Where's this guy going with all that fuel? **Page 16**

Radio World®
ENGINEERING EXTRA

October 17, 2007

KNOW IBOC: Space-Combined Antenna Match Is Key

After Reports of Noise, Measurements and Tests Conclude Aux, Main Antenna Patterns Must Match

by Mike Hendrickson

Minnesota Public Radio owns 37 radio stations in Minnesota and the neighboring states. Three are in the Twin Cities of Minneapolis and St. Paul.

When the Corporation for Public Broadcasting announced funds to assist public broadcasters with the conversion to IBOC, MPR immediately applied for assistance to make the conversion at KNOW (FM), Minneapolis-St. Paul. After MPR received the grants, construction was begun.

KNOW is a Class C station operating at 100 kW ERP from the Twin Cities Telefarm tower site. The site is in the northern Twin Cities suburb of Shoreview. When the site was constructed in the early 1970s, Shoreview was a rural area. Now it is a densely populated suburb (Figs. 1 and 2).

The station has an ERI SHPX-10AC antenna as the main antenna, and an ERI SHPX-1AC antenna as an auxiliary (Fig. 3). The main antenna is mounted at 304 meters HAAT (274 meters AGL). The auxiliary antenna is mounted at 241 meters HAAT (211 meters AGL).

The initial design plans for KNOW IBOC were to use the auxiliary antenna for transmission of the IBOC signal using "space combining." In order to maintain the proper analog-to-IBOC ratio, the IBOC signal would have a power of 1 kW ERP. This requirement meant the transmitter that would be used for the installation would need an output power of about 2.65 kW after taking into account the transmission line losses and antenna gain.

MPR purchased a Broadcast Electronics FMi703 transmitter for KNOW. This transmitter also was easy to change to an FM-plus-IBOC broadcast mode and could be used to replace the old CCA transmitter that had been used as the KNOW auxiliary transmitter. In fact the new transmitter would have twice the analog power of the old auxiliary transmitter.

In October 2005, KNOW began broadcasting with the IBOC system.

NOISE TO SIGNAL

Immediately after the IBOC transmission began, the MPR switchboard and the MPR membership line began receiving reports of "noise" in the KNOW(FM) audio.

All of the callers were within 1 to 2 kilometers of the transmitter site or were traveling by the site on Interstate 694 or city streets. Many of the callers described the noise as being like "static." The callers who heard the noise while driving gave a

SEE KNOW, PAGE 8

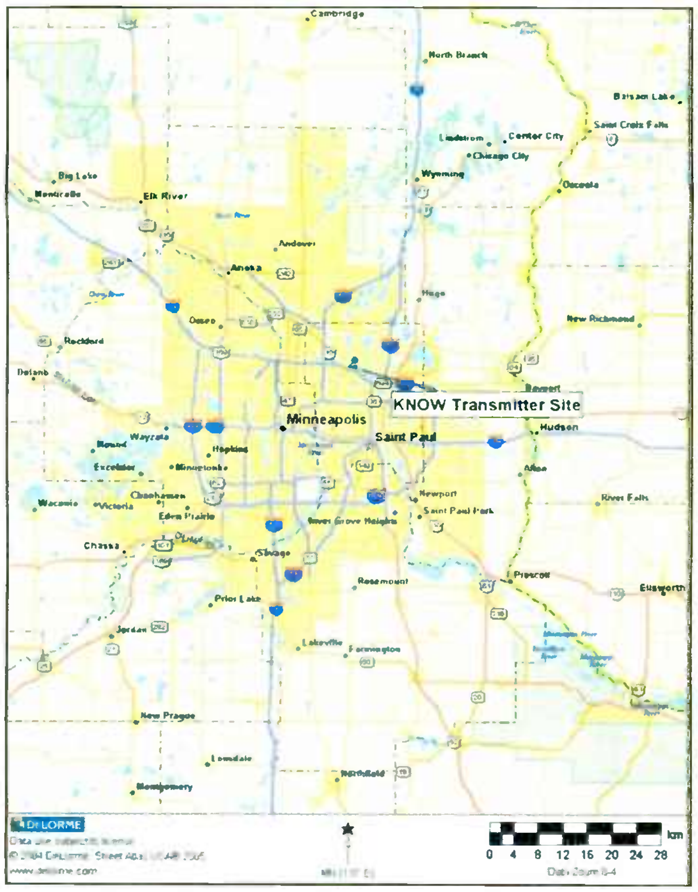


Fig. 1: Map showing the greater Twin Cities region and the location of the KNOW transmitter.

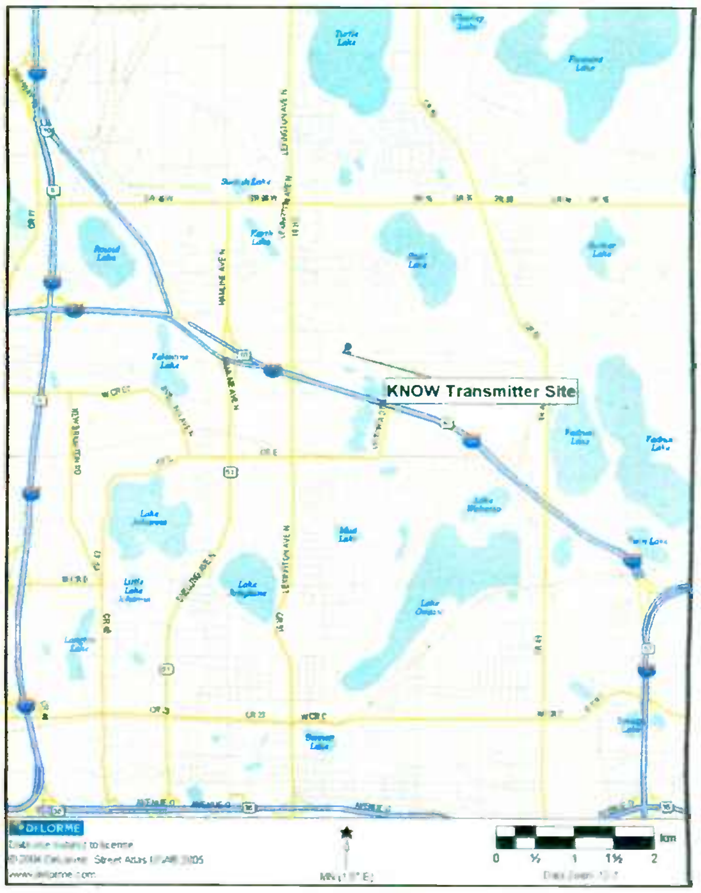
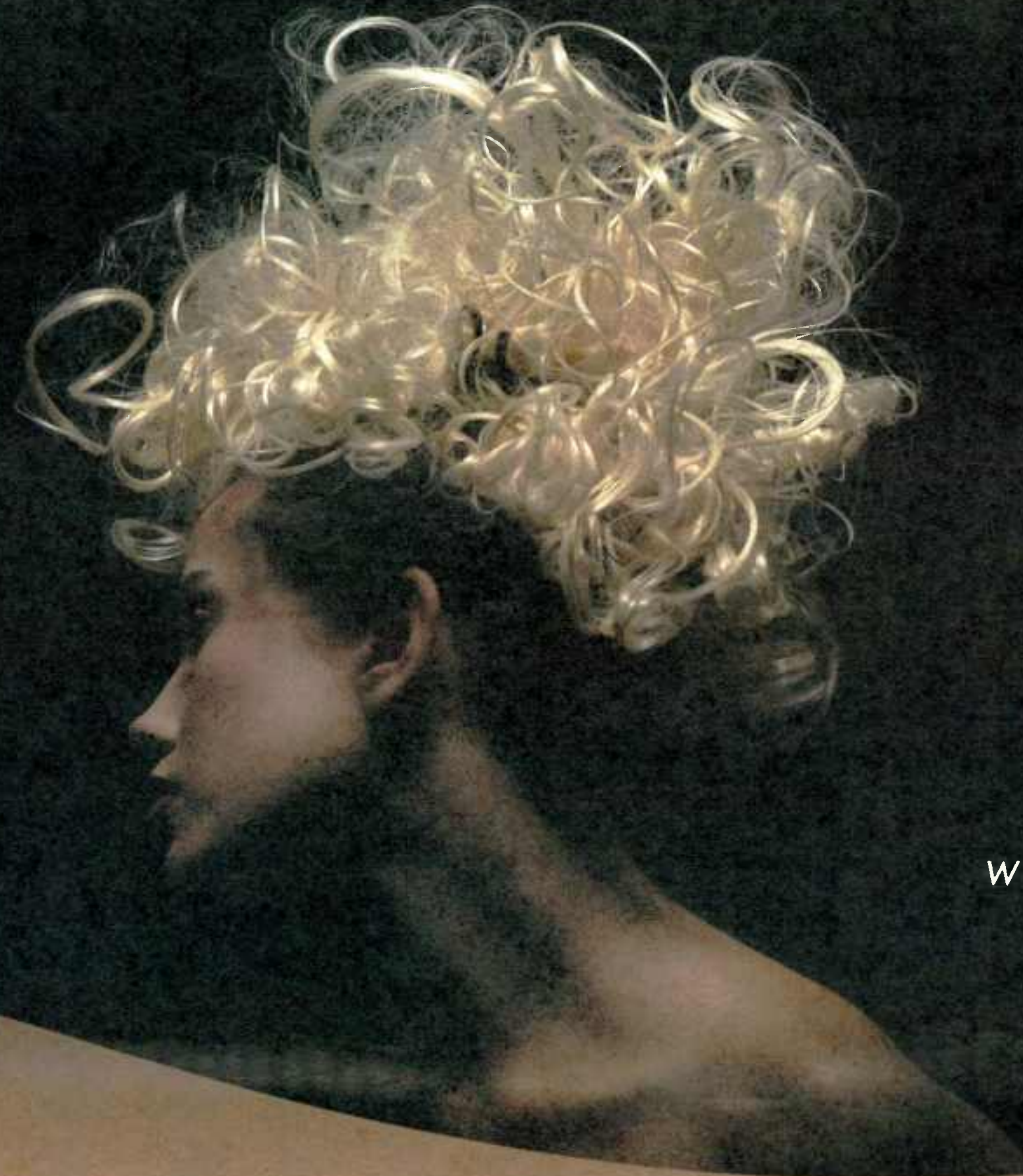


Fig. 2: Shoreview and the immediate area around the transmitter, now a densely populated suburb of the Twin Cities.



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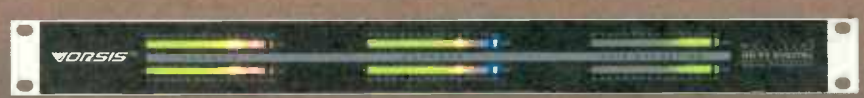

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Vol. 31, No. 26 October 17, 2007

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Next Issue
Radio World: October 24, 2007
Engineering Extra: December 12, 2007

Radio World (ISSN: 0274-8541) is published bi-weekly with additional issues in February, April, June, August, October and December by NewBay Media LLC, P.O. Box 1214, Falls Church, VA 22041. Phone: (703) 998-7600, Fax: (703) 998-2966. Periodicals postage rates are paid at Falls Church, VA 22046 and additional mailing offices. POSTMASTER: Send address changes to Radio World, P.O. Box 1214, Falls Church, VA 22041. REPRINTS: For reprints call or write Caroline Freeland, P.O. Box 1214, Falls Church, VA 22041; (703) 998-7600; Fax: (703) 671-7409.

