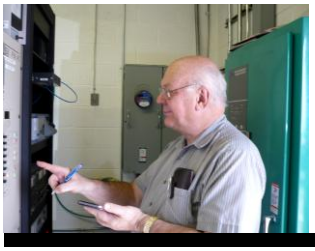
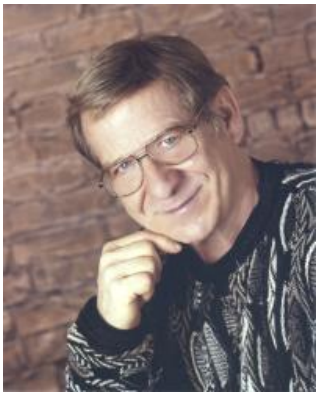


The
**Broadcasters' Desktop Resource**
www.theBDR.net ... edited by Barry Mishkind – the Eclectic Engineer

# SOUND PROCESSING

## A History of Audio Processing

### Part 2 – The Era of Multiband Processing



***by Jim Somich***
***with Barry Mishkind***

*[February 2010] 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 this article.*

*Both of us had been involved in the production of the multiband processors that gave radio a loud, clean voice in the 70s and 80s, and we had watched the changes over the years, from simple levelers to the microprocessor-driven digital processors of today. Part 1 focused on the first audio processors, built for transmitter protection, and ran through to the era of super modulation – where loudness was the singular goal. As before, 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 seems to be contrary to the way artists would like to see their music presented: the dynamic range is purposely reduced and peaks are clipped off. However, much of the "openness" and detail of a work can be lost when audio is compressed and limited this way.

At the same time, audio processing could make stations much louder and the reduced dynamic range made it easier to listen in cars. That made program directors happy. But the audio sounded somewhat flat, and were subject to nasty side-effects of the processor. The artists had to be content that their songs were played – and hoped they sold well in the record stores.

But a change was coming.

**A NEW PLAYER: MULTIBAND AUDIO**

Before the 1970s, most audio limiters and processors came from the big companies: RCA, Western Electric, General Electric, and CBS. However, that began to change, rapidly – and in a big way.

Radio is an exciting business. The pioneers who have led the way were usually an engineer or programmer who was seeking a different sound to the point of obsession. Perhaps you, dear reader, are one of those.

A young recording studio engineer turned broadcast engineer, Mike Dorrough was not a great fan of the famous "Maxx Brothers." He disliked the severe limitations of broadband audio processing, especially when it was pushed hard, simply for loudness. After all, that was why many engineers had been developing Audimax modifications left and right.

I (Jim Somich) first met Dorrough in the early 1970s, as he wandered around the country selling his DAP (Discriminate Audio Processor) or trading it for old gear. His partner, Barry Mishkind, held down the fort in LA. Little did I know how his idea would revolutionize the sound of broadcasting.

However, even Dorrough could not imagine back then how far we come in forty years. There is no question that we have better processing tools today than ever before. Yet, in many ways, we are still learning how to use them.

**WHY MULTIBAND WORKS**

The greatest problem with broadband compression is inter-modulation, caused, for example, when a heavy bass line modulates the mid and upper frequencies. Listeners could literally hear the audio "pumping." Abrupt audio spikes can cause the whole audio package to "duck" – or worse – as instruments (violins, for example) would disappear and reappear in time with the beat.

An Altec-Lansing compressor from the 1950s provided the key concept for a different approach to the inter-modulation problem. It split the audio into two bands and processed them separately. The results were far superior to broadband designs and the idea for the Discriminate Audio Processor was born.

Dorrough's first prototype split the audio into eight bands with passive filters, processing the individual bands with SpectraSonics modules. "The Monolith," as this monster was dubbed, was put on the air at KRLA in Los Angeles and the results were spectacular. This 50 kW AM flamethrower instantly became the most distinctive sound on the LA radio dial!

Unfortunately, the box was very tweaky, with each song sounding quite different from the one preceding it. Dorrough learned two things from his prototype: Eight bands were just too many, and the filter slopes had to be much gentler, allowing the individual band control to be much broader. The DAP 310 was born.


**The DAP310**

The Model 310 was a three-band processor with FET gain-control elements; the limiter was little more than a diode clipper. As the three bands acted independently on the audio, the RMS level was greatly increased, while the dynamic range seemed to stay wide and open. It just sounded good.

