Radio World®
ENGINEERING EXTRA

REPRINTED FROM JUNE 11, 2008 WWW.RADIOWORLD.COM

DESIGNER INTERVIEW

Dorrough Sets Sights on Blind, Deaf

These Days He Is Committed to Helping Handicapped Broadcasters

by Steve Callahan

In any rack in any broadcast facility there is equipment that is best known, and always will be known, by its inventor's name.

When it's time for a remote, you reach for a Marti, and when you want to measure loudness, you turn to your Dorrough Loudness Monitor.

Mike Dorrough, recipient of the 2000 NAB Radio Engineering Achievement Award, has a long and interesting history in broadcasting. Born in Southern California, he had the opportunity to be part of the broadcasting scene in the 1960s in Los Angeles at some venerable call letters with some very memorable people.

Dorrough shared with Radio World how he developed the Discriminate Audio Processor, or DAP, and by doing so set the stage for multi-band audio processors we use today.

He and his wife Kay live in Wisconsin. One of his passions these days is preserving broadcasting heritage by restoring and preserving classic broadcast equipment and programming. Another project close to his heart is the establishment of a shortwave broadcast station that could help the blind and print handicapped. His wish is that blind and print handicapped people would operate the station and provide programming of interest to the blind community. However, that project has run into obstacles.

Where were you born and where did you go to school?

I was born in Southern California and due to a rheumatic heart went to a special school in Northern California called the "Sunshine School" for children with disabilities. It was there that I had my first interactions with blind children and came to appreciate their remarkable coping skills in a world of touch and sound.

He'd like to thank the Academy: Mike Dorrough (pictured with wife, Kay) won a 2000 Emmy for the Loudness Monitor.

What was your first radio experience?

We lived two blocks from radio station KYA(AM). One day at the age of six or seven, I ambled into the station. They were wide open to the public before the age of lawyers, vandals and copper thieves. By and by I saw the transmitter and was instantly hooked on big iron.

As a very young kid at the end of World War II, I discovered that the local dumps were full of radio hardware discarded by the military. Disc cutters and audio gear also were discovered in those treasure piles. Thousands of pounds of the stuff got dragged home and formed a strange kind of playground. Putting those radio bits and pieces back together gave physical form to my interest in radio and audio.

To this day it's painful to see so many wonderful pieces of historical, lovingly designed and built pieces of hardware rusting away or crushed and melted into refrigerators.

As a less-than-stellar student, it was possible to compensate and even buy some favor with teachers by fixing their house and car radios, a kind of '50s version of the recent "schools to work" programs. It was hard to resist the temptation to do a little bootleg radio broadcasting, tapping into the junkyard stash and an assortment of hardware discards from local radio stations.

My first official job while still in high school was doing remotes for KITO(AM) in San Bernardino. It was amazing to see the mixer's meter go off the scale while the off-air signal being fed back to me through the headphones didn't get loud on those spikes but actually backward modulated before rebounding. This seemed a little like magic at the time.

Was this "shock absorbing" characteristic inherent in the transmitter or was there some other device in the audio chain? That's when I discovered limiters.

The station engineer pointed out the RCA 86A. I learned through doing those remotes that conventional limiters were disproportionately affected by low audio frequencies. That simple observation planted the seed eventually leading to the Discriminate Audio Processor.

An assortment of radio station jobs in maintenance and audio engineering eventually led to a move to Los Angeles and a transition to the recording industry.

When and where was it that you discovered that radio was what you wanted to do?

There was never any doubt that audio and broadcasting would be my career.

Growing up before television became so pervasive, kids could exercise their imaginations to enjoy drama, music and comedy, all while doing their chores, hobbies or homework. A medium that informs, entertains and enhances productivity at the same time is worthy of devotion.

Was there a memorable person who mentored you early?

In a general context, my technical heroes are Edwin Armstrong, Nicola Tesla and, on a first-name basis, Leonard Kahn.

Mike Dorrough, right, and jazz great Les Paul.

Before some interesting "button-down" time as a recording engineer at RCA, I worked in the early 1960s as a sound mixer for "Emperor Productions," owned by Casey Kasem and Bob Hudson. I was very proud to have earned their trust. It was a great environment for a young audio engineer, affording almost unlimited creative latitude.

It was there that I first met my wife and partner Kay.

She was a producer with an ad agency then using the services of Emperor Productions. With Kay acting as the agency's liaison, we recorded Dodge car commercials and Rockwell Tools spots.