FROM THE TECH EDITOR

by Michael LeClair

Summer Fun With FMeXtra

I had a bit of playtime this summer during the August doldrums trying out some new technology.

A friend of mine, Lyle Henry, known to many as "The Radio Doctor," was on a whirlwind tour of the United States to demonstrate FMeXtra from Digital Radio Express. Lyle offered to try this out on our FM station so we could do a coverage comparison to our foreign-language analog subcarrier.

FMeXtra uses the portion of the FM channel that has historically been known by the FCC acronym of SCA, or Subsidiary Communications Authority. This region of spectrum is not needed for analog FM transmission and is often used to create one or two analog "private channels," which may provide a reading service for the blind or be leased to a foreign language service. These channels are inexpensive to lease but require special radios to receive.

However, the service area of analog SCA is small compared to standard FM and the audio quality is far inferior, with limited frequency response and high noise floor even in the best of reception conditions.

FMeXtra applies the techniques of digital communications systems to this limited channel and as you would expect, the improvements are dramatic.

COMPUTER-GENERATED

Lyle arrived with his Prius packed with goodies for the demonstration.

The main piece of gear is an encoder that, like HD Radio, is essentially a rack-mount computer. Depending on what services are offered by the FM station, FMeXtra can use more or less of the spectrum above the analog stereo sub-channel.

For example, at our FM station we are running RDS at 57 kHz with 1 percent injection and also an SCA channel at 67 kHz with 10 percent injection. We also are running HD Radio, from 129 kHz to 200 kHz either side of the main channel.

The FMeXtra encoder was configured to provide digital carriers in the "open space" between the 67 kHz SCA and the HD Radio digital carriers. For those stations that do not have RDS or SCAs on the air, a larger number of digital carriers can be used by FMeXtra to provide a more robust signal.

Lyle also brought with him a pair of the new Aruba subcarrier radios that can be used to monitor either analog or DRE digital subcarriers. These came with a power splitter, switched attenuator and a magnetic-mount antenna for our station vehicle so we could drive around and get a good idea of the coverage area and performance under mobile conditions. With two radios and my Kenwood HTC-100 car radio we could simultaneously compare FMeXtra to our existing SCA, analog FM and HD Radio.

For the purposes of the demo, I installed the FMeXtra signal into our FM system in place of the RDS generator. This allowed us to proceed without having to run a new coaxial cable into one of the exciter SCA inputs, which would require opening the transmitter cabinet. The FMeXtra signal occupied 76-99 kHz.

Injection was set using our Agilent E4402 spectrum analyzer. I wasn't able to really play around with measuring the FMeXtra subcarriers but we adjusted them using an averaged display so that the RMS level matched the 10 percent of our 67 kHz analog subcarrier. The FMeXtra signal has a fairly high peak-to-average ratio of 3:1. However, our Belar Wizard digital monitor did not show a large increase in modulation peaks when using the peak weighting function.

> FMeXtra provided a coverage area similar to HD Radio and did not interfere with any of our existing services. It is worth consideration for clients using an analog SCA who want improved coverage area and sound quality.

You would expect it to be necessary to drop down the analog modulation to remain legal; the same as you would have to do when you add an analog SCA. But Lyle explained that with peak weighting on the high speed data subcarriers, this reduction is less than the one half rate that many engineers are used to. It was my impression that only a small reduction in modulation would be necessary.

NICE CODEC

The audio quality of the FMeXtra signal was excellent on the Aruba radio. As source material, we used linear voice recordings, lightly processed and with no distortion. For the tests we used a coding algorithm optimized for voice.

The Voice Age Technologies AMR-WB+ codec is amazing in what it is able to do with a fairly small number of bits (in our case, two channels of about 10.4 and 12 kbps). I would have to give it the edge over AM HD, which operates with more than twice the data rate. In addition to a good audio bandwidth for voice, I could hear no trace of artifacts on the FMeXtra signal. Generally, artifacts are the weak point on systems with high ratio digital compression, causing the voices to sound watery or swishy.

I wanted to push the system to its limit and find out where it would break down so we headed out for an afternoon of driving and listening at the edge of our coverage area.

I chose two test areas: one was an urban area about 30 miles from the transmitter in Lowell, Mass., and the second was just a straight line away from the transmitter while we monitored to determine the point at which the various signals began to drop out.

The urban area distance test was intended to investigate how each system responded to relatively high multipath conditions but fairly low signal strength. The analog SCA was all but unlistenable once we hit the downtown area and significant multipath. The FMeXtra too began to suffer enough dropouts that it was hard to follow.

Interestingly, the HD Radio swam through this just fine with perhaps a few dropouts. With the analog fallback it provided continuous programming that would keep a listener tuned in.

On the distance test, we drove until we began to reach the edge of reception for HD Radio. The FMeXtra was still just working at this point, although when we got off the highway it began to drop off as well. Analog FM was still sounding good but the analog SCA had become noisy enough to be unlistenable long before this point.

Overall, FMeXtra did surprisingly well in this mobile listening environment; there were only a few dropouts along the way, and the Aruba table radios don't have motion or multipath compensation. On the HD Radio, essentially there were no dropouts until we reached the limit of coverage. Along the route we periodically passed through points where the multipath literally wiped out the analog SCA with noise, but FMeXtra continued to work just fine.

It is clear that Digital Radio Express has a system that outperforms the analog subcarriers that have offered stations a secondary audio service for many years. Under

SEE FMEXTRA, PAGE 4

IN THIS ISSUE

NEWSMAKERS

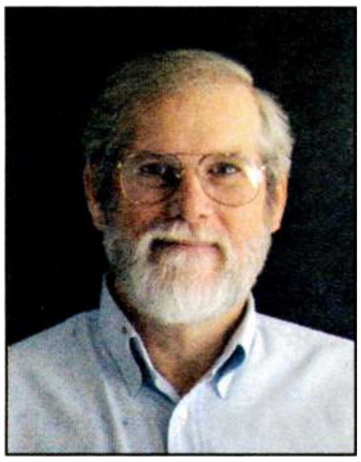
by Tom McGinley

Wheatstone Tackles Audio Processing Market

Vorsis Line Introduced a New Player to a Competitive Niche

A handful of companies have dominated the broadcast audio processing market in the United States for as long as anyone can remember.

Recently Wheatstone Corp., known as an audio console and router manufacturer, introduced a high-end, full-featured audio processor called the Vorsis AP-1000. In many ways, Vorsis propelled the state of the art of this field into important new directions such as an FFT graphical display of real-time waveforms; low-latency, 31-band limiting and clipping functions available on all presets; and giving the user access to a full range of controls without imposing the usually encountered limits on adjustable parameters.



Andrew Calvanese

Jeff Keith

Since then, Wheatstone has expanded the Vorsis family into a line of stand-alone audio processors. Shortly after the spring NAB convention this year, we engaged two key members of the Wheatstone audio processing team, Andrew Calvanese, vice president of engineering, and Jeff Keith, design engineer, in a discussion about Vorsis.

Wheatstone has been a name associated with audio mixing consoles for many years. Tell us a little about how the company got started.

Wheatstone started 30 years ago making audio processing equipment. As a matter of fact, we introduced one of the first true parametric equalizers in the market, many of which are still in service today. We were making analog equalizers and compressor/limiters in the 1970s.

Then as now, we felt that technology had progressed to a point where there were effective new ways to address the traditional audio issues of "sound" and "loudness."

When and why did you decide to branch out and break into the audio processing market?

We're glad you've asked that question. It is a mistake to think that we have branched out and added audio processing to our product line. Our products have always included a full suite of audio processing in them.

Just look at one of our live TV consoles or radio production consoles with surround processing and multi-channel dynamics control with a GUI interface.

We wanted to bring the new approaches and technical expertise we had available to on-air radio.

Who are the principal designers and members of the audio processing team?

Our design team includes owner Gary Snow, Andrew Calvanese, Steve Dove, Jeff Keith and about eight other people. We have been involved in designing audio products going back more than 30 years to before microprocessors were available.

As primarily an audio console and router company, could you draw any special expertise from that field to apply to audio processing?

One of the main things that our experience as a console company gives us is an understanding of how to design and build equipment to work right out of the box, and to remain reliable for year after year. Our 30 years experience doing this has taught us a lot of things that we carry with us as we design new products, and our manufacturing structure — we have complete control of the manufacturing processes under one roof — gives us the tools to make sure things are built right in the first place.

Another important factor is that our years of building consoles and having clients tell us how much better they sounded after installing a Wheatstone console have taught us to never lose sight of how important sound is.

You introduced the Vorsis AP-1000 last year as your first stand-alone audio processor series. It's now your flagship product in a full line. Describe the line.

Each application area has unique requirements, and some of the specialized functions can be confusing to other industries, so we have targeted these areas with individual models mainly to match the user interface to the application area. Our product line currently includes the M1, AP-3, HD-P3, FM5, AM5 and AP1000, and more are on the way.

The M1 is a digital signal processing-based microphone processor with four-band EQ, expander, de-esser, high-pass filter, low-pass filter and compressor/limiter. It has front-panel controls for these functions plus optional software for controlling it remotely over your network.

The AP-3 is a general-purpose, two-channel stereo processor with microphone, analog line and AES digital inputs with both analog and digital outputs. The DSPs provide all of the M1 functions plus a three-band AGC/compressor/limiter/clipper to do sophisticated microphone, IFB, phone, mastering and basic air processing. It has front-panel controls plus a Windows-based graphic user interface for remote control applications.

The HD-P3 is a three-band processor dedicated to processing HD signals. It is designed to be software controlled only and therefore has no front-panel controls.

The FM5 is a dedicated FM air processor with a five-band front end and 10-band limiter/clipper. It comes with a flexible GUI for remote control.

The AM5 is dedicated for AM and includes a five-band front end, 10-band limiter and separate final output limiter. It likewise comes with a remote GUI.

The AP-1000 is a specialized FM processor with a five-band AGC compressor on the front end and two independent 31-band limiter/clipper paths that allow for extremely precise control of both FM and HD paths. It includes an

SEE VORSIS, PAGE 12

FMeXtra

CONTINUED FROM PAGE 3

our operating conditions, FMeXtra provided a coverage area similar to HD Radio and did not interfere with any of our existing services. It is worth consideration if you have clients using an analog SCA who want to enjoy improved coverage area and sound quality.

FROM THE BOOKSHELF

About 10 years ago I had my first experience with an AM directional array and it was something of a trial by fire. In addition to what I learned from patient engineering consultants, there was one book that taught me a great deal on how these complex systems work: "Directional Antennas Made Simple," by Jack Layton.

Just released this summer is a new, second edition of this classic book, and it contains all that you would ever need to know about how a directional array works and how to maintain them.

The second edition also contains recommendations on how to build a directional antenna system, install it properly and make measurements for the proof. The book is easy to follow and understand. This is an essential resource for anyone who needs to take care of directional AM systems.