Then came a unique marketing campaign, as Dorrough drove around the country.

**SPREADING THE WORD**

Visiting markets, large and small, Dorrough would not only demonstrate the processor, he would leave it

behind so the stations could carefully compare the sound.

In a series of one-on-one, personal visits to of hundreds of engineers and program directors, he would install a DAP in their air chain and let them play with it. Few returned the DAPs, and the Model 310 became one of the most popular broadcast processors to date – with thousands sold.

Dorrough's passion was to make radio sound better. Not just louder, but better. He achieved success with the DAP. DAPs became "secret processing weapons" with their own set of "special tweaks." (One interesting tactic was running two DAPs in parallel, setting one for light processing and the other for much heavier action.)

In the 1980s He introduced the Model 610, an attempt at a discriminate processor with digital control. While the 610 was a decent processor, it never achieved the blockbuster status of the 310.

Meanwhile, the real loudness wars of the 80s and 90s were right around the corner.

**THE ORBAN OPTIMOD**

While a freshman at Princeton, Bob Orban decided to do something about how FM stations were processed. The Stanford engineering graduate had started a small company to build equipment for recording studios, but was dissatisfied with the state of radio audio – FM radio audio in particular.

Up until that time, most FM processors were really AM processors, sometimes with a little modification to handle the 75 uS pre-emphasis curve employed on FM. The result was low average modulation and a lot of peaks – it was not uncommon to hear an overmod light relay clicking away behind the announcer.

In 1972, after experimentation with existing products and different approaches, including FET gain control, program-controlled time constants, nonlinear smoothing, and a pre-emphasized clipper, Orban built a self-described "contraption," the "Overload Protection System." Although not yet a complete processing solution, it stood out on the FM dial when unveiled on KPEN in Los Altos, California.

**The Orban Overload Protection System**

But the big hurdle to overcome in achieving a major advance in FM processing was figuring out how to resolve the significant overshoot caused by the 15 kHz low-pass filters required to protect the 19 kHz stereo pilot region. Orban's breakthrough came when he realized that by integrating the FM processor *and* stereo generator "under one roof" he could effectively control this overshoot, resulting in as much as 6 dB greater loudness on the dial *without overmodulation.*

The whole package came together in 1974 with the prototype: Model 8000.


**The Optimod 8000 was the first FM processor with a built-in Stereo Generator**

The next year, the Optimod 8000A was released for production. To say it was an instant hit is an understatement. A radio legend was born! In fact, to this day for many broadcasters the name "Optimod" has become synonymous with FM processing.


**The Optimod 8000A**

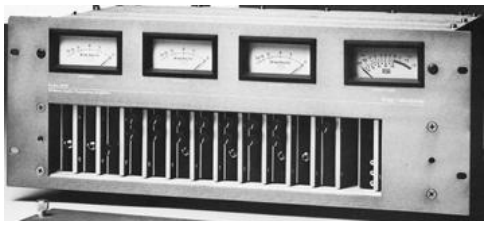
The Optimod 8000A easily made stations louder than anything that had come before with substantially less distortion than the Audimax/Volumax combos of the time. It is a tribute to Orban that there still are many 8000A's running on the air today – over 35 years later.

Orban ended the 1970s by bringing his processing philosophy to the AM band, with the Model 9000A.

## SOUTHERN CALIFORNIA ROCKS

While Bob Orban was making history in Northern California, the tech gurus of Southern California were also hard at work. Among them was Greg Ogonowski, a Detroit engineer who had migrated to the West Coast. Finding no station in LA sounded as good as CKLW back in his home market, Ogonowski was inspired to design his own processor.

Gregg Labs began selling the 2510 Broadcast AM Audio Processing System in 1978. The five-band stereo processor (remember AM Stereo?) had a very clean, yet full sound – the low end was crisp and clear, not muddy, as with many processors of the time.



**Gregg Labs 2510**

The 2510 processed in the L/R domain, so that output would never reach the -75% threshold that was required by Motorola's specifications for C-QUAM audio. The added benefit was a cleaner sound than the matrix processors that most of the other manufacturers were producing because the inverse modulator in the receiver's stereo decoder would not be stressed as hard.

