The
Broadcasters' Desktop Resource
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SOUND PROCESSING

A History of Audio Processing

Part 4 – Louder and Louder

by Jim Somich
with Barry Mishkind

[March 2019] The late Jim Somich and I were both involved with the multiband processors that gave radio its loud, clean voice in the 70s and 80s, and we had watched the changes over the years.

Jim Somich took the lead on this guided tour. I get to help finish it off as a tribute to a great radio engineer.

On one hand, audio processing changes the way artists would like to see their music presented. The dynamic range is purposely reduced and peaks are clipped off, losing much of the "openness" and detail of a work.

At the same time, audio processing can make stations much louder – and the reduced dynamic range makes it easier to listen in cars. That makes program directors happy.

Unfortunately, the ultimate bargain at many stations in the 70s' and into the 80's was audio sounding somewhat flat and subject to nasty side-effects from the processors as they were turned up to 11.

TRICKS AND TRAPS

In their efforts to stand out, stations tried many tricks, like speeding up the turntables – as much as 5% – or cart machines or using digital boxes to time-slice and shorten songs.

That combination did give an apparent increase in a station's "energy," but when listeners bought the song and played it at home, some were puzzled at the way it sounded. (Some sped up songs were quite noticeable, especially when A/B'd with the actual records.)

Other approaches used four or five bands of audio and some EQ and input leveling. Chasing that with a solid limiter did move the average (or RMS) levels up – well into the 80-90% range on some stations. .

BANG!

That jump – from some 30-35% – that came with the technical advances that had come along, had an interesting effect.

One result of everything was: all of a sudden, manufacturers noticed a "run" on modulation transformers to replace those burned out by the higher RMS levels of audio demanded of the transmitters. An emergency solution – and a dangerous one, which many stations kept in place for years – was to put blocks of wood under the transformers, to eliminate the case-to-ground shorts.

Some manufacturers quickly put together packages where a heavier transformer than usual was installed. For example, an RCA 5H 5 kW transmitter would often be purchased with a 10 kW modulator section. This gave even greater modulation capability with less danger of burning out the transformer.

PILOTING THE WAY LOUDER

George Frese is perhaps best known in broadcast for his audio processing invention: the Frese Audio Pilot. Acknowledged as among the best audio processors of the time, the Audio Pilot was noted for clean, high modulation which made stations stand out on the dial – as much as 200% modulation with asymmetry!

During the installation, which Frese did himself, a rackful of tube equipment he developed in the 1950's was installed, as were often some transmitter modifications. It might take him four days – and nights – but when Frese was done, there was no question which station had the best sound in the market.

Eric Norberg relates that to achieve his goals, attention was given to "equalization, gating, asymmetrical peak reversal, clipping (soft clipping) the negative peaks to avoid distortion but to maintain a consistently high modulation level), and two innovations that are still somewhat unique today. "

LOUDER AND LOUDER

Norberg continues: "One was that, by keeping the positive peaks unrestricted while soft-clipping the negative peaks and setting them to the exact percentage modulation ceiling, he found he had solved the subjective loudness issue – the more asymmetrical the sound, the higher the positive peaks got – and those were the sounds most likely to seem softer in convention-al limiting, so this automatically compensated for that.

"Secondly, by using a return line from the modulation monitor back into the Audio Pilot, the unit could compensate for errors in the audio processing and the transmitter modulator, and could manage the soft clipper to exactly the desired modulation level without artifacts."

Phillip Davies recalls the KMBY installation: "in addition making internal part changes in our Gates BC-1H, l kW transmitter … Frese had an AC unit installed, ducted directly into top of transmitter to keep the 833A modulators cool – due to the Audio Pilot making the 833A's plates glow bright red to white on some songs, from positive peaks at 165% to 170%. Our antenna current literally doubled."

The result: "When the record people came to town and heard KMBY on the air they thought we were 10,000 Watts!" To this day, Davies claims that he has heard nothing to match the Audio Pilot.

At the 40 stations where Frese installed the Audio Pilot, only one was returned – by a cheap owner. The rest had modulation levels that were head and shoulders above other stations.

Program directors of the 39 stations, however, were beyond delighted.

