of music can actually lose impact by the fact that transient and percussive instruments are reduced and left weak in the mix. However, the battle for success in the commercial world, radio distribution methods and the use of poor quality and low headroom consumer reproduction systems make heavily compressed masters the current norm.

A recent initiative by The Pleasurize Music Foundation (www.pleasurizemusic.com) is to educate the music industry and music consumers in the values of higher dynamic range audio. A future goal is to define industry standards for the dynamic range levels of mastered music, in a similar manner to those associated with the film industry. The authors’ current research is in the gathering of evidence and data to quantify listeners’ response to different levels of dynamic range in reproduced music: How do listeners adjust the listening volume with respect to the dynamic range? What are the effects of listener fatigue with respect to over-compression and excessive distortion? What are the listener expectations of dynamic range for different music genres?

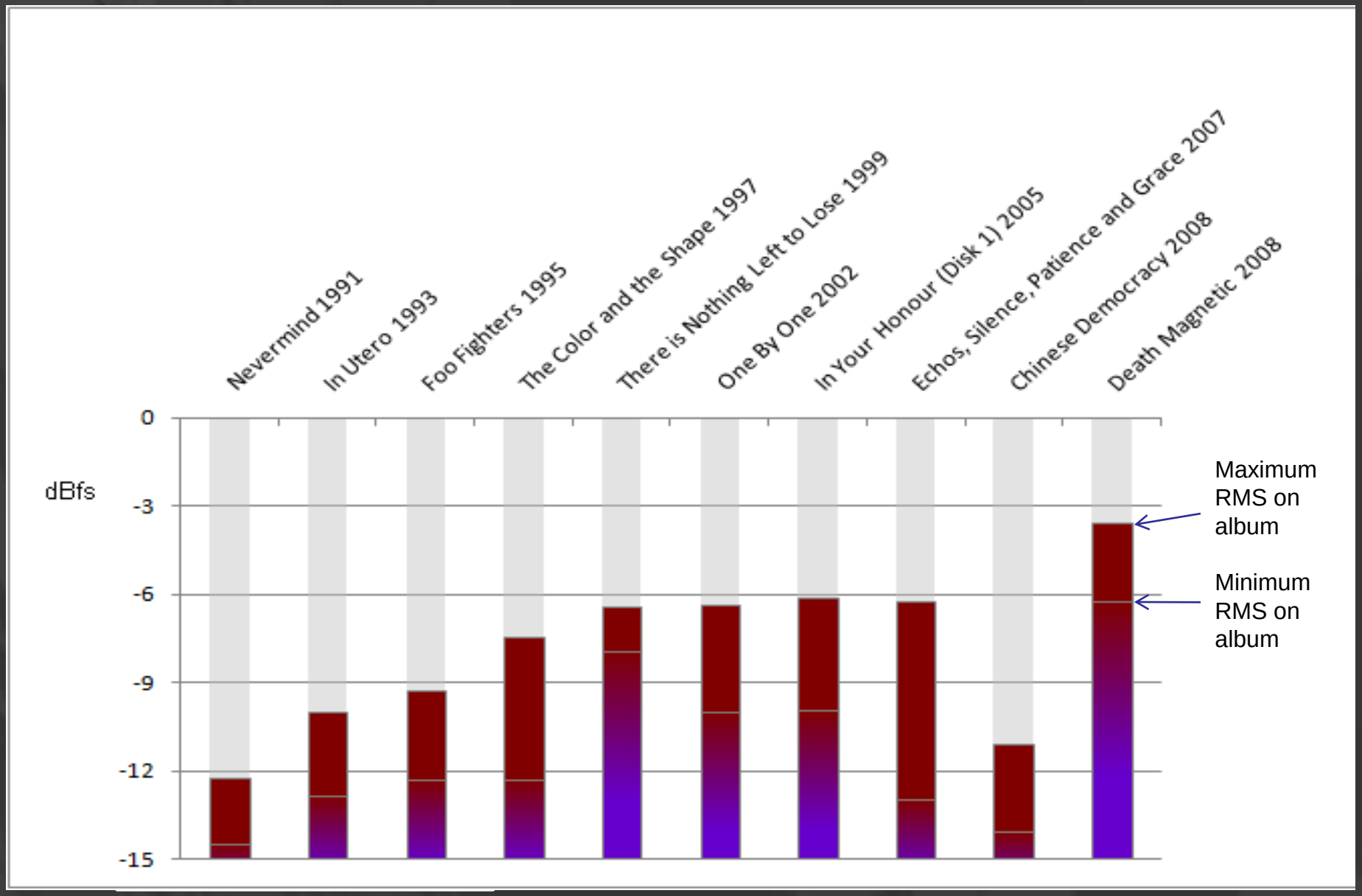
The History of Dynamic Change



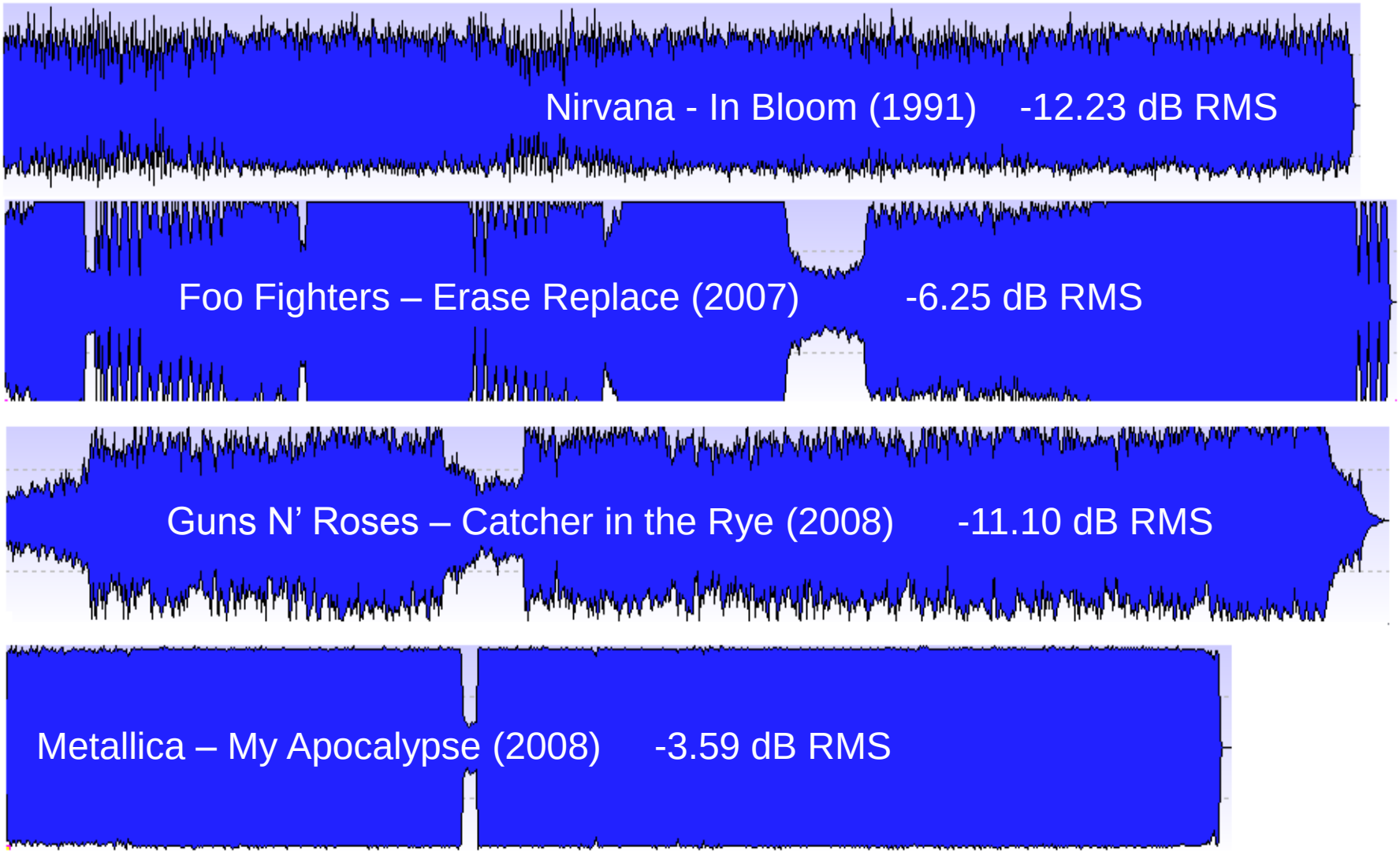
RMS levels of the loudest releases

(Katz, B. Mastering Audio, 2nd Edition, Focal Press, 2007)