## LOUDER AND LOUDER

In their efforts to stand out, stations tried many tricks, like speeding up the turntables (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 stations sped up records as much as 5% … which is quite noticeable, especially when A/B'd with actual records.)

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

Manufacturers quickly put together packages where a heavier transformer than usual was installed. For example, a 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.

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 call The Modulation Wars.

**LOUDNESS BECOMES PARAMOUNT**

With the technical advances that had come along thus far, radio stations had boosted their average (or RMS) levels from perhaps about 30% modulation up to the 80-90% range. 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. Usually, 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" 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. 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, and Glen Clark (Texar Audio Prisms), which were multi-band gain riders with brick-wall limiters. Stations worked hard to set their modulation to 124.5% positive, 99.5% negative.

**… AND THE METERS STOOD STILL**

Among the most desired processors at the time were products from Ron Jones' Circuit Research Labs (CRL). Jones and his partners developed a full line of audio processors, but perhaps it was his approach to AM processing was the most brilliant.

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

**The CRL AM System**

Another "trick" that was becoming 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 much crisper.

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

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. But as the 80s dawned, it became clear that listeners truly had not heard anything as yet.

## GENERATING THEIR OWN STEREO

CRL sold FM packages as well, 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 a 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 to 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 the main processor at hundreds of stations around the world.

## 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 – 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.

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 was 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 Werbach's 2020 analog processors, a highly complex box that would define and redefine analog broadcast audio processing for some time to come.

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

There were other engineers, some even before Werbach, 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 99.5% negative on the modulation monitor. It did not hurt that Inovonics products were modestly built and priced, although in use at many major market stations as either the primary or backup processors, it was 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 engineers and programmers have found out how easy to get lost on the New York radio dial - just try to apply conventional audio processing techniques to an NYC station. The market is loud and brash - just like the city itself.

In New York, 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 Buzzard in Cleveland, WMMS and he was ready for the big time.

Foti developed what was called the "Wall of Sound" at Z-100, using Glen Clark's Texar Audio Prisms as the backbone of the chain. Word of their performance 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 it was anything, the Vigilante – an extensively modified Aphex Dominator peak limiter – was *aggressive and loud*, 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. When combined with Scott Shannon's programming genius (he invented the "morning zoo") the team was invincible.

## NRSC COMES TO TOWN

As the 1980s drew to a close, the Modulation Wars reached a point where – especially for listeners on the AM dial – that the compression, limiting, pre-emphasis and more were creating such splatter than some stations were actually "stepping" on their neighbors two channels up the dial. In between was a lot of "monkey chatter" – sibilant artifacts that were just hard to listen to – and kept it up under the song the listeners were trying to hear.

Car radio manufacturers retaliated by narrowing the bandwidth of their radios – which just led to more pre-emphasis. Especially at night, the AM band was a pretty nasty place to listen. Something had to happen, or it would be totally unlistenable.

A sort of disarmament treaty was negotiated. Bob Orban and Greg Ogonowski stepped up to the plate in 1983. After discussions with the Society of Automotive Engineers (SAE) and automobile radio manufacturers, Orban and Ogonowski proposed a National Radio Systems Committee (NRSC) and a planned reduction of high end pre-emphasis. In the end, a modified 75 microsecond curve, recommended by Motorola, was adopted.

A number of stations cooperated, bringing a bit of sanity back to the AM band. But it took the FCC to put a modified, new curve - dubbed NRSC-2 into the Rules in June 1990. This not only put a limit on the frequency response, but codified it in the Rules. The aural relief was substantial, thanks to Orban and Ogonowski's efforts.

## ANALOG'S DAY ENDS, DIGITAL'S DAY DAWNS

Toward the end of the 80s decade word spread of a new form of audio processing, different from anything that came before. Around 1988, a prototype of the Audio Animation Paragon digital processor appeared, and gave a glimpse into the future. Valley People, a recording studio equipment manufacturer, had also been showing a prototype digital processor. I do not know what eventually happened to either box, but we moved into the 1990s with dreams of digital audio processing in front of us, but nothing was quite concrete as yet.

Stay tuned! We are ready to hit the digital accelerator!

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The History of Audio Processing - PART 1

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