Because Kasem and Hudson were also top DJs at KRLA(AM) at the time, they knew lots of important people and brought them into the Emperor studio to do their commercials, program bumpers and other radio bits. We also recorded artists such as The Seeds, The Impressions and Jim Messina. Through this flow of talent I got to know Dick Bogart of RCA. That connection would have significance down the line.

As all good things must pass, so it was with Emperor Productions. Casey Kasem was hired by Hanna-Barbera for cartoon voices, the next step toward becoming a living legend, and Bob Hudson went on to write for television.

The studio was up for sale so I was at liberty to do a brief stint in Detroit for Motown. I loved working with the talent at Motown but missed Kay and California. After returning to L.A., Dick Bogart got me the gig at RCA.

Can you tell us about your experiences as a recording engineer for RCA in the 1960s?

The time at RCA was the highlight of my career in recording. As a kid from a working class background, the wonderful talent and atmosphere of pure class set a benchmark in my life. It might seem terribly dated but there is something to be said for jackets, ties and good manners in setting a tone of professionalism.

I had the honor of working with great producers like Joe Reisman, Neely Plum, and my most favorite, Al Schmidt. The artists who passed through that Hollywood studio were a who's who of the arts.

I had the honor of working with Odetta, Carol Burnett, Harry Nilsson, Peggy March, Lorne Greene, Glenn Yarbrough and other notables. The legends I got to see in action included Elvis, Eddy Arnold, Chet Atkins, Artie Shaw and many more.

The musicality, creativity and perfectionism were inspirational. In those days it wasn't "cut and paste"; orchestras were there in back of the artists, live! I experimented with three RCA BA6A limiters in a patchwork, composite multi-band processor system. People loved the quality but the rig was cumbersome.

RCA was wonderful but large corporations are not as receptive to technical innovation and experimentation from the trenches. I became obsessed with shrinking a multi-band processor into a single box so I could apply the technique to multiple channels. The pursuit of a compact multi-band audio processor eventually led me away from RCA.

Can you tell us about the genesis and development of your Discriminate Audio Processor?

Even as a youngster I began toying with ideas for making recordings sound better on radio, and in the 1960s experimented with crude composite multi-band processor rigs to punch-up studio recordings. Simple broadcast audio limiters, first used in the 1930s to protect transmitter components from harm due to occasional spikes in audio levels, had the side effect of creating more "talk power." The "compression effect" allowed the broadcast engineer to safely turn up the gain. Signals sounded louder, but there was a downside-reduced fidelity.

As stated before, undesirable side effects such as "pumping" were just accepted as the price of protecting the transmitter. A sustained high note, such as a horn, would actually be modulated by prominent, repetitive bass notes.

The solution for broadcast might also be separate limiters for each portion of the sound spectrum. A bandpass system was

devised to first separate "highs," "mids" and "lows." Through a long process of experimentation the ideal breakpoints were determined. Once segregated, the three bands were fed into discrete limiters. The limiters were painstakingly configured to provide the sweetest balance.

Early on it was determined that to maintain "transparency," in order for the processor not to draw attention to itself, some deliberate overlap, or tapering of frequencies, would be necessary. The active filters exhibited a gentle slope.

The next step was to feed the output of each bandpass filter to an individual processor, each with an ideal ratio of compression over the entire audio spectrum. These processors were not summed through the conventional method of applying tone, but rather by injecting pink noise to achieve power flatness as opposed to simple electrical flatness.

This is the first design where the time factor was properly considered along with amplitude. Power, or loudness, as a function of time and amplitude. As a result, the audio material's original waveform balance, complexity and delicacy were not compromised.

After a number of prototypes, my wife Kay and I began manufacturing the Discriminate Audio Processor 310 right on our kitchen table.

The only way to spread the word was to barnstorm throughout the country, literally putting a half million miles on my car installing the units in each market, virtually on speculation. It didn't take long for the engineers and sales departments to see that DAP-equipped stations had improved their coverage.

These days very little is manufactured in the United States. What was it like to manufacture your own electronic products in the 1970s?

From the Kasem/Hudson days on, I had been using variations on multi-band processing for recording.

These early composite versions took up an entire rack, but in 1967 I became aware of new technology that might make it possible to manufacture a compact, fully integrated system. The IC (integrated circuit) made it practical to produce our processor in the context of a "cottage industry." With a major assist from Academy Award-winning electronics pioneer Bill Lasmondes, we put a compact, fully-integrated unit into limited production.

The Dorrough/OpAmp Labs version was an important learning experience. I think that the historical record will support that we were the first to apply integrated circuits to a broadcast/audio product. We never wanted to be a manufacturer but the OpAmp Labs iteration showed us that the necessary components could be integrated onto one chassis.