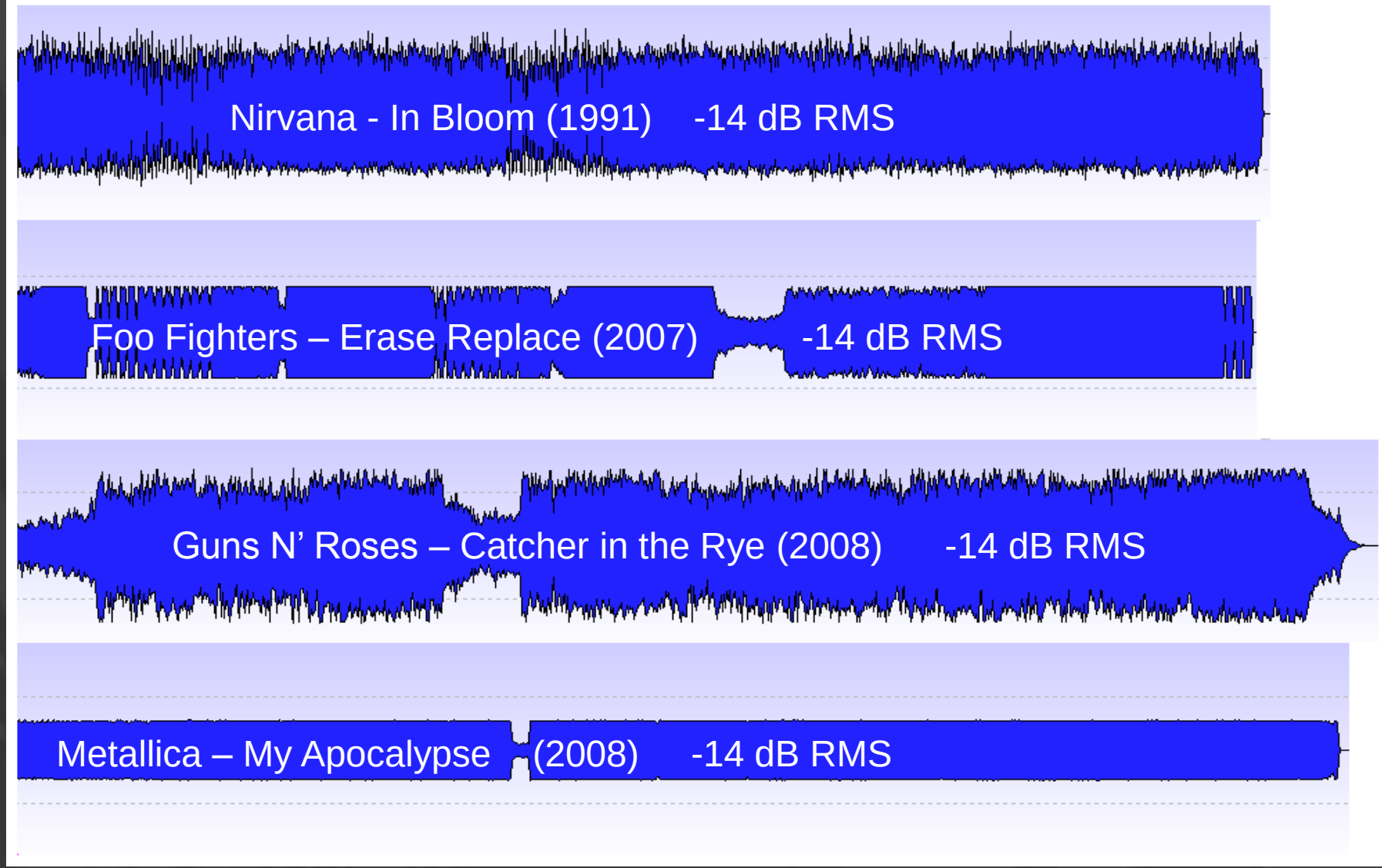
Tracking the change of RMS levels through 1991-2009