ADDICTION

However, whether they had had an Audio Pilot installed or were merely being beaten on the air by a competitor, achieving such a high level of

modulation had a rather addicting effect on programmers.

Those stations that did not have an Audio Pilot complained loudly (pun intended) to the FCC, which eventually limited positive peaks to 125%

Meanwhile, the emergence of the solid-state transmitters, which did not rely on heavy transformers, reduced the problem. Overshoot correction raised the loudness levels a bit more. And on many modulation monitors around the country, it began to look like the meter was glued in place.

It was clear that radio had entered a period characterized by what some now recall as "The Modulation Wars."

LOUDNESS BECOMES PARAMOUNT

The competition, largely among the rock stations, to have the "biggest sound" was starting to foster an obsession on the part of program directors to be "louder than anyone else."

It was something unheard of in the past: program directors driving the sound of a station. Historically, PDs had acquiesced to the Chief Engineer, and in most cases that worked well. The engineers were always trying to get the best out of their transmitters, both in terms of power and bandwidth, while the programmers kept their eye on the on-air content and station promotion.

But as the use of a "Top 40" format and heavy research started to make playlists more and more similar, pressure mounted to find other ways to gain any competitive edge. Programmers swore that as listeners tuned across the dial, they would stop at the loudest sounding station.

Thus they pressed the engineers to use more and harder limiting, and that added a measure of loudness.

It also introduced some "grittiness" to the audio, which set engineers off to find alternatives that would be loud *and* clean.

Notable among these processors were those by Ron Jones (Circuit Research Labs, or CRL), Greg Ogonowski (Gregg Labs), Bob Orban, Frank Foti (Vigilante) and Glen Clark (Texar Audio Prisms), which were essentially multiband gain riders with brick-wall limiters..

Stations worked hard to get their modulation to consistently hit 124.5% positive and 99.5% negative. Modulation monitor lights flashed a lot …

… AND THE METERS STOOD STILL

Among the most desired processors at the time were products from Ron Jones' CRL.

Jones and his partners developed a full line of audio processors, but perhaps it was his complete approach to AM processing was his most brilliant.

Jones was the first to utilize "pre-distortion" in an AM processor to cancel out transmitter problems like the "power supply tilt" and thereby increase modulation a bit more.

The early CRL AM System
(eventually there was a shiny black face)

Another "trick" that become very popular – and both Orban's and CRL's processors were ready to take full advantage of it – was to crank up the high end of the audio band to try to overcome the roll-off in receivers.

The audio, which would have been rather shrill on a receiver with a flat audio response instead sounded crisp.

Since the ear responds more sensitively to the upper mid-range, this did serve to increase the perceived loudness. But it also contributed to the Modulation Wars.

Eventually, one wag commented that about the only way to get louder was to broadcast a 2.7 kHz square wave tone.

"THE OTHER GUYS ARE LOUDER – DO SOMETHING!"

Working at an oldies FM station in Pittsburgh, Glen Clark came to work one morning in 1979 to find the competition had done something amazing. They were so loud, the initial thought was "they had to be over-modulating."

But that was not the case.

Panic set in. Much to Clark's surprise, the other station's signal was completely legal. However, their average modulation was clearly higher than anyone else on the dial. Pressure to match the competition was coming from all directions, and they all looked to Clark for a solution – and fast. The result was what he later called "a design born of desperation." But what a design it was!

THE AUDIO PRISM

A little industrial espionage quickly uncovered the secret weapon "across the street."

A chatty weekend disk jockey who worked at both stations spilled the beans about the then-new CRL System-4 for FM.

Like many people at the time, Clark had never even heard of CRL. But there was no combination of settings for his air chain that was going to catch up with the CRL System-4.

In 1979, the secret to increased loudness was to make the attack and recovery time constants faster. But there were limits to what could be done without inducing a large AC component, grunging up the audio.

It took two months in the lab for Clark to overcome this problem, and develop separate gates for each of the four bands, to keep them from chasing tape hiss and other unwanted noise.

Adding some audio sweetening – harmonics that made the sound more pleasant – along with some stereo enhancement completed the first Audio Prism. As tall as an Optimod 8100A, it had four analog meters.