In 1968 KRLD was outfitted with the "second-generation" multi-band processor. The results were so gratifying that we redoubled our efforts to join forces with a large corporation with the power to fully exploit the worldwide market. As with all unproven technologies it became clear by the early 1970s that we were on our own.

The brilliant Mike Callaghan built us a prototype of a fourth-generation unit, the DAP 310, which was a clever industrial design, more practical for a gradual ramping-up of production. I'm proud that their desirability on eBay 30 years later is a tribute to the 310's performance and visual appeal.

At first we assembled and calibrated the units in our kitchen, a half-dozen or so at a time, and I would go out with hat in hand, station by station, trying to convince engineers to try them out.

The DAP 310 took off and quickly exceeded the capacity of our kitchen table assembly line. Younger readers may not realize that in the 1970s, southern California was the center of advanced electronics manufacturing before we all but surrendered that capability to Asia.

Military and aircraft industries demanded high quality and innovation. Many subcontractors with mil-spec construction standards were available to us at the time. During the first few years of wild growth we tapped into these resources.

As sales increased into the late '70s, it was possible for us to set up our own factory to centralize operations and start development of the first digital-controlled DAP 610, and its companion product the Loudness Monitor.

Dorrough's archiving complex on his property in Wisconsin. 'This kind of space provides a means for us to preserve some of the history of broadcasting,' he said.

The monitor is extensively used today. How did that come about?

The Loudness Monitor actually grew directly out of the DAP 310 and development of the second-generation DAP 610 in the late 1970s. The Loudness Monitor was invented as a way to visualize the effects of processing, displaying the true, real-time relationship between average and peak power.

LEDs were a fairly new technology at the time and seemed ideally suited to studio and broadcast environments. Forty inertia-free, color-coded LEDs in specially designed isolation cells provided superior resolution and readability.

The Loudness Monitor would be the first audio metering device to show a "third dimension," beyond peak and average audio level readings. The peak and average

parameters are based on complementary algorithms.

With more aggressive processing and compression, the gap between the average and peak ballistics closes because the monitor is responding to the dynamics of the audio waveform itself. With pure tone or extreme flat topping, the two ballistics merge. The peak ballistic can display instantaneous transients that would be utterly missed by conventional peak-reading meters.

The Loudness Monitor warns users visually of clipping and distortion that might have occurred at some earlier link of the audio chain. Built-in, fully buffered left/right inputs give the audio engineer the ability to select and monitor discreet left and right channels, or sum and difference.

This capability provides an instant check on channel phase relationships and "center-channel buildup," becoming more and more problematic as engineers struggle with the complexities of mixing surround sound for a wide variety of output devices.

We have recently been awarded additional patents for carrying these unique capabilities into the analysis of digital audio streams as well as analog. It was apparent from the beginning that the Loudness Monitor might have even wider applications than the Discriminate Audio Processor itself.

The transmitter room at the archival house.

Discriminate Audio Processor

You are now trying to establish a shortwave facility operated for and by handicapped folks. What started you on this project?

I've had a long and fulfilling relationship with gifted blind and visually impaired people in the audio and broadcasting fields.

Our family acquired a 16.2 acre plot of land in the town of Oregon, Wis., as the setting for a home and unique broadcast/archiving complex. This kind of space provides a means for us to preserve some of the history of broadcasting.

We have been collecting and protecting rare and fragile transcriptions, tape recordings, films and documents for decades, including much of the UCLA record and transcription library. This new property is the perfect place to properly archive and preserve these irreplaceable treasures of broadcasting's Golden Age.

The establishment of the first-of-its-kind shortwave radio service for and by visually impaired persons would dovetail perfectly with the massive audio archive. The planned non-profit, low-profile, low-power residential operation would be no more noticeable to the widely spaced neighbors than a typical ham radio station. Due to the unique characteristics of shortwave radio, even at the planned modest power levels, the signals would still be heard across the nation.

The benefits to the sightless broadcaster would be apprenticeship and a sense of achievement, and to visually impaired listeners it would offer an endless array of diverse programs created for radio — a medium that once told vivid stories and entertained without visual cues. The program mix would not only include vintage radio plays but new productions from a largely untapped reservoir of creative talent.

With buildings and antennas already in place, just as we were about to apply for our license, we were shocked to see ground stakes outlining what looked like a house foundation in close proximity to our antenna array. The land was a small, triangular parcel left over from the farm subdivision process, only about 1/6 of the minimum required for residential construction.

We're still seeking the advice, legal or otherwise, to help salvage this project and at least a part of our recorded heritage before time and the elements erase the archives forever.

Steve Callahan is the director of engineering for Rhode Island Public Radio. ■