Waveform Profiles



Waveform Profiles – normalised to -14 dB RMS



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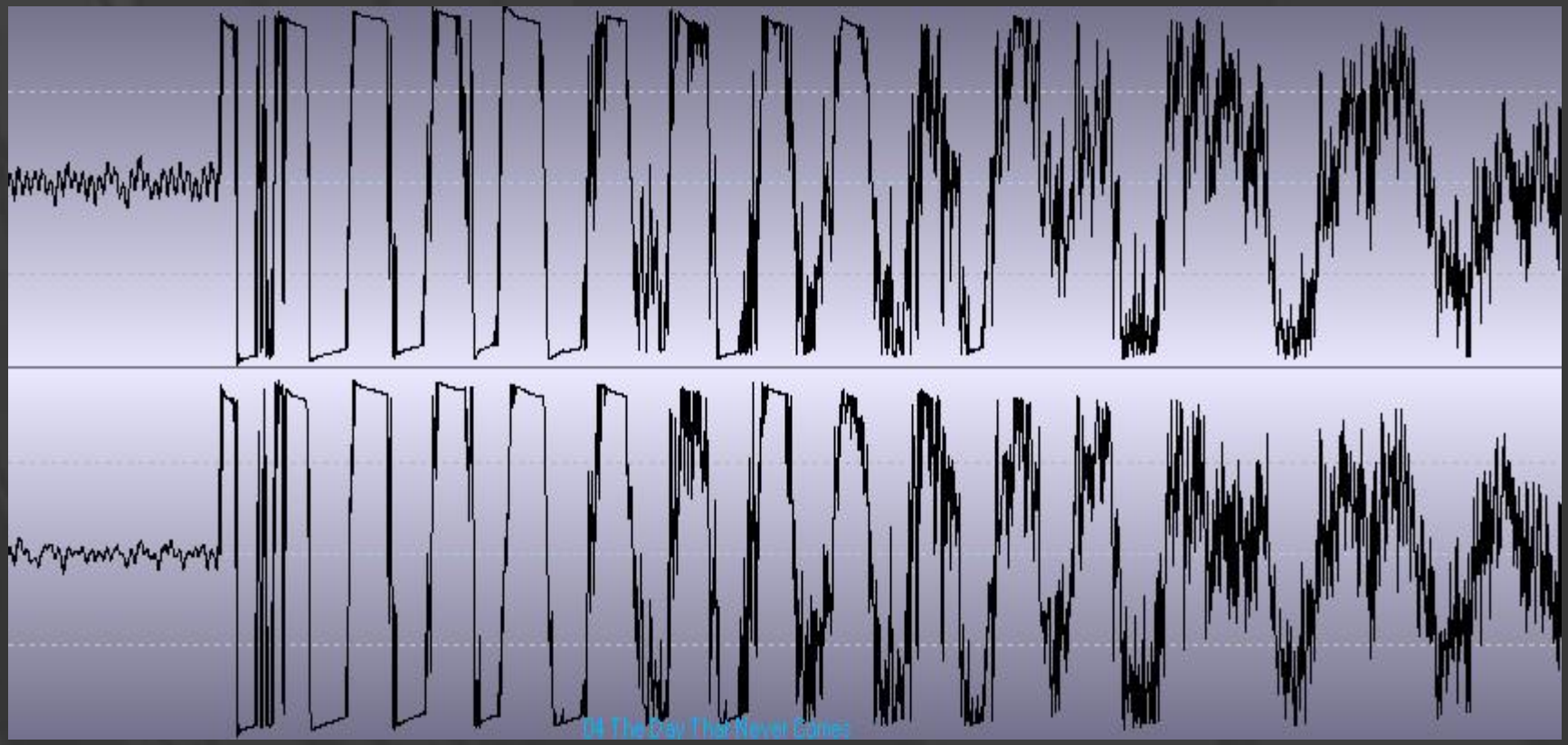


Snare drum waveform from:
Metallica – The Day That Never Comes, My Apocalypse (2008)

Bob Ludwig

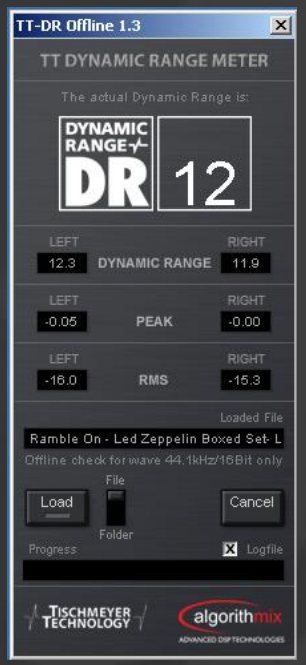
“Any pressure on the industry would be welcome. There is such a communal desire to have it loud, I don't know if it can ever be universally reversed.

