Evaluating FM On-Air Processors

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Broadcast audio processing is both an artistic and engineering discipline. The station's management sets the artistic goal. It may be to avoid audibly modifying the original program material at all, or it may be to create a distinct sonic signature for the broadcast by radically changing the sound of the original. Most broadcasters operate somewhere in between these two extremes. The main goals are usually to increase the perceived loudness, to obey FCC modulation limits and to avoid signal contamination that can reduce the station's coverage.

Any audio processor that performs weakly in either the engineering or artistic categories will put a radio station at a competitive disadvantage. Ultimately, the success of a station's audio processing must be judged by its results—does the broadcast get the desired audience?

We believe that professionally produced processing for popular music formats should be clean on voice and music, polished, "produced," punchy, and consistent. (Consistency is probably the most difficult goal to achieve.) The processing should sound good to the desired demographic on a vast majority of consumer radios with all program material, except for the very occasional pathological case. It should be tuned to the station's target audience, which may require dayparting the processing.

In a matter of speaking, processing can be viewed as an art form, just like painting a picture. What one individual finds attractive another may find irritating. However, the general trend towards commercially successful audio processing systems, aside from superb technical performance, is to improve the loudness/brightness/distortion tradeoff and to give the listener the illusion that the signal is not processed. The idea is to get the original artist's performance on the air, within the constraints and limitations of the medium, without gross modification of the original artist's and producer's intent.

Stations should consider how the original recording artists and producers intended a record to sound, and should not radically change this sound without careful consideration. In cooperation with the original artist and producer, all major-label CDs have been "mastered" to make final tweaks to the master tape (such as cut-to-cut level matching, fine-tuning equalization and adding compression and peak limiting), with the intent of giving these CDs an "international, major-label" sound. We believe that it is wise for the individual evaluating and adjusting an audio processor to be very aware of this contemporary, major-label sound texture. The evaluator should then try to reflect it in the station's sound, because this is what the radio audience associates with top-grade commercial CDs from the big international labels. Moreover, the top mastering engineers are very experienced specialists who know what it takes to make a CD sound like a hit on all common consumer playback equipment. Unlike radio program directors, which have to wear many hats, the *only* job of a mastering engineer is to make a cut sound as commercial as possible.

It is a waste of time to argue subjective preference beyond the issues above. People can go round and round forever and do no more than "agree to disagree." What should count to any broadcast professional is not personal preference, but whether the processing appeals, in some statistical

sense, to the target audience of a given radio station. With the above in mind, we can give some specific advice about subjective evaluation of processing.

Listen on a high-quality home receiver, a typical auto radio, and a portable or tabletop radio. In particular, the lack of bass response in the portable may reveal problems like midrange pumping that were masked by the radios with good bass response. And listen at both quiet and loud volumes. Sometimes, listening with the radio playing quietly (as is common in offices during the day) reveals problems that you don't notice at all when the radio is cranked up.

Also, bear in mind that every radio has a volume control and every listener knows how to use it. In FM, beyond a very marginal contribution to coverage, the only positive contribution that a dB or two of loudness can make is a momentary impact in the car when a listener switches stations. (A louder station may be perceived as more powerful.) After that, the listener will usually adjust the volume control to his or her preferred listening level and must then tolerate whatever artifacts the processor produces. Loudness wars that degrade quality are self-defeating because they produce, at best, a momentary, fleeting impact on the listener, while ignoring the fact that every listener has a preferred listening level and an easy means to achieve it.

Evaluating *consistency* requires you to devote considerable time to an evaluation. Listen to all of the different types of program material presented within your format. Listen to a wide variety of music and voice, both previously produced and from your own live microphone channel. Make sure that all of this material emerges from the processing with a consistent texture. Transitions from one item to the next should be smooth. The spectral balance should not shift unnaturally, particularly within one piece of program material. No material (particularly live voice) should exhibit raspiness or other overt distortion. The loudness of live voice or spots should be consistent with the surrounding music so that transitions between the two are smooth and the listener is not required to readjust the volume control to achieve his or her preferred listening level.

Evaluating *texture* is a multifaceted procedure. Most modern processors come with factory presets designated for different programming formats. Choose the preset closest to your format.

There are several subjective aspects that should concern you. The first is *density.* Dense audio has a small short-term dynamic range. Formerly, it is a sound that was rarely, if ever, found in an unprocessed CD. Unfortunately, it is now becoming more and more common, reportedly because labels are pressuring mastering engineers to "hypercompress" CDs. Operating multiband compression with fast release times usually creates it. Very dense audio is generally appropriate for stations looking for maximum loudness and dial impact. However, it tends to be fatiguing in the long-term, so it is usually most appropriate for formats that emphasize cume over time-spent-listening.

The second aspect is fuzzy- or crackly-sounding distortion. In a correctly designed processor, audible distortion is entirely determined by the amount of clipping or other very fast limiting process that is used for final peak limiting. The harder the final limiting process is driven, the louder the sound but the higher the distortion. It is unwise to have processing-induced distortion levels that are high enough to be audible on portable and auto radios. It is not unusual to have slight distortion audible on very high-quality receivers, although you should avoid this in any format designed for long-term listening.