Do you have a favorite book that helped you in your career as an engineer? We always like to read your comments and suggestions. Don't be shy; drop us a line at *rwee@imaspub.com* and let us know what you're thinking. ■

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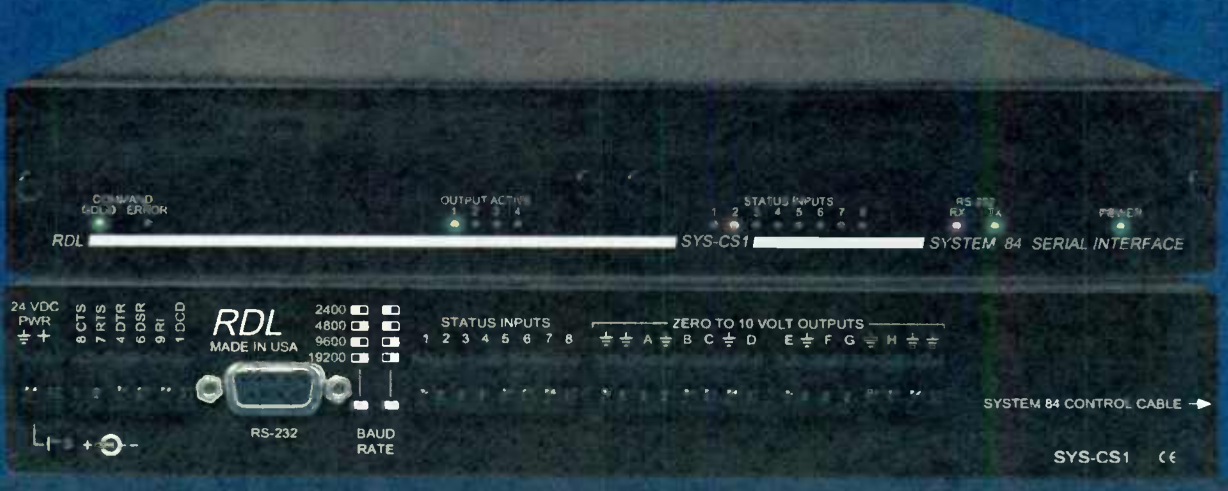
RS-232



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by Blažo Guzina

Solid Acoustics Yield Quality Studio Performance

Studio design approaches may differ in detail between North America and Europe, but the quality of acoustics is an important factor regardless. Blažo Guzina, a senior engineer at Radio Televizija Srbije in Belgrade, Serbia, writes about studio design considerations.

The basic requirement for a small radio station is one main studio complex for broadcasting, consisting of a studio and accompanying control room, and a second studio for recording and editing that can serve as a hot reserve for the first studio.

Larger radio and television centers have various classes of studios, control rooms and other technical areas created to satisfy the manifold demands of the listeners.

TYPICAL SETUP

A typical regional radio center may have several studios for speech only, pop music, light and orchestral music, light entertainment (with room for an audience), general purpose studios and, in the case of the largest radio centers, a drama studio.

A studio is an acoustically isolated room with the interior acoustic treatment designed to meet the desired reverberation time. Microphones are placed and sound sources — speakers, musical instruments, actors, vocalists — are recorded in the studio.

The control room is adjacent to the studio. It is used for the mixing, editing, recording, monitoring, metering and processing of sound signal output from the microphones in the studio.

In order to understand the principles of the interactions of sound with the physical structure that forms the studio, it is necessary to look at basic aspects of the generation and propagation of sound.

Movement of a vibrating surface — human vocal cords or the membrane of the loudspeaker, among others — produces a pressure wave. The air in the sound field is compressed and rarefied, so that the variation of air pressure is propagated from the sound source, as depicted in Fig. 1.

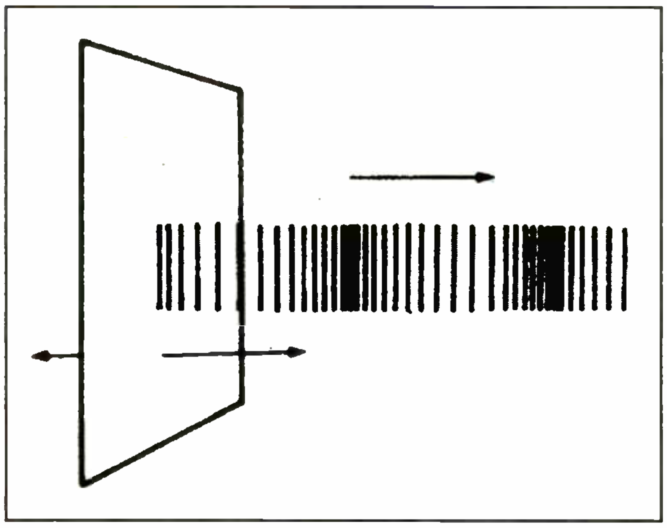


Fig. 1: Generation and Propagation of Plane Sound Waves

The sound waves cover the audible frequency spectrum from 16 Hz to 20,000 Hz.

A corresponding range of wavelengths is comparable with the dimensions of entire buildings — 17 meters (about 55 feet) at a low frequency of 20 Hz down to 17 millimeters (about .66 inches) for a high frequency of 20,000 Hz.

The loudness of sounds is a function of the amplitude of the pressure variations in the air and the corresponding amplitudes of vibrations in the ear. The sensitivity of the human ear is frequency dependent, around 14,000 Hz at its most sensitive.

When discussing the insulation between two rooms against airborne or impact sound, the simplest case is to consider one room as the source room and the other as the receiving room with one common dividing element, in other words a wall or a floor and ceiling.

MASS LAW

The sound energy incident upon the boundary surface will depend on the sound power output of the source and the total sound absorption in the room, in this case any studio premises.

When soundwaves strike the boundary of the studio, part of their energy converts into vibration of the surface, while the rest is reflected back. Heavy structures have a large mass reactance — hence, only a small part of the acoustic energy converts into vibration energy.

The impedance of the boundary surface increases both with an increase of the mass of the structure and with higher frequencies.

This is known as the so-called "mass law" for sound insulating materials. Mass law behavior is complex and frequency dependent — sound insulation will show large variations across a frequency range, which is bounded by resonances of various types.

The average sound reduction index of single boundaries as a function of their surface mass, over the range of 100 Hz to 3200 Hz, is shown in Fig. 2.

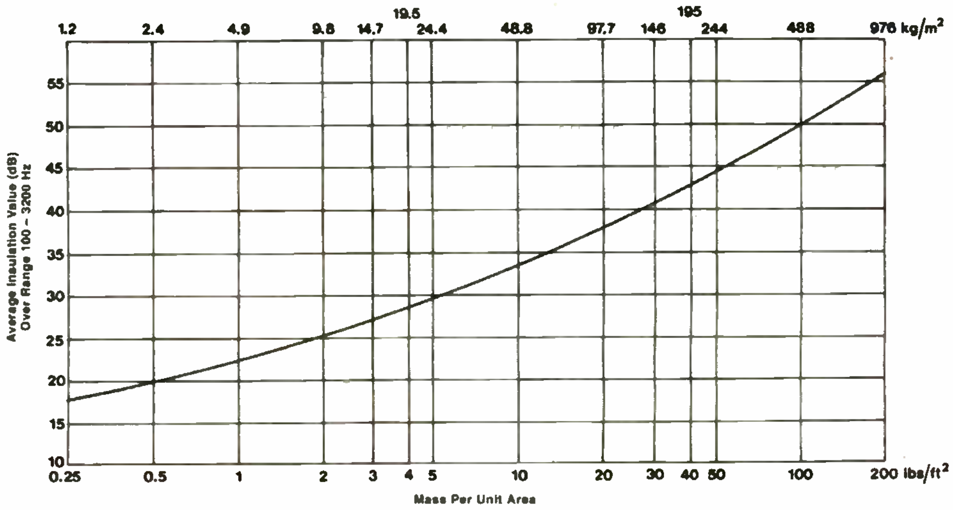


Fig. 2: Average Sound Reduction Index Over Range 100 Hz–3,200 Hz

If the sound reduction index of a boundary wall is 52 dB, then the incident sound energy would be reduced by 52 dB in transmission through it. Hence, a sound source of 75 dB in one room will produce only 23 dB in the receiving room (75 – 52 = 23).

As regards sound insulation, studio and sound control room, the basic studio premises in a radio center should meet certain requirements in order to prevent unwanted sound (noise) from being audible on the program output, and engineers from being annoyed while subjectively controlling the sound quality.

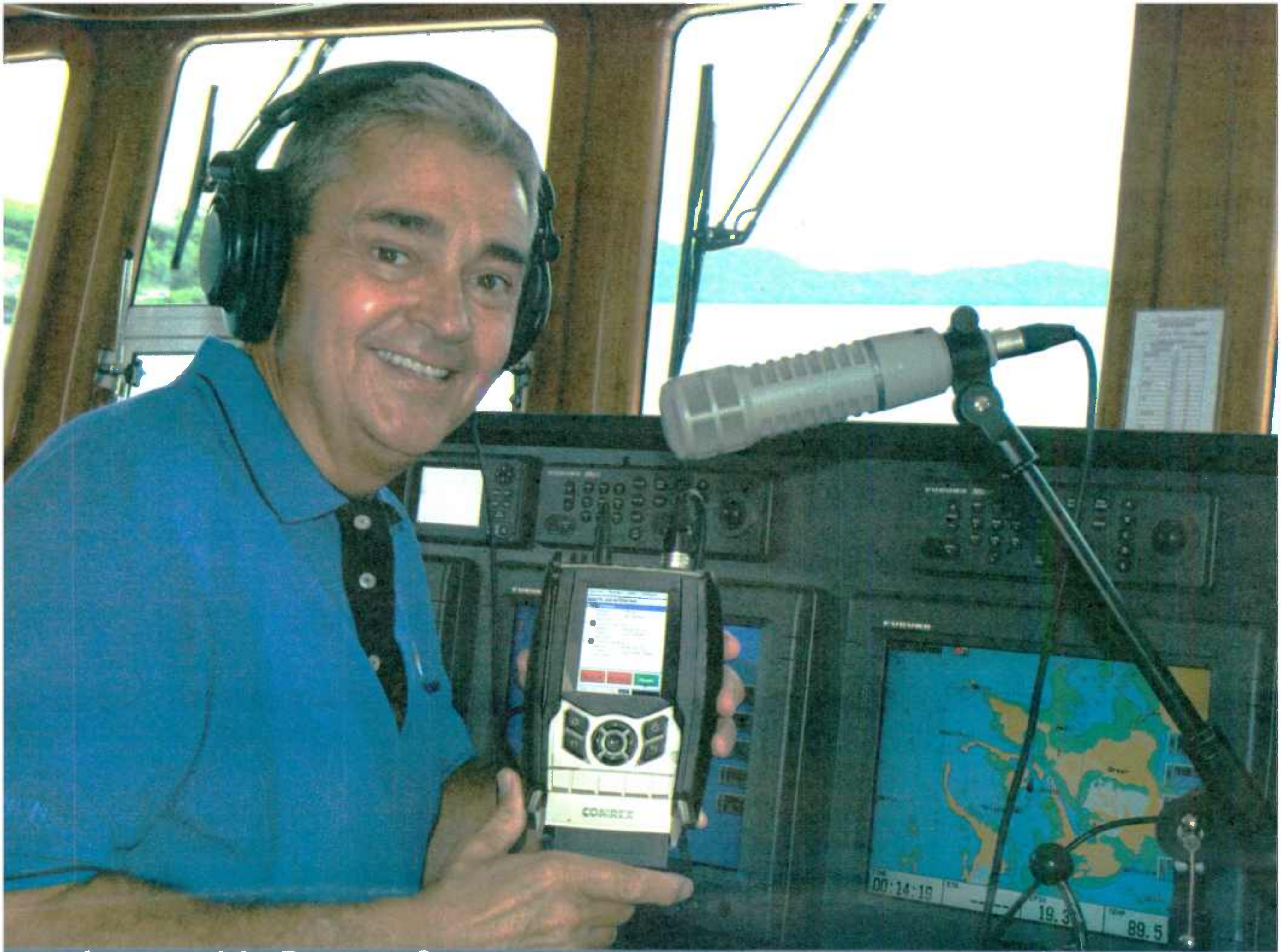
The amount of sound insulation necessary to avoid interference between areas, and hence the acceptable level of attenuation of the unwanted sound in the protected room, depends on the existing ambient noise level, taking into account the psychoacoustic properties of the so-called masking effect.

