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The Quantification of Emotion

Why some musical performances are emotionally moving and others are not



By Craig Anderton

Occasionally I run into people doing really interesting work, and sometimes I'm lucky enough to convince them their work deserves a wider audience. So at the most recent AES, when Ernest Cholakis showed me his notes on trying to quantify emotional responses in music, I couldn't resist asking if I could describe what he's doing in EQ. He agreed, so...thanks, Ernest.

Ernest is a researcher in Toronto, Canada who is involved in high-level audio analysis and mastering. He's probably best-known for his work on the WC Research Groove Templates, which were in turn inspired by Michael Stewart's ground-breaking article on the "The Feel Factor," the first article that analyzed the importance of small timing differences in creating particular types of rhythmic grooves and feels.

As an "audio architect," Ernest has been analyzing, de-constructing, and manipulating sound for a long time - in the late 70s, he bought a Digital Equipment PDP11/10 mini-computer with a 16-bit D/A converter and started creating software to develop computer-generated sounds,

which he later ported over to the Synclavier.

He also made me aware of a very interesting phenomenon: intensive sound editing and mixing of music creates sidebands, particularly between 1 and 20 Hz. This is often due to control signals, such as fades, superimposing their spectra onto the audio spectrum. Therefore, removing frequencies below 20 Hz with high-quality digital filters adds clarity and dynamic range. I used a software spectrum analyzer to check out some digital audio files that had undergone extensive DSP, and confirmed his findings. I've since paid a lot more attention to what's happening below 20 Hz!

Anyway, that's all interesting...but let's get to the heart of the subject: why some musical performances are emotionally moving, and others are not.

CAN EMOTION BE QUANTIFIED?

The subject of quantifying emotion is bound to raise a few eyebrows, and perhaps some hostility: it brings up the horrid possibility of programs with things like "emotion algorithms" built in, and engineers pressing "emotion" buttons. But there's no need for concern. With groove templates, merely invoking one is no guarantee that your music will indeed groove. Similarly, just because we know the basic rules of harmony doesn't mean that we will therefore be accomplished at writing multi-part orchestral music. Applying any of these concepts in a haphazard manner is easy, but ultimately unsatisfying.

After working with some of Ernest's techniques, I've found that putting theory into practice is not cut-and-dried, and requires artistic

judgement to be effective. It requires going with your feelings more than using your intellect, which can often set up pre-conceived notions that prevent seeing a situation objectively. So while there may be some techniques that can be applied more or less by rote, they probably won't create the intended results unless you can judge whether those changes make artistic sense.

SO WHAT IS IT?

This all started because Ernest was wondering why certain performances of the same piano piece, by musicians with roughly equivalent technique, would invoke very different emotional responses in him. Of course, some of this was due to timing differences that created different

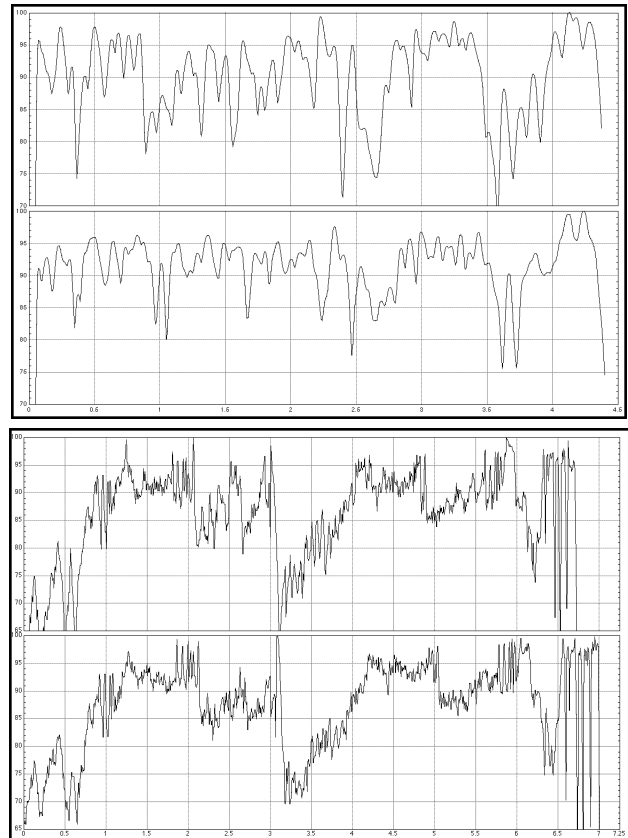


FIGURE 1 (top): Comparing treble dynamics for Vegh (upper graph) and Perlman (lower graph).

FIGURE 2: Comparing overall dynamics for Holst's "Mars," by the Toronto (upper graph) and Montreal (lower graph) symphony orchestras.

Industry Insider

“feels,” but even taking that into account, he felt there was something more.

In the process of mastering music, Ernest frequently looks at the dynamics in various frequency bands. Out of curiosity, he started applying this kind of analysis to existing recordings that he considered emotionally satisfying to see if they had any common characteristics, and he also compared this to music he didn't find as satisfying. As we go through these examples, remember his criteria were not whether the music was “good” or “bad,” “commercial” or “non-commercial”; he was looking solely for music that has an emotional impact, preferably on a significant number of people as to provide a sort of validation regarding a piece's ability to move people.