Clark finished his first Audio Prisms and put them on the air at 2 PM on the day before the next Arbitron started. He had met the challenge, and built a processor that was soon in great demand. Subsequent versions resulted in the familiar one rack unit model that became a popular "front end" to the Optimod 8100A

The Texar Audio Prism

THE MODULIMITER

There was another audio guru who decided to give broadcast processing a go during the 1970s. Bill Putnam, owner of a major studio in the Los Angeles area, introduced the Universal Audio BL-40 AM Modulimiter.

The Modulimiter combined Putnam's patented, unique optical gain-control compressor that had achieved legendary status in the "LA" series of leveling amplifiers, with an FET limiter stage and proprietary "phase optimizer" circuit to maintain optimum polarity for maximum positive modulation.

The BL-40 was a hit and, combined with Orban's AM Optimod 9000A, gave the AM stations of the 70s a new, bigger sound.

The UREI Modulimiter

Jack Williams at Pacific Recorders and Engineering also sold a version of the BL-40 and

another product: a multiband unit called the MultiMax.

In just ten years, AM and FM stations had taken full advantage of these advances to audio processing technology. Radio was LOUD, but it did sound better. Yet, as the 80s dawned, it became clear that listeners truly had not heard anything as yet.

GENERATING THEIR OWN STEREO

CRL also sold FM packages, including a stereo generator that was considered much cleaner than most of the other products on the market – with one exception: the Orban Optimod.

Orban introduced the 8100A in 1981. The new model was a significant improvement on the 8000A, going on to become the most successful Orban product – and became perhaps the best selling broadcast processor of all time, with approximately 10,000 units shipped. Like the 8000A, the 8100A featured an integrated stereo generator which virtually eliminated overshoot, and gave FM stations the ability to modulate right to the limit, as with AM, and adding an incremental increase of loudness.

The Optimod 8100A

Among the major improvements in the 8100A were two-band processing with a unique cross-coupling scheme, an improved 15 kHz low-pass filter with distortion cancellation, and an Orban-designed VCA which was based on the RCA CA3280 dual Operational Transconductance Amplifiers.

The design yielded greater loudness with less distortion, and was used in several other Orban products.

Of course, with the Modulation Wars in full gear, many engineers started to build their own "mix" of processing enhancements to improve on the Optimod 8100A, including pre-processing - input leveling, or multi-band or parametric equalizers - or clippers to the audio chain.

This eventually led some manufacturers – including Orban - designing a variety of replacement module cards to enhance the Optimod's operation. Orban's optional six-band accessory processing chassis (XT) was released in 1984, and included a distortion-cancelling clipper.

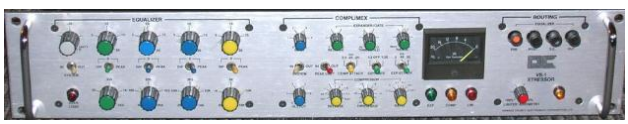
As a measure of its place in processing history, it is interesting to note that with or without the various add-ons, the 8100A is still popular – and is still the main processor at hundreds of stations around the world.

ORANGE COUNTY

At around the same time, Chief Engineer at CKY in Winnipeg, Manitoba, Mike Gillespie had the opportunity to develop gear to upgrade a station that had a strong signal but little modern gear.

Gillespie had been interested in audio since he built a microphone at age 13. After forming Orange County Associates, he sold audio gear and built dozens of AM, FM, and TV studios and built everything from power supplies to EQ and compressors to speakers.

Eventually, to complete an order, he took over a design from Audio Design + Recording, a UK company that failed, and sold the audio processors. For our purposes here, the most familiar processor made was The Vocal Stressor.


Orange County VS-1 Vocal Stressor

Gillespie never expected to be manufacturing audio processors, but has sold over 2500 audio processors around the world – even exporting to

Japan. They are no longer in production, but are still popular on the resale market. Gillespie continues to upgrade existing processors, now to version 5.

LOOKING FOR AN EDGE

As one can imagine, the pressure to stand out on the dial intensified year by year.

Stations worked harder to match the audio to the music format. For example, the disco years (you may remember them!) had featured a lot of constant deep bass for the dancers. This led to a lot of experimentation on augmenting the low end – to make it loud, but crisp, not muddy.