I got to master the Guns 'N Roses **Chinese Democracy** record at 1980's CD levels and it was fantastic. I never got so many positive emails from people who loved it. On the other hand, I just did a big Soundtrack for an upcoming movie and I mastered it as loud as I thought possible and still be musical and they came back asking for it even louder, so it is tough.”

In correspondence, October 2009

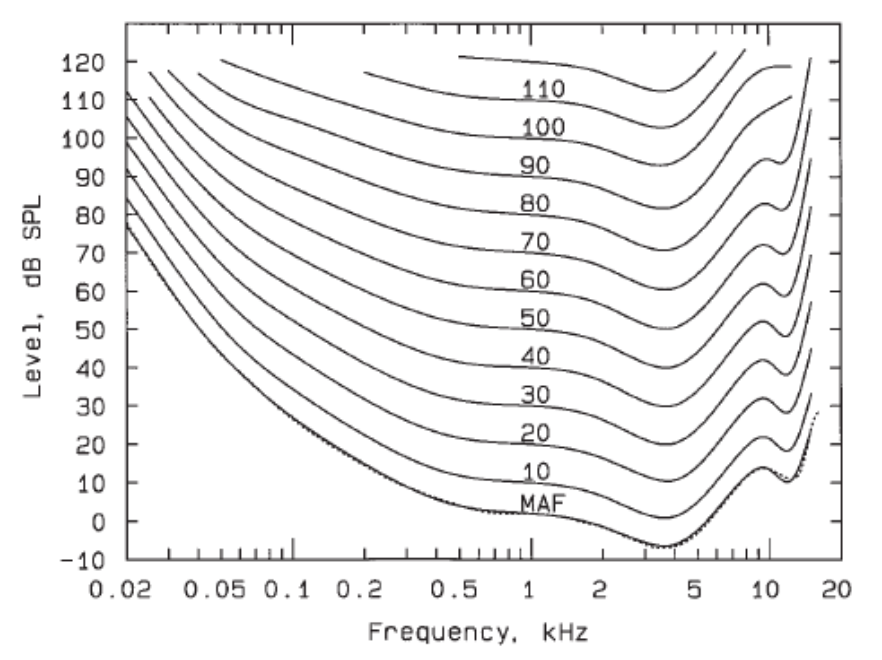
How Do We Measure The ‘Loudness’ of Music?

- Is RMS enough alone? Loudness perception changes with frequency.
- But music has intro’s, verses, choruses, loud bits, quiet bits…
- Is it possible to introduce a standard for loudness of audio?
- The Pleasurize Music Foundation



Stone and Moore

- Moore, B. C. J., Glasberg, B. R., Baer, T. A. (1997). Model for the Prediction of Thresholds, Loudness, and Partial Loudness, JAES Volume 45 Issue 4 pp. 224-240; April 1997



- Moore, B. C. J.; Glasberg, B. R.; Stone, M. A. (2003). Why Are Commercials so Loud? ' Perception and Modeling of the Loudness of Amplitude-Compressed Speech*, JAES Volume 51 Issue 12 pp. 1123-1132; December 2003

- Stone, M. A., Moore, B. C. J., Füllgrabe, C., Hinton, A. C. (2009). Multichannel Fast-Acting Dynamic Range Compression Hinders Performance by Young, Normal-Hearing Listeners in a Two-Talker Separation Task, JAES Volume 57 Issue 7/8 pp. 532-546; July 2009

Bob Katz

“Honestly, I don't think even mountains of your psychoacoustic and other data are going to stop the TECHNICAL origins of the loudness war, caused by Peak normalization combined with compression. As long as that 0 dBFS Peak meter is available we have no hope. In other words, as long as peak normalized program exists, which gives a loudness advantage to compressed material--- we have no chance in hell. Once the peak meter is abolished, and once servers take over in the home with their built-in loudness normalization, and the radios and TVs convert to the ITU standard will we see a major change. In the meantime, ideas such as yours and seminars such as ours at AES, and articles in papers are MAYBE helping to see a small pullback, a dB or 2 or 3, that's about all you can expect for now. We need 6 to 8 to 10 dB or more and that you will not see, no matter how prevailing your research paper. As I explained in the talk, loudness is a prevailing influence, loudness even trumps sound quality in many instances (sadly), and the weapons are out there; you can't just "ask" people to pull back their weapons since it's so easy to use!