A processor can sound fine on some program material, yet produce disturbing distortion on other material. Listen carefully for distortion on spectrally sparse material like piano, nylon-string

acoustic guitar, and voice. Also, listen carefully to pure low bass (typical of urban and rap recordings) for a buzzy or clicky distortion. If it's blatant, it's probably caused by overt bass clipping because the processor isn't intelligent enough to keep bass away from the final clipper. If it's more subtle, a badly-designed compressor can cause it, or it could be a small amount of clipping.

Clipping distortion that seems highly correlated to the input signal level can be caused by headroom problems in the program chain before the processor, which can usually be cured by carefully readjusting operating levels in equipment like consoles and STLs.

The third aspect is *spectral balance.* Compare the on-air sound to the sound of recently produced major-label CDs. The spectral balance on-air should be similar from the upper midrange through the mid-bass.

De-emphasis is basically a built-in "treble control" in the radio that is set to radically roll off the highs. (In 75 microsecond countries, 15 kHz is rolled off by 17 dB, which is a lot.) "Pre-emphasis" is a complementary treble boost at the radio station. Ideally, station pre-emphasis and receiver de-emphasis cancel each other out, yielding an uncolored result. But there's a catch. When the original audio has a lot of treble power, the on-air audio processor must constrain this high-frequency power so that the entire audio waveform (including treble) does not overmodulate after the treble has been boosted by pre-emphasis. This action can cause audible treble loss. The amount of loss depends on how bright the original program material is and therefore how much high frequency power the processor has to remove to control modulation to legal limits. The amount of audible loss is also highly dependent on the sophistication of the algorithms that the processor uses to constrain high frequency power. There are large performance differences between processors in this crucial area.

For a given source, the higher the on-air loudness, the more brightness you will have to sacrifice. This is because audio processing is a "zero-sum game": the available modulation is always 100% and the processor must allocate various frequencies within this available modulation according to your goals. If your goal is higher loudness, the processor must work harder to constrain the highs to 100% modulation because it must allocate less room for the highs and more room for the crucial midrange frequencies that contribute to the sensation of loudness. This tradeoff may be particularly difficult with contemporary CDs because many current pop CDs are mastered with very bright balances.

For similar reasons, a very loud station will have to sacrifice low bass. This is because the ear is very insensitive to low bass by comparison to midrange energy, so there is little "room" within the 100% modulation limit for heavy bass when audio is processed for maximum loudness. Indeed, bass waveforms usually approach the 100% modulation point when one processes for loudness. This can cause all sorts of audible problems—anything from the buzzy, clipped bass described earlier to overt intermodulation between the bass and midrange. Be sensitive to effects like an announcer who sounds like he or she is gargling when talking over music containing low bass—this is a classic example of this kind of problem, and processors vary widely in their ability to prevent this kind of distortion, which is a very fast manifestation of the "spectral gain intermodulation" described below.

The fourth aspect is *dynamic distortion.* This includes classic *compressor pumping* caused by attack and release time constants that are not well matched to the program material. The resulting sound has a strained, unnatural quality. Also in this category is *spectral gain intermodulation*, caused by a dominant sound in one frequency range causing gain reduction that reduces the

loudness of a second sound unnaturally. A typical example is heavy bass that modulates the loudness of midrange material in a wideband compressor. A further problem can be caused by *clipper pumping*, where bass transients smash against the processor's final clipper, momentarily shutting it down and blocking other program material. This can sound like severe compressor pumping.

Any competent processor will have some sort of gating that freezes or slows the compressor release process to prevent the processor from pumping up low-level material or noise. The gate should operate unobtrusively, preventing these effects without introducing problems of its own. For example, in a multiband processor be sure that the gating does not cause the various bands to get stuck with widely varying gains so that the resulting frequency response unnaturally colors the low-level audio passing through the processor.

Proper evaluation of an audio processing system is hard work and is crucial, because there are real, important differences between processors. Evaluation requires careful, long-term listening and rigorous measurement by your engineering staff to ensure meaningful results. It requires a clear concept of the station's processing goals and the mental discipline to ignore marketing hype, spin, and the "junk science" that some marketers use to fool potential customers. (For example, the alleged audible superiority of 96 kHz sample rates in FM processors is one of junk science's greatest hits, given that lower sample rates can represent all the information with identical accuracy.)

Although it requires a great deal of thought, time, and energy, painstaking evaluation is crucial. Processing is one of the most important factors determining the overall impression that your station makes on its target audience. Make the wrong subjective choice and you can damage you chances to get that audience. Make the wrong *engineering* choice and you can end up with a processor that is a nightmare to install in your plant that throws data errors into your RDS, that interferes with your subcarriers, and that reduces your coverage area because it interacts with the variable-blend circuitry in consumer receivers.

Good luck!