Ambient noise levels are different in a studio and control room, and so are the permissible noise levels. These levels usually have single-figure descriptors, such as dB(A), noise rating (NR) or noise criteria (NC). For design purposes, it is essential to observe the entire spectrum of noise in the form of NR or NC curves.

Although architects only have to consider a range from 100 Hz to 3,150 Hz, the acoustics designer of a radio studio should typically consider a broader range, sometimes even as broad as 63 Hz to 8,000 Hz.

The curves relate octave-band sound

SEE ACOUSTICS, PAGE 22



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KNOW

CONTINUED FROM PAGE 1

description similar to that of multipath.

This problem seemed to be much more severe on analog-tuned radios, compared to digitally-tuned radios. If an analog-tuned radio was mistuned even slightly, the noise completely overrode the KNOW analog audio.

After the calls began, the transmission system of KNOW was checked. The network control operators could not hear any noise in the analog signal on the monitoring equipment in the network control center at the studios of MPR, about 13 km from the transmitter site. Several of the MPR staff verified that there was no noise in the received signal as heard on car radios in the area of the MPR studios in downtown St. Paul.

Randy Greenly, the transmitter supervisor for KNOW, went out to the site to verify that all equipment was operating correctly. Once he was within 2 kilometers of the site he verified that there was indeed noise in the analog signal, but it was location-dependent. The noise would increase and then decrease as he drove closer to the transmitter site. The noise disappeared completely when the IBOC signal was turned off.

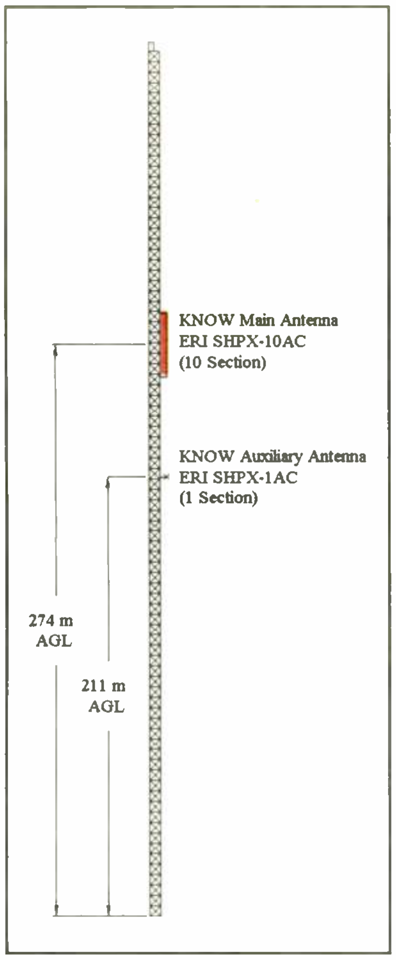


Fig. 3: Diagram of KNOW tower showing location of main and auxiliary side-mounted antennas.

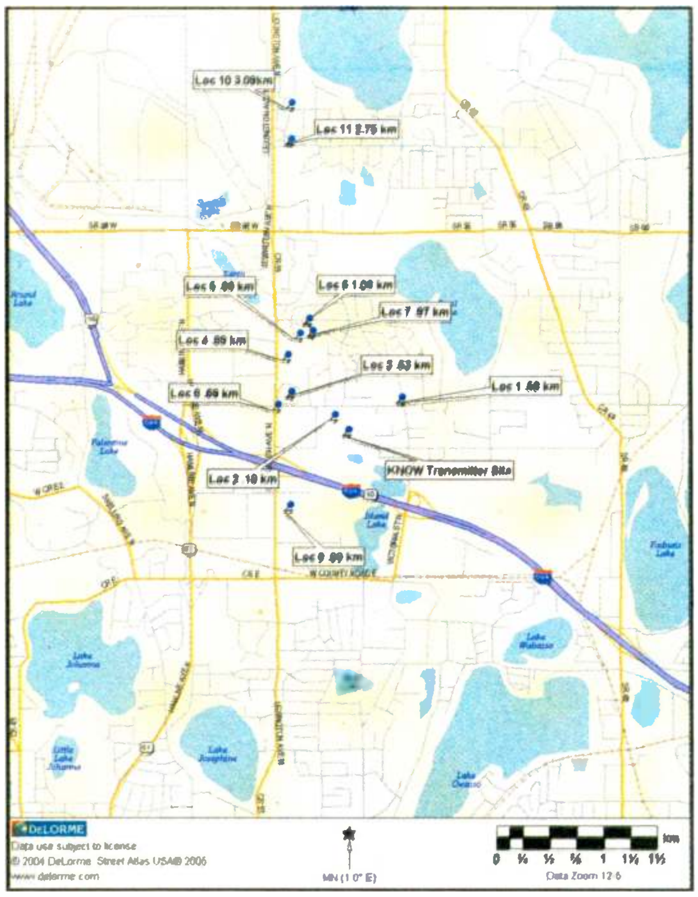


Fig. 4: Map of measurement locations at points where analog interference existed due to IBOC operation

The engineering department suspected the problem was a result of the digital signal interacting with the analog signal in some way. It was decided to conduct a series of measurements in the immediate area of the transmitter site.

A spectrum analyzer was placed in a van connected to a magnetically-mounted whip antenna mounted on the center of the roof.

The initial measurement of KNOW was made approximately 30 kilometers south of the site. The spectrum display showed the station completely meeting the IBOC mask. The IBOC carriers were approximately 43 dB below the FM carrier. KNOW's FM audio sounded fine, without any noise, at this location.

Measurement locations were determined by driving in a radius of up to 3.1 km of the transmitter site while listening to the vehicle's radio, which was tuned to KNOW. When the noise floor of the station increased, a measurement of the signal was made with the analyzer. Each time a measurement was made of the KNOW signal, the exact location of the measurement was recorded from a GPS receiver. Measurements were only done in the locations where noise was heard on a radio. A photograph of the spectrum analyzer display was also made (Fig. 4).

THE WRONG RATIO

It was discovered almost immediately that at the measurement locations with the increased noise floor on the analog signal, the IBOC carriers were much higher in level than the –43 dB relative to FM carrier measured at the initial location. The IBOC carriers were in the range of –20 to –30 dB below the FM carrier (see Fig. 5).

The noise in the analog signal was resulting from the interference of the IBOC

SEE KNOW, PAGE 10

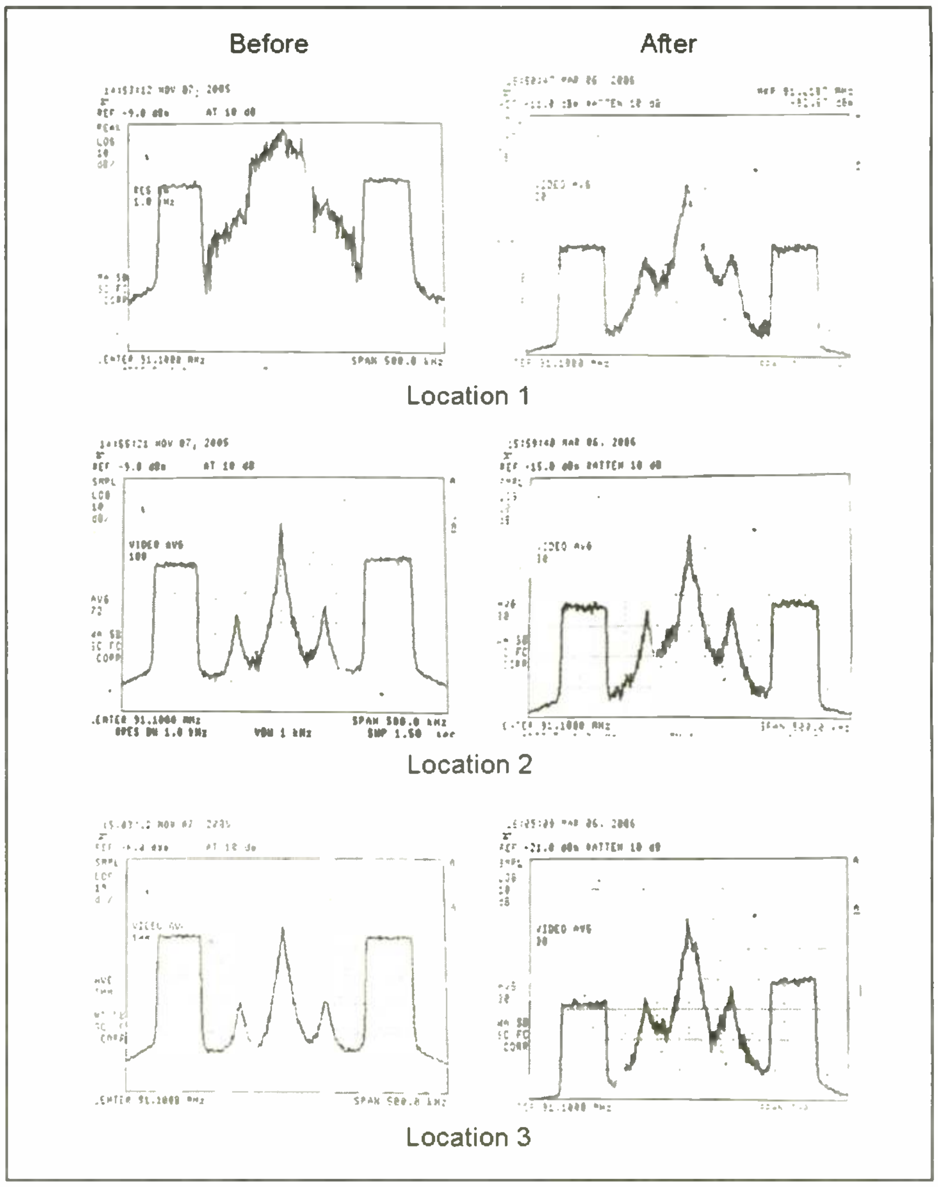


Fig. 5: Spectrum analyzer display shows IBOC carriers on the left well above the proper level relative to the analog FM carrier. On the right are photographs of the signal levels at the same locations using high-level combining.