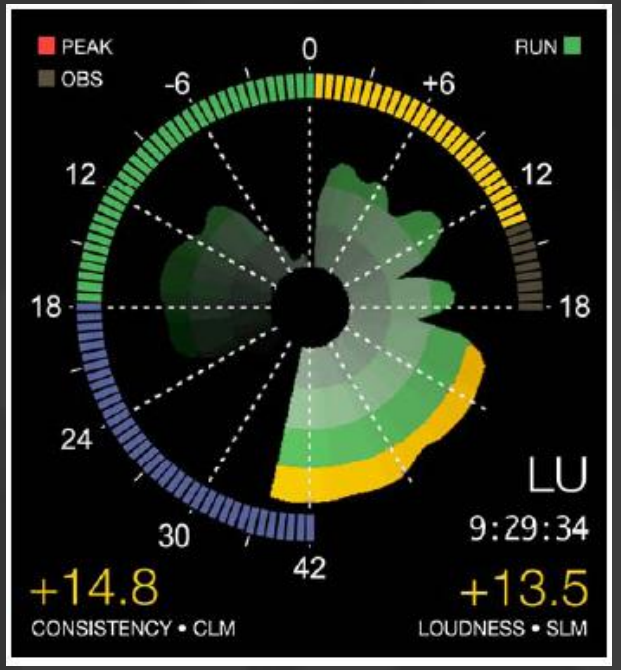
Your targets should not be the record companies, which are so scattered and disorganized you won't get them even to put out "standards" for material which is submitted, it's a losing cause. However, TV and radio networks do set standards and soon we will see some movement in that direction. We hope that when music producers start to see advertisements and sound quality improvement on TV, they will be inspired to do better stuff for home music consumers.

Your targets should be the manufactures of DVD players, CD players, Itunes, music servers (such as the Squeezebox) and so on. That's a more direct target. Make loudness normalization in these boxes a standard, not an option. Once the loudness has been normalized, the impetus to push loudness by overcompressing will go away. It's that "simple”

In correspondence, October 2009

Thomas Lund

- Lund, T. (2006). Control of Loudness in Digital TV NAB BEC, Las Vegas, United States, April 2006.
- Lund, T. (2007). Specifying Audio for HD, Proc.Of NAB Broadcast Engineering conference, Las Vegas, 2007.
- ITU-R, Draft BS.1770: Algorithms to measure audio programme loudness and true-peak level, Geneva, Switzerland, April 2006.



TC Electronic LM5D Loudness Radar Meter

Moving Forwards - Research Methodology

- Psychoacoustic Analysis
  - How is listener fatigue quantified with respect to loudness?
  - What are the physiological results of listener fatigue when brought on by loudness?
  - How do different types of compression affect listeners' ability to distinguish between sounds?
  - How does compressed audio (as opposed to high dynamic range audio) affect listeners' concentration and cognitive ability?
  - How do listeners choose comfortable listening levels and how does the audio's dynamic range influence this?
  - Do listeners correlate audio quality or impact with dynamic range

- Technical Investigation
  - Signal analysis of compression and loudness enhancement system.
  - Development of signal processing algorithms to quantify the 'Loudness' of a particular audio track.
  - Analysing methods of music and audio delivery, and investigating opportunities for enhanced, high definition audio quality in upcoming and future delivery methods
  - Analysing analogue hardware design practice with the aim of recommending playback standards

Moving Forwards - Research Methodology

- Cultural and Creative Context
  - Map historical technical advance against loudness and compression in commercial audio. This will allow future trends to be extrapolated and to provide for recommendations for industry change to take full advantage of future technological advances.
  - Analyse loudness in published music against commercial success. Does the loudness war actually achieve its goal – i.e. are the loudest records the most successful?
  - Define and analyse different consumer listening trends and identify methods to enhance audio delivery to each consumer preference.
  - Analysis of loudness against music genre.
  - Analyse radio distribution tools and techniques and relate both source audio production and subsequent mastering.
  - Interview and document expert opinion in the field of loudness and dynamic range.

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