On the AM band, Orban brought out his second version, the 9100A, in 1982. As with many sequels, the 9100A raised the bar for AM station processing. But there were manufacturers up to the challenge.

For example, many users of the Gregg Model 2540 processors were passionate about its performance, especially the "killer bass," and they became "secret weapons" at many highly competitive stations.

CHECKING THEM OUT

Rich stations, especially those in the larger markets with big tech budgets, would try each and every new processor they could get their hands on.

Visitors to stations occasionally would find racks full of competing processors – and only smiles when they asked which one was on the air.

Among the other processors that might be seen were some from Aphex, a company best known for its recording studio equipment. However, they ventured into the world of broadcast audio processing in the 1980s with Donn Werrbach's 2020 analog processors, a highly complex box that would define and redefine analog broadcast audio processing for some time to come.

Werrbach's team at Aphex proved, with the 2020, that analog was far from dead. While the future is no doubt digital, the 2020 is a counterpoint to most of today's broadcast processors and shows there is yet much that can be accomplished in the analog domain – and that is good.

Aphex 2020

There were other engineers, some even before Werrbach, who were more interested in achieving clean audio from the processing, as opposed to loudness. Jim Wood founded Inovonics to make solid-state replacement tape deck amplifiers for the recording (and broadcast) industry.

Soon an average and peak-responding limited, the Model 200 was made, designed primarily for studio use. As Wood spoke with more and more broadcasters, asking them what they wanted in the way of processing, the concept morphed into the Model 220, the "Audio Level Optimizer."

Inovonics Model 220 – Audio Level Optimizer

This and other models, leading to the MAPs and the DAVID series, as well as the Omega, were very popular with stations that were not fixated above all else on hitting 124.5% positive and 99.a5% negative on the modulation monitor.

It did not hurt that Inovonics' products were all modestly built and priced, although often found in use at many major market stations as either the primary or backup processors.

The modest price made them even more popular in the medium and smaller markets.

THE WALL OF SOUND

Anyone familiar with the New York City radio market knows that it places unique demands on the science of audio processing.
Many programmers and engineers have found out how easy it is to get lost on the New York radio dial – just try to apply conventional audio pro-cessing techniques to an NYC station. The mar-ket is loud and brash – just like the city itself.

In New York, Frank Foti was uniquely qualified to shake up the market with the new Z-100, a fast-paced, take no prisoners CHR format. He had cut his processing teeth at The Mighty Buz-zard in Cleveland, WMMS – and he now was ready for the big time.

Foti developed his "Wall of Sound" at Z-100, using Glen Clark's Texar Audio Prisms as the backbone of the chain. Word of their perfor-mance spread like wildfire. A pioneer in digital processors, Clark's digital Prism was adopted by many stations. Used in combination with the Optimod, some pretty amazing audio came out of that station.

Then Foti put the prototype of his "Vigilante" processor on the air at "The Big Gorilla in New Yawk" and it created quite a buzz. If anything, the Vigilante – an extensively modified Aphex Dominator peak limiter – was *aggressive and loud.*

It was just what the New York market needed

The Vigilante

WHTZ (Z-100) went from worst to first in less than two books and the Z-100 sound had a lot to do with it. Combined with Scott Shannon's pro-gramming (he claims to have invented the "Morning Zoo") the team was invincible.

ANALOG'S DAY ENDS,
DIGITAL'S DAY DAWNS

Toward the end of the 80's decade, word spread of a new form of audio processing, different from anything that came before.

Around 1988, a prototype of the Audio Anima-tion Paragon digital processor appeared, and gave a glimpse into the future.

Valley People, a recording studio equipment manufacturer, had also been showing a proto-type digital processor. I do not know what even-tually happened to either box, but we moved into the 1990's with dreams of digital audio pro-cessing in front of us, but nothing was quite concrete as yet.

Stay tuned! In our next part, we are going to hit the digital accelerator!

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Before his untimely death, Jim Somich and I had a number of conversations by phone and email as we discussed the history of broadcast audio processing and laid the basis for these articles.

Jim took the lead on this guided tour. I get to help finish it off as a tribute to a great radio engineer. Barry Mishkind, Editor@theBDR.net

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