Consider Fig. 1, which shows amplitude vs. time for the midrange band of two violin performances of Bach's Solo Violin Sonata in G (the Adagio). The upper is Sandor Vegh's performance, and the lower, Itzhak Perlman's. When Ernest sent me the graphs along with an audio CD of the performances, I decided to listen to the audio CD first. I definitely found Vegh's performance more emotionally satisfying than Perlman's. Upon looking at the graphs, I noticed that Vegh's dynamics were not only more wider, but more tightly controlled, ramping smoothly from peak to valley.

Fig. 2 compares two performances of Holst's “The Planets” (in this case, Mars) by the Toronto Symphony on the top, and the Montreal Symphony on the bottom. When listening to the CD, I preferred the Montreal version, and again, their graph shows wider, more tightly-controlled dynamics.

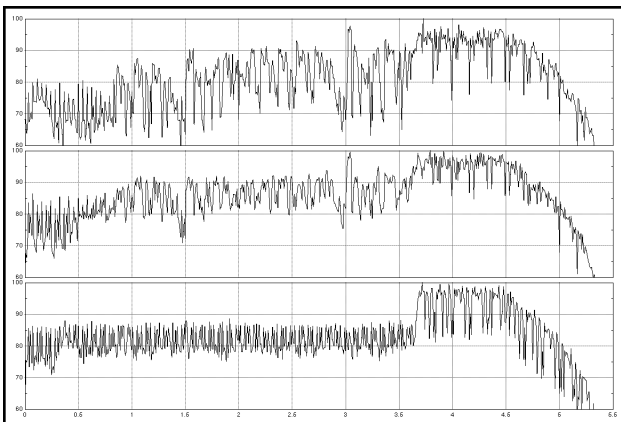


Fig. 4. Dynamics for the treble, midrange, and bass regions (going from top to bottom on the graph) for “In the Air Tonight,” by Phil Collins.

Analysis Gear

For his audio analysis and mastering projects, Ernest uses the following:

Computers: 2 Powermac 7100s, 2 PowerMac 9600s, and a 300MHz Pentium II.

Sound cards: Audiomedia II, SampleCell II, and Ego-Sys Waveterminal 2496

External monitoring DAC: Audio Alchemy Digital Decoding Engine V1.1

Software (Mac): Momentum Data Systems' DSP Designer, Digidesign Sound Designer II and PowerMix, BIAS Peak, and MOTU Digital Performer

Software (Windows): GigaSampler, Cakewalk Pro Audio

Now consider the graph of the Chemical Brothers' “Block Rockin' Beats” (Fig. 3), and its relative lack of dynamics in the treble, midrange, and bass frequencies. Actually I really like the tune, but that's because it moves my body, not necessarily my emotions.

Perhaps this is why many people, when reacting to electronica, find it lacking emotion; the dynamics-killing aspect of excessive compression could be the culprit.

Fig. 4 shows the treble, midrange, and bass graphs for Phil Collins' “In the Air Tonight,” which is a very emotional song. Of course, the vocal performance is a big part of that, but note how the bass anchors the tune during the first two-thirds of the song, while the midrange and treble build slowly but relentlessly. During the climax, the drums and the bass guitar kick in, contributing a major surge of bass that takes the tune to a higher level.

THE BOTTOM LINE

As with the feel factor regarding timing, all of this seems obvious in retrospect -- “of course dynamics make a difference in music.” But by analyzing these graphs, it's pretty easy to see it's not just dynamics that makes a difference, but the degree of control over those dynam-

ics. In other words, practicing dynamic control is as important as practicing any other aspect of music, such as pitch discrimination. Perhaps this is also why some people feel automated mixing has taking some of the soul out of music; in the pre-automation days, engineers were more prone to

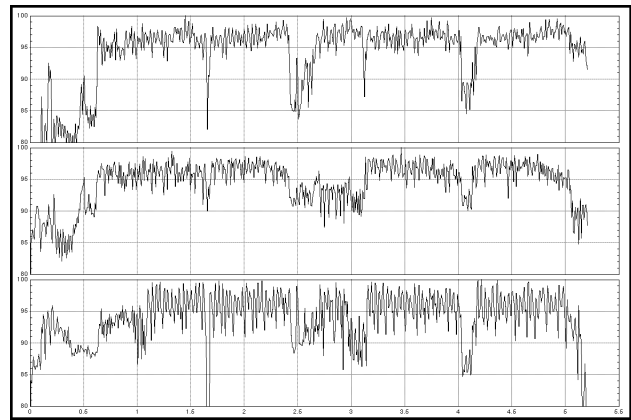


Fig. 5. Dynamics for the treble, midrange, and bass regions (going from top to bottom on the graph) for “Block Rockin' Beats,” by the Chemical Brothers.

add dynamics to the mix with faders. I vividly remember watching an engineer at CBS Studios (who had several hits, by the way) keep his eyes completely closed as he mixed, so he could concentrate on moving the faders rhythmically and dynamically. I must say it was a compelling mix.

In any event, in these days when we have so much control over music (be it through digital audio or MIDI), here's one more element that deserves further exploration. If you come up with any interesting insights of your own, you can contact Ernest via www.numericalsound.com

Craig Anderton has played on, produced, or mixed 17 major-label recordings, presented lectures on technology and the arts in 37 states and 10 countries, and written 15 books. He is also the Online Content Editor for the MPN Network (www.MusicPlayersNetwork.com).