Feature packed.

(Kind of like our ads.)

Go (con)figure • The folks at MPR say they really love being able to configure and administer an entire building full of consoles and routing equipment from the comfort of their own offices. Put an Internet gateway in your Axia network and you can even log into Element (or any other part of an Axia system) remotely from home, where there's plenty of Cheetos and Pepsi. Great for handling those 6 P.M. Sunday "help me!" phone calls from the new weekend jock.

Who are these guys? • Why buy a console from Axia? Element was designed by Mike Dosch and his team of ex-PR&E renegades (who know a bit about consoles). And Axia is a division of Telos, the DSP experts.

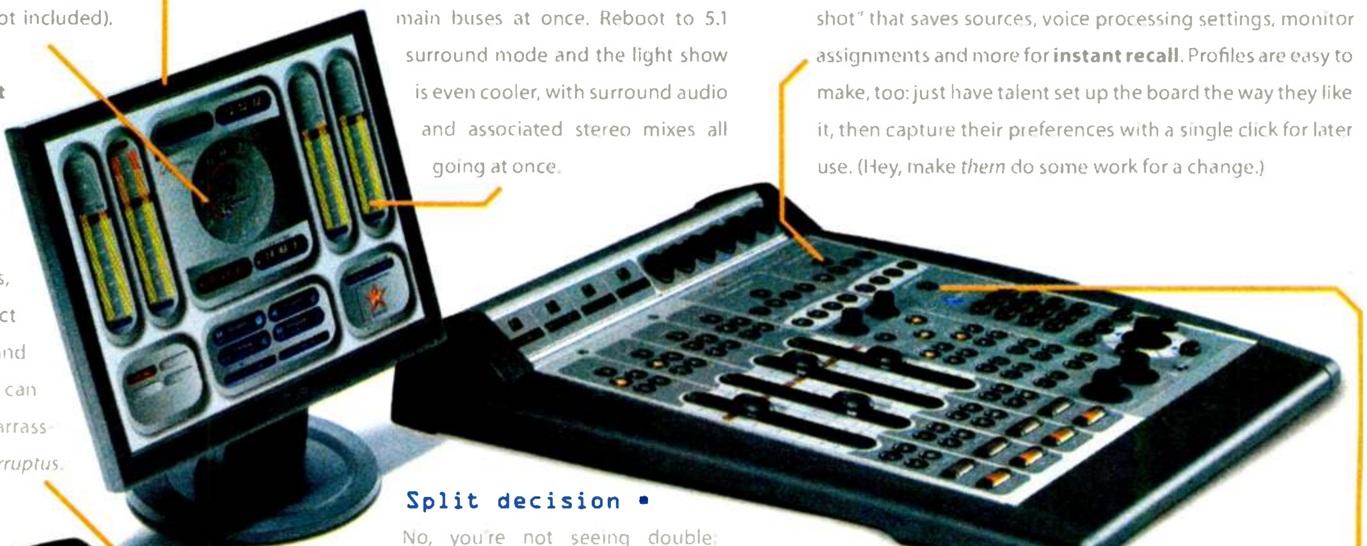
Perfect timing • You can't have too much time. That's why Element's control display contains **four different chronometers**: a digital time-of-day readout that you can slave to an NTP (Network Time Protocol) server, an elapsed-time event timer, an adjustable count-down timer... and there's also that big, honkin' analog clock in the center of the screen (Big Ben chimes not included).

Screen play • Use any display screen you choose, to suit your space and décor. Get a space-saving 12" LCD, or go for a big 21" monster. (This is Dave Ramsey's favorite Element feature, by the way. Anyone want to bet he bought his monitors on sale?)

Lovely Rita • LED program meters? How 1990's. SVGA display has lots of room for timers, meters, annunciators and more — enough to show meters for all four main buses at once. Reboot to 5.1 surround mode and the light show is even cooler, with surround audio and associated stereo mixes all going at once.

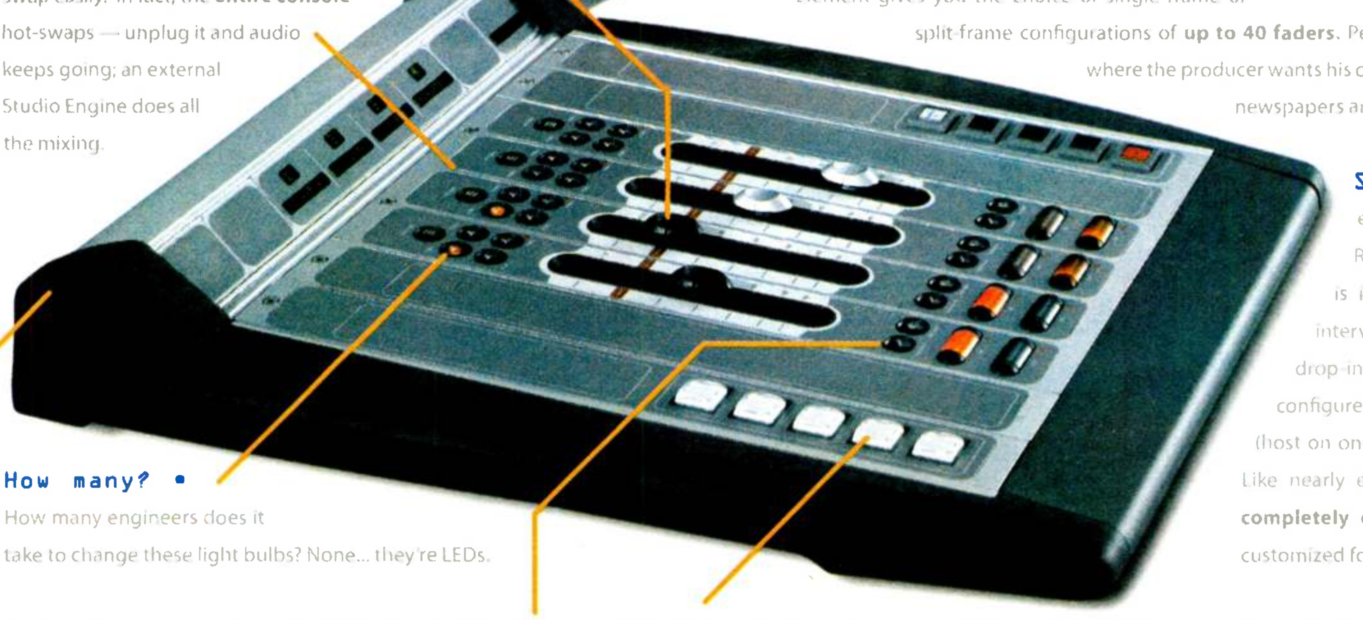
Memory enhancer • We know how forgetful jocks can be. That's why Element remembers their favorite settings for them. Element's Show Profiles are like a "snap-shot" that saves sources, voice processing settings, monitor assignments and more for **instant recall**. Profiles are easy to make, too: just have talent set up the board the way they like it, then capture their preferences with a single click for later use. (Hey, make *them* do some work for a change.)

Black velvet • Some things **just feel right**. Like our premium, silky-smooth conductive plastic faders and aircraft quality switches. We build Element consoles with the most durable, reliable components in the industry — then we add special touches, like custom-molded plastic bezels that protect on/off switches from accidental activation and impact. Because we know how rough jocks can be on equipment. And nothing's more embarrassing than a sudden case of *broadcastus interruptus*.



Split decision • No, you're not seeing double: Element gives you the choice of single-frame or split-frame configurations of **up to 40 faders**. Perfect for complicated talk or morning shows where the producer wants his own mini-mixer, or to give talent space for copy, newspapers and such. Solomon would be proud.

Swap meet • Element modules hot swap easily. In fact, the **entire console** hot-swaps — unplug it and audio keeps going; an external Studio Engine does all the mixing.



Stage hook • This button activates the emergency ejector seat. OK, not really. It's the Record Mode key; when you press it, Element is instantly ready to record off-air phone bits, interviews with guest callers, or remote talent drop-ins. One button press starts your record device, configures an off-air mix-minus and sends a split feed (host on one side, guest on the other) to the record bus. Like nearly everything about Element, Record Mode is **completely configurable** — its behavior can even be customized for individual jocks. Sweeeet.

How many? • How many engineers does it take to change these light bulbs? None... they're LEDs.

Talk to me • Need some one-on-one time with your talent? Talk to studio guests, remote talent, phone callers — **talk back to anyone** just by pushing a button.

The Busy Box for jocks • Element comes standard with a lot of cool production-room goodies you'd pay extra for with other consoles, like per fader EQ, aux sends and returns and custom voice processing by Omnia™, enabling you to quickly build and capture compression, noise gating and de-essing combinations for **each and every jock** that load automatically when they recall their personal Show Profiles. Context-sensitive SoftKnobs let production gurus easily tweak these settings, while simultaneously satisfying their tactile fixations. (Don't worry: for on-air use, you can turn off access to all that EQ stuff.)

Missing features • Did we forget something? Program these **custom button panels** with any macro you want, from recorder start/stop to one-touch activation of complex routing and scene changes using PathfinderPC™ software. You could probably even program one to start the coffee machine (black, no sugar, thanks).

Mix-plus • If constructing a complicated mix-minus on the fly brings a big grin to your face, you're excused. But if you're like us, you'll love the fact that Element does mix-minus **automagically**. Forget using all your buses for a four-person call-in, or scrambling to set up last-minute interviews. When you put remote codecs or phone calls on-air, Element figures out who should hear what and gives it to 'em -- as many custom mix-minuses as you have faders.

Great Phones • With Element, jocks never have to take their eyes or hands off the board to use the phones. Element works with any phone system, but really clicks with the Telos Series 2101, TWOx12, and new NX-12 that connects four hybrids plus control with a **single Ethernet cable**. StatusSymbols™ (cool little information icons) tell talent at a glance whether a line is in use, busy, pre-screened, locked on-air, etc. Even dial out with the built-in keypad.

AXIA
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Element

Shown: 16-position split-frame Element, nicely equipped, $12,558.00 US MSRP. Not shown but available: 4-, 8-, 12-, 16-, 24- and 28-position Element. Dual exhaust and whitewalls optional at extra cost.

KNOW

CONTINUED FROM PAGE 8

carriers to the analog carrier. This interference only appeared close to the tower site. It was resulting from the difference in the vertical patterns of the FM antenna and the auxiliary antenna being used for the IBOC carriers (Fig. 6).

Immediately after the IBOC transmission began, the MPR switchboard and the MPR membership line began receiving reports of 'noise' in the KNOW(FM) audio.

After the measurements were completed, the engineering department made the decision to reduce the power of the IBOC transmitter from 2.65 kW to 0.9 kW. This reduction eliminated most of the noise resulting from the interference.

The engineering department then looked at the possible alternatives to the space-combined method. It was quickly decided to convert the installation to a high-level combined type of IBOC system. A high-level combined system would require a transmitter output power of approximately 2.2 kW. Fortunately, the auxiliary antenna was of low gain, so a high-powered IBOC transmitter had been purchased for the space-combined system.

The initial planning of the IBOC system was to permit the IBOC transmitter to be operated in a FM + IBOC mode into the main antenna in the event of a main transmitter failure. The same transmitter could be used for the high-level combining system. In fact, the only extra equipment required for the change to the transmission system were the IBOC injector and some rigid transmission line components.

The changeover to the high-level combined system went smoothly, but slowly. KNOW is the flagship news and information station of MPR and one of the higher-rated stations in the Twin Cities market, so construction could only be done between the hours of midnight and 5 a.m. to avoid disruption of the programming. When the high-level combined system went on the air there was no evidence of the interference or "noise" to the analog signal by the IBOC carriers.

Another set of measurements was made at the same locations measured in the initial KNOW IBOC system. These measurements showed the digital carriers were maintaining the proper IBOC-to-FM ratio in the field (Fig. 5).

After the measurements were completed, the theoretical nulls for the main antenna

See KNOW, page 12 ▶

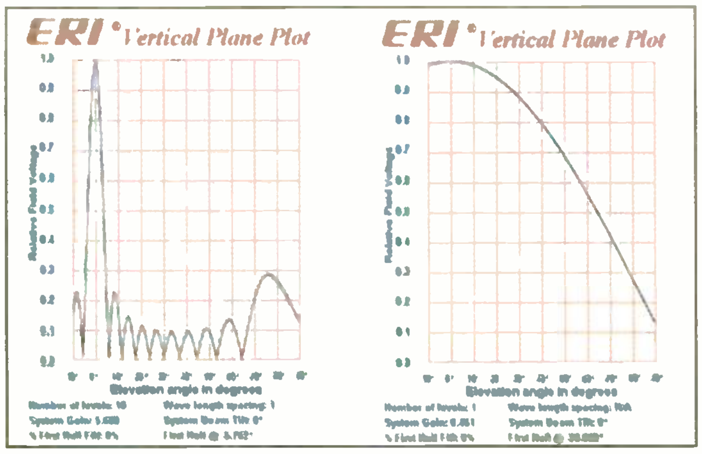


Fig. 6: Vertical plane plots of the KNOW main and auxiliary antennas. Note the multiple nulls in the pattern for the 10-bay antenna vs. the single bay.

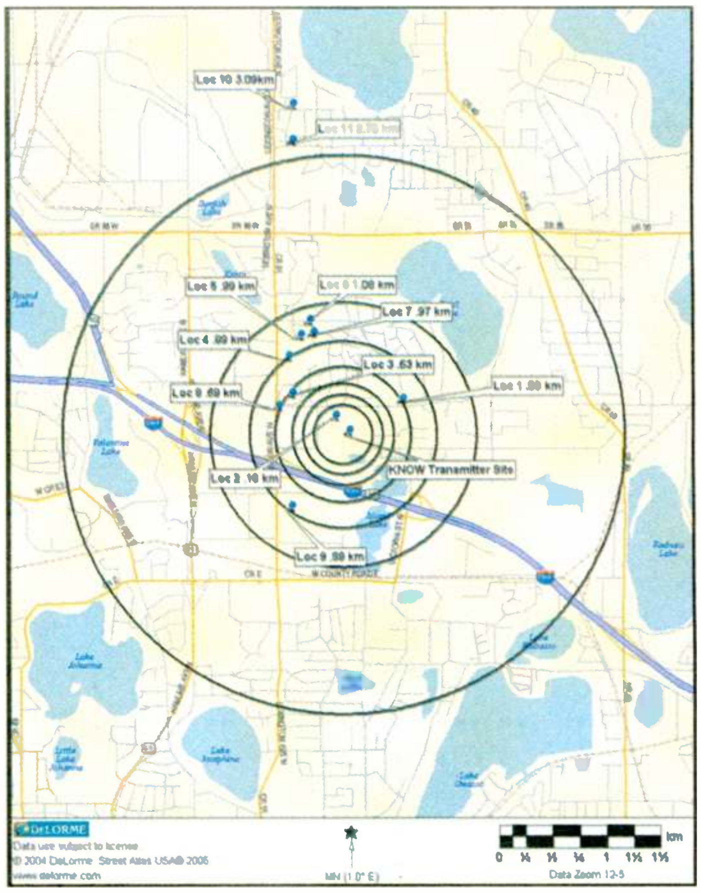


Fig. 7: Map showing predicted locations of signal nulls from the KNOW main antenna from vertical plane plot.

Vorsis

CONTINUED FROM PAGE 4

on-board computer running a front-panel GUI display for local control plus a Windows GUI for remote control over your network.

What is the Vorsis design philosophy?

The design philosophy behind the Vorsis product line draws on years of Wheatstone's experience in the broadcast industry. Our factory and design resources are state of the art. We use those resources to make fine, reliable broadcast products.

Also, our goal for the Vorsis line is to provide our customers with the latest in audio processor technology. We'll reach this goal by using not only the latest DSP technology and design tools, but also through our creative and talented design team, who collectively have well over 150 years of broadcast industry and DSP coding experience.

Third, we're providing Vorsis customers with an opportunity to step out of the norm of present-day processing algorithms and into a new way — a better way — of doing things. The industry has taught us well about what audio processing customers really want. Our combined experience in many facets of broadcasting — everything from years of real-world field experience, to years of designing audio processing algorithms, to years of writing DSP code for myriad products, to design and manufacturing facilities — gives us a competitive edge that the other companies just can't begin to touch.

Our lower-cost audio processor offerings are in most cases partial derivatives of our more complex ones. Therefore we have the benefit of economies of scale and are able to offer features and performance in those products that would be unheard of for the cost.

Discuss how you went about constructing your format preset offerings. Do you offer "low-latency" versions of presets for all major formats?

Our factory presets are excellent starting points for the 95 percent-plus of customers who don't wish to try to create a sound from scratch. In fact, you can think of factory presets as more of a "quick start, get on the air without embarrassment" kind of thing, rather than trying to give every user the "Holy Grail."

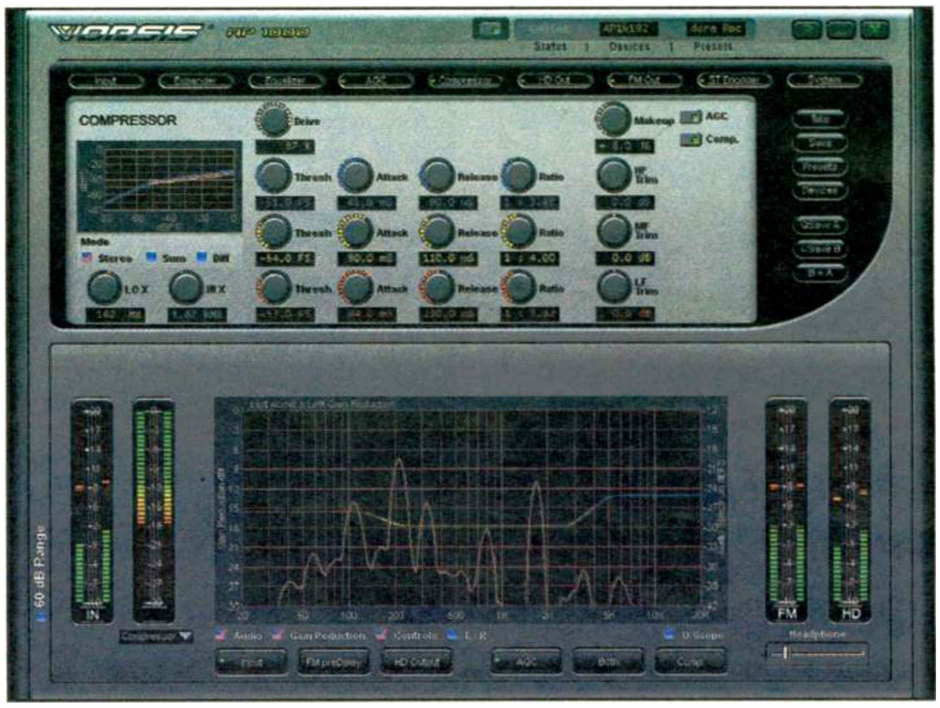
Vorsis products have no need for "low-latency" presets. In fact our most complex processor, our flagship AP-1000, has a total input to output latency of less than 6 milliseconds. This is around one-half the latency of one competitor's product and many times less than another's flagship processor. We've accomplished this with not only high internal sample rates (high speed DSPs are relatively inexpensive now) but also some extremely crafty DSP coding.

As part of our ongoing research we revise presets as well as come up with new ones as our customer experience grows and our technology evolves. Our processors can store quite a few presets on board, and our easy-to-use GUI allows extremely easy access to hundreds of presets stored on a user's PC.

How do you handle HD processing in the same processor feeding an analog transmitter?

Our philosophy about HD processing is that at least at the present, while the primary HD program is a simulcast of the analog channel, the best way to approach audio processing for the HD side is to process similarly in the AGC/compressor stages.

We then split the signal into separate final limiters for the two paths, each optimized for its respective requirements. By taking this approach we can create much smoother digital to analog crossfades for a station's listeners when they are in the fringes of digital coverage.



Compressor Setup Screen for the AP-1000

How much control do you give the user on adjustment parameters, and do you employ limits so that unwary users don't degrade the result with "too much" processing?

We do not limit the range of controls on our processors. Our philosophy is that when a customer buys an audio processor from us, they're buying the entire box and everything that it can possibly do. Doing otherwise would be like a car manufacturer making sure your new car can't go over 20 miles per hour so you can't hurt yourself.

That said, our GUI makes adjustment far easier than other processors in its class, and it's hard to get into trouble. This is because our controls have obvious and intuitive names, they do exactly what you would expect them to do and they have enough range to let you know exactly how much power you have between your fingertips and where you should or should not go.

What is your opinion of the ongoing loudness wars being waged by stations on both the AM and FM bands?

Ask just about anyone, and loudness will always have importance. Now, whether it remains as it is today, with loudness seemingly the most important parameter of all, is yet to be seen.

One of our biggest challenges, as fellow colleagues working within the broadcast industry, is the loudness war being waged not just on the radio dial, but the one in the mastering studio. With few exceptions, one quick listen to any recently released CD will tell you that loudness wars aren't limited to just broadcasting anymore.

While right now we can "undo" a lot of the dynamic squashing that took place in the mastering processor — or alternatively, just leave it alone — we don't currently have a way to easily remove the hard clipping and associated distortion from the program material without creating some new and very foreign-sounding types of

SEE VORSIS, PAGE 14

KNOW

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were plotted on a street map of the area. The plot did not take into account distortion that resulted to the vertical pattern from the effect of the tower. It also did not account for the slight differences in ground elevation in the area in which the measurements were made, but the ground elevation difference were so slight as to be negligible.

When the locations were plotted on the map, it was remarkable how closely the high-noise area fell on the locations of the nulls. Even though theory said that should be the case, it is nice to have real-world results match theory (Fig. 7).

OUTCOME

MPR made decisions as a result of the KNOW problems.

The first was that MPR would not install a space-combined system using an auxiliary if a transmitter site was located in an urban area.

This resulted in the change of plans for KCMP(FM), another MPR station in the Twin Cities area for which plans had been developed to use an auxiliary antenna. This has now been changed to a high-level system.

MPR also decided that the pattern of the auxiliary antenna had to match the main antenna, not just in the vertical plane, but the horizontal field pattern had to match as well. MPR feels these installations need to be designed for the long-term success of the IBOC system. This means the coverage of the IBOC system needs to match the analog signal as closely as possible. An auxiliary antenna with a pattern that is different from the main antenna will not comply with this requirement.

Mike Henrickson is radio network supervisor, Minnesota Public Radio, Minneapolis. ■

Wireless Broadband Internet Remotes

"The first time out with the Tieline was a brilliantly simple experience for everyone involved. For lack of a better phrase, the codec just worked."

- Christian Vang
Chief Engineer
Clear Channel St. Louis

"The codecs sounded great. My management was very, very impressed with the demos"

- Grady Jeffreys,
Technical Manager,
Mackay Communications

"The remote was a spectacular success, in no small part thanks to the flawless sound which the Tieline G3 provided over the public Internet"

- Mike Rabey
Chief Engineer
Entercom Indianapolis

100% *COMREX POTS Compatible

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Vorsis

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distortion.

Digital audio processors have been around since the early 1990s. There are still lots of folks who are convinced analog is the best and purest form of audio, one that cannot be duplicated in every nuance detail by current digital sampling and processing.

We don't agree. Maybe in 1991 when Bob Orban introduced the 8200 it was true that "analog could sound better," but not now. Bob was certainly a pioneer in that regard, and sometimes the pioneer gets the bruises.

We have a lot of respect for Bob and he gets a lot of credit for being willing to go where no one else had dared go before with a "DSP-based" broadcast audio processor, the Audio Animation Paragon processor of the mid-1980s notwithstanding.

What we can do today in DSP is so far beyond what we were able to do only 15 years ago. Just look at some of the software-based modeling algorithms, or plug-ins, available today that perfectly emulate vintage gear from 30 to 40 years ago. In an A/B/X comparison, the really well-done algorithms, or "software clones" of that hardware, are virtually indistinguishable from the original.

What this means is that with ongoing research, and creativity and care, we as audio processor manufacturers can make products that sound not only as good as some people think the old analog stuff sounds, but also it means we have the potential to make them sound far better while still getting the other benefits that precision math allows.

Vorsis AP-1000 Processor

How do you assess the quality of audio compression or bit-rate reduction algorithms used in digital audio and how they affect audio processing?

Audio processing can either exacerbate coding artifacts or assist in masking them. Several methods of cloaking the coding artifacts exist today, and even more will be available as time goes on.

It may surprise you to learn that our company has been quietly involved with coded audio research, and that our coding experts have been studying the technologies involved for many years.

We don't believe we've yet reached the practical limit of any of the perceptual coding schemes. Have we hit some plateaus in the technology? Perhaps. But if history is any indication, new coding methods that will sound better than anything we have today are just over the horizon. Will we be able to get the perceived quality of a 192 kbps AAC stream at only 8 kbps? We doubt it.

What about "digital grunge" and audio artifacts of all kinds that challenge every processor today? Other companies like Neural and Telos have developed special audio preconditioning algorithms to address that. What similar design elements or tricks do your processors employ to battle such gremlins?

The term "digital grunge" was a marketing lever coined by one of our competitors that had to do with the perceived quality of communication circuit and at all the possible mixes of bit rates.

However, it is most certainly possible to precondition audio prior to a single codec in a way that makes the audio sound much better than it does alone. In fact we have studied that problem quite extensively over the years and are already doing it today.

The current crop of broadcast audio processing companies is well established and each has its base of loyal fans and repeat customers. Is there something unique about the Vorsis and other Wheatstone processors that would compel a fan of the others to seriously consider buying the next time they go shopping?

The most compelling reason to consider Vorsis is that Wheatstone's team of algorithm designers has a thorough grasp of the challenges of broadcast audio processing. Also, when we set out to design our first audio processor targeted at higher-end broadcast applications, we made a conscious decision to ignore the methods previously used by others to process audio.

We did this because as a company we believe that there will always be new ideas for audio processing algorithms. We have decades of experience designing audio processing for myriad broadcast applications, and we will use those skills to approach and solve the well-known broadcast audio processing challenges in completely new ways.

With the resources of Wheatstone behind it the Vorsis design team is making significant advances in the digital broadcast audio processing state of the art.

'One of our biggest challenges … is the loudness war being waged on the radio dial and in the mastering studio. A quick listen to any recent CD will tell you that loudness wars aren't limited to broadcasting anymore.'

audio processing algorithms, particularly audio clipping, when performed at sample rates that were inadequate. That was 10 years ago and we're all well beyond those days now.

Other artifacts, however, such as those related to both generating extreme levels of on-air loudness and those related to audio coding, are certainly real.

We've developed new technology that takes advantage of the psychoacoustics of human hearing to cause the artifacts naturally generated in creating competitive loudness to be invisible to the ear.

These new algorithms are extremely DSP-hungry. However, we believe that the manufacturing costs associated with providing the additional DSP resources required to run them is more than offset by the tremendous benefit to the end user.

Compared to other products on the market today we can achieve equal loudness at greatly reduced distortion levels, or if desired, achieve much greater on-air loudness with nearly the same artifacts.

Do you think it is possible for audio processors to employ some kind of process or algorithm to help reverse or reduce the fall-out from "dueling codecs"?

It is hard to say if an audio processor can ever completely ameliorate the effects of chaining codecs, considering the different types of coding that can be performed on a

What are the next important audio-processing product introductions we should expect to see from Wheatstone? Do you have plans to add surround sound capability to the line?

As anyone who is familiar with our company knows, we have a long history of innovative product development. We have dedicated a lot of effort and engineering into the Vorsis product line, and gone to great lengths to make sure our audio processors are as good as can be done within the technology. The majority of this effort has been in the software area.

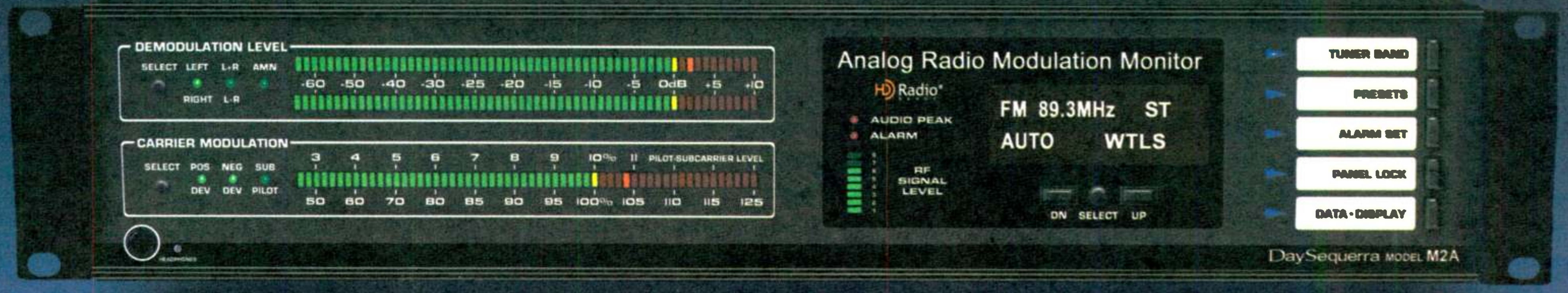
Without letting the cat out of the bag, it wouldn't be too much of a stretch to leverage this technology and expand our product line to include form factors beyond the traditional AM or FM on-air processor box.

As for surround sound, our Bridge networked audio system has always been surround-capable, and our TV control surfaces and some of our radio ones have had surround sound processing in them since 2001.

Our mission is to be at the forefront of audio processing technology. Keep your dial tuned to Vorsis for developments in this area.

Tom McGinley is technical advisor for Radio World. ■

Monitor your Analog station today
Monitor your HD Radio® station tomorrow



DaySequerra M2A
HD Radio® READY Analog Radio Modulation Monitor

Now you can have the world's best Analog monitor at a competitive analog price. Then, whenever you're ready, you can upgrade your unit to add full HD Radio™ capability complete with world-wide tuning and de-emphasis settings.

DaySequerra is the leader in HD Radio™ monitoring, and every one of our HD Radio™ monitors starts with a superlative analog monitor section. The M2A measures your analog signal with digital accuracy, insuring that readings will remain stable and reliable over time. Selectable measurement integration times let you control peak reading for maximum modulation.

The M2A includes a sensitive yet selective synthesized FM preselector with 20 presets so you can quickly monitor other stations off the air. A high level input with built-in attenuator lets you connect directly to a forward power RF port for greatest accuracy. RBDS is decoded and shown on the M2A's Vacuum Florescent Display (VFD).

The M2A's brilliant LED meters can be read from across the room. The upper meters measure stereo, L+R, L-R and incidental AM noise. The lower meter measures positive and negative carrier deviation, and also pilot and SCA injection levels. 57kHz RBDS subcarriers can be accurately read to a minimum level of 2.6 percent. A multiplex output lets you connect external SCA demodulators.

The M2A comes complete with opto-isolated alarm outputs for audio peak, audio program, carrier loss and RBDS, with flexible settings for level and duration..

In addition to its accuracy and features, the M2A gives you audiophile-grade Class-A biased audio outputs, so you can precisely monitor and adjust your processing. In addition to L and R analog outputs, the M2A has a full-time digital output, so you can feed your AES monitoring chain, and a front panel headphone jack powered for uncompromised, full-quality audio.

AM measurement is available in an optional package, as is Ethernet Remote Control with DaySequera's Remote Dashboard™ software, a proprietary PC-based application that gives you 100 station scanning, remote control monitoring, logging and alarms with E-mail alarm notification.

DaySequerra M2A features and benefits:

- Analog FM unit with HD Radio™ upgrade path protects your investment
- Optional AM station monitoring package including C-QuAM
- Brilliant, accurate bargraph metering of analog programming
- Multi-function vacuum florescent display (VFD)
- Precision metering of FM Pilot and SCA injection levels, includes MPX output connector
- High level direct (+7 Vp-p) and antenna level RF inputs
- Synthesized pushbutton tuning with 20 station presets
- Balanced analog audio outputs at +4dBu on XLR connectors
- Full-time transformer-isolated 110 ohm digital audio output on XLR connector
- High current, Class-A headphone output with front panel gain adjustment
- Audio, RBDS and carrier loss alarm outputs with peak flasher
- Front Panel control lockout feature
- Optional Ethernet port and Remote Dashboard™ for full remote control and monitoring
- FLASH–upgradeable for future-proof operation
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by Cris Alexander

What Have We Learned About IBOC?

After Four Years and 26 Conversions, Alexander Reflects on What We Thought, What We Now Know

It's never a fun thing to go through a crisis like the Catalina wildfire I told you about back in August ("Wildfires a Challenge, Even With Preparation," Aug. 22).

Such things "try men's souls." In modern-day vernacular, they stress us out. They stretch us and drag us out of our comfort zone. But in crisis lies opportunity — opportunity to learn, prepare and become better at what we do and better prepared for future crises. It's really up to us whether we profit from these crises or just get stressed out by them.

The same can be said of big projects, particularly ones where we break new ground. Those more or less force us to learn new technologies, master new skills and improve our pedigrees as radio engineers.

I have been through quite a number of such pedigree-builders in my career. Some were enjoyable and some were not. But in every case I learned something of value.

In mid-August, we got the news we had been anticipating for months: the new terrestrial digital rules the FCC had enacted in March had at long last been published in the Federal Register. Publication started a countdown clock ticking on the effective date of the new rules.

These rules contain a number of operational provisions under which we have, at least to some degree, been operating on an interim basis for some time. They also contain at least one controversial and new provision: enabling AM stations to transmit their digital carriers at night.

It's a grand nighttime digital experiment. As I write, the Sept. 14 start date is a couple of weeks into the future. I'm going to go out on a limb here and predict that as you read this, the jury will still very much be out on the whole issue. The sun will still rise and set and the "AM apocalypse" that some predicted will not come (more on that later). You can be the judge as to whether my prediction was at least as accurate as a typical Colorado weather forecast.

26 CONVERSIONS LATER

Since the Federal Register publication of the rules, I have given the whole terrestrial digital conversion process some thought.

It was four years ago last summer that my company converted its first stations to digital. Those early conversions were really pioneering efforts (see Fig. 1). There was so much we did not know. There is so much we still don't know! But in those four years and 26 conversions, we learned a great deal. Today, that knowledge base provides the technological foundation for our present digital operations.

We relied heavily on manufacturers in the early days. They told us what to do and how to do it. They were sometimes wrong, mostly because of their own limited knowledge base.

Digital transmitters in those days were first-generation products. They had very little installed base, very little track record. We were test pilots, learning the characteristics of our new craft while we tried to stay airborne and not crash our mainstream analog products. The manufacturers learned along with us and they retrofitted the first-generation products while adding features and fixing bugs in new production transmitters and peripheral gear (Fig. 2).

Fig. 1: We found the original 10 dB injector supplied by the transmitter manufacturer to be undersized.

Fig. 2: Digital exciters and HD generators with internal CD-ROM drives in them initially seemed out of place at transmitter sites — and they still do!

I learned some hard lessons in those early days. First, I learned that in high-level combined FM systems, the reject load needs to be sized for the *peak* power of the digital transmitter plus 10 percent of the power of the analog. The manufacturers (transmitter and load) had advised us that we needed to size the reject load for the *average* digital power plus 10 percent of the analog. There is a big difference between peak and average in digital systems (Fig. 3).

We found this out the hard way. The load failed after a few weeks in operation. The digital transmitter, with 90 percent of its load now an open circuit, tripped off, but the analog transmitter hardly noticed the added reflected power. As a result, it continued to pump out close to full power.

Where, then, was the 10 percent analog power normally dissipated in the reject load going? I'll give you a hint: not through the combiner and into the antenna!

The digital transmitter assumed the role of reject load and began dissipating close to 3 kW of RF power in its output stages. Our chief engineer swore that the digital rig was glowing the cherry-red shade of a set of properly biased modulator tubes when he walked in the transmitter room door!

From that little episode we learned we had to immediately upsize our reject loads. We also learned that the digital transmitter could somehow take a number of hours of operation as a dummy load without damage.

BYPASSES

Another hard lesson early on was that with all the audio passing through the digital exciter, a problem at that point would take down both the digital and bread-and-butter analog signals. We had to craft an AES bypass to get around that. Since then, the whole architecture of the AES path has changed in FM systems and we no longer have that issue.

We learned that even the best transmitter site is a harsh environment for a mis-

Fig. 3: This load may be a bit undersized for full-power Class B or C high-level reject load applications.

sion-critical computer. We continue to struggle with that issue, particularly at our AM stations where the AM carrier is generated in the HD exciter. A failure at that point can, and sometimes does, take the station completely off the air.

In AM systems, we learned how important it is to start with clean source material and avoid A/D passes, sample rate conversions and digital compression. AM stations can sound almost FM-like in the digital realm or they can sound like Internet audio streams on a noisy dial-up connection.

We learned the importance of load symmetry and rotation and how absolute sideband VSWR values are really of secondary importance. We learned that the RSS/RMS

SEE IBOC, PAGE 18

OMNIA-5EX HD+AM

LAUNCH YOUR HD AND UPGRADE YOUR AM SIMULTANEOUSLY

There's a reason why more of the world's powerhouse AM radio stations have turned to Omnia processing...It just sounds better! Additionally, Omnia continues to lead the industry with constant innovation. We pioneered the first non-aliasing digital clipper. (Some still feel it's the only one!) We introduced combo processing for HD-AM broadcast – dedicated processing for conventional AM, as well as a separate processor for HD Radio.

Omnia.5EX HD+AM has a powerful toolbox. 5-Band limiting for conventional analog transmission, along with a powerful oversampled, distortion-controlled, non-aliasing clipper that delivers loud, clean, and competitive audio. Output filtering that is suited for NRSC, ITU, or HD Radio requirements.

Processing for HD Radio/DRM is smooth and clean, thanks to a precision look-ahead limiter that reduces unwanted intermodulation distortion (IMD). This enables one box to generate two incredible sounding signals.

And for convenience, Omnia.5EXi HD+AM offers built-in Diversity Delay, which reduces redundancy, and points of failure in your transmitter plant. (BTW: It was our idea to put the Diversity Delay in the audio processor.)

Analog or digital, it doesn't matter. With Omnia.5EX, your signal will be remarkably clean and clear, with punch and presence that makes AM radio come alive!

INNOVATIVE OMNIA ENGINEERING: WHERE AM AND HD COME ALIVE!

Omnia
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ratio determines, to a large degree, the difficulty of making an AM directional antenna work in the digital world.

The learning process continues. The digital facilities we are building and rebuilding today are far better than those of four years ago. I've heard it said that the definition of wisdom is "applied knowledge." I'd like to think that we've gained a little wisdom over four years and are using that wisdom as we engineer today's digital facilities.

And now, we are poised for a whole new learning experience. In the coming months and years, as more and more AM stations make the move to nighttime digital operation, we will learn the true impact of the added interference. The message boards and trade press have been filled with predictions on both sides, from no meaningful impact to the "apocalypse."

I don't believe the short-term effects will be serious or widespread. The reason: mainly because there will be few stations on the air at night with digital signals, at least early on. There are fewer than 250 AM stations on the air with digital signals. Some of those are daytimers and not eligible for nighttime operation at all. A good number of the remainder employ directional antenna systems that are different than their daytime antennas.

Additional work and investment will likely be required to get those stations ready for digital nighttime operation. That will likely take a while. And there may be a few out there that have been waiting on the nighttime go-ahead before converting at all. Some stations in that group will probably light up their digital carriers soon, but I think most will be circumspect and wait to assess the impact and viability of AM digital nighttime operation.

There are a good number of stations that are ready to go, and some of those are Class A stations, like WOR(AM) in New York, and "old guard" Class B regionals. Those stations will provide a good test base for this grand nighttime digital experiment. Stations that are on adjacent channels to those digital stations will soon know the impact of digital carriers at night in the AM band.

I think that gives us a good opportunity to learn something before the number of AM stations transmitting digital signals at night grows into the hundreds. As in most "crisis" situations, whether we profit from this new knowledge is up to us.

Within Crawford Broadcasting Co., we have several stations that are ready to go at night. One of these is 50 kW DA-1 WDCD(AM) in Albany, N.Y. Two others are regionals: KLZ(AM) in Denver and KKPZ(AM) in Portland. We are ready to go at night on those three stations. We'll soon learn something about the impact of our digital operation on our spectrum neighbors.

We also have a good number of other AMs in our company that won't be going digital at night. On those stations, we'll likely soon know what it's like on the receiving end of digital interference. I look forward to learning all I can as we go forward.

Engineer Bill Agresta had help from a friend when he hauled more than 1,000 gallons of diesel fuel up the hill during KBRT's 10-week period without power.

CATALINA UPDATE

Since we went to press with the Aug. 22 issue of RWEE, we have made some progress with the two crises I have been dealing with.

At the KBRT(AM) transmitter site on Santa Catalina Island, we are now operating once again on commercial power. Power was restored 10 weeks to the day after wildfire swept through the area. We operated on generator power for that entire 10-week period.

I did a little math and calculated that our engineer, Bill Agresta, hauled over 1,000 gallons of diesel fuel up the hill during that period. That's about 8,000 pounds of fuel; a five-gallon can at a time. At $5 a gallon, that was a lot of money too!

We also got our T1 and phone lines back ... after a fashion. A temporary cable was run to our site over the ground. It is not suspended on poles or buried and is thus

SEE IBOC, PAGE 20

JUST ENOUGH TEST

Is your bulky bench analyzer more test than you use and more weight than you want?

Sophisticated Minstruments from NTI give you just enough test capability, plus functions not even available on their larger siblings...
and these flexible instruments fit in the palm of your hand

ML1 Minilyzer
Analog Audio Analyzer

The ML1 is a full function high performance audio analyzer and signal monitor that fits in the palm of your hand. The comprehensive feature set includes standard measurements of level, frequency and THD+N, but also VU+PPM meter mode, scope mode, a 1/3 octave analyzer and the ability to acquire, measure and display external sweeps of frequency response generated by the MR1 or other external generator.

With the addition of the optional MiniSPL measurement microphone, the ML1 also functions as a Sound Pressure Level Meter and 1/3 octave room and system analyzer. Add the optional MiniLINK USB computer interface and Windows-based software and you may store measurements, including sweeps, on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.

- Measure Level, Frequency, Polarity
- THD+N and individual harmonic measurements k2→k5
- VU + PPM meter/monitor
- 1/3 octave spectrum analyzer
- Frequency/time sweeps
- Scope mode
- Measure signal balance error
- Selectable units for level measurements

DL1 Digilyzer
Digital Audio Analyzer

With all the power and digital audio measurement functions of more expensive instruments, the DL1 analyzes and measures both the digital carrier signal (AES/EBU, SPDIF or ADAT) as well as the embedded audio. In addition, the DL1 functions as a smart monitor and meter for tracking down signals around the studio. Plugged into either an analog or digital signal line, it automatically detects and measures digital signals or informs if you are on an analog line. In addition to customary audio, carrier and status bit measurements, the DL1 also includes a sophisticated event logging capability.

- AES/EBU, SPDIF, ADAT signals
- 32k to 96k digital sample rates
- Measure digital carrier level, frequency
- Status/User bits
- Event logging
- Bit statistics
- VU + PPM level meter for the embedded audio
- Monitor DA converter and headphone/speaker amp

AL1 Acoustilyzer
Acoustics & Intelligibility analyzer

The AL1 Acoustilyzer is the newest member of the Minstruments family, featuring extensive acoustical measurement capabilities as well as core analog audio electrical measurements such as level, frequency and THD+N. With both true RTA and high resolution FFT capability, the AL1 also measures delay and reverberation times. With the optional STI-PA Speech Intelligibility function, rapid and convenient standardized "one-number" intelligibility measurements may be made on all types of sound systems, from venue sound reinforcement to regulated "life and safety" audio systems.

- Real Time Analyzer
- Reverb Time (RT60)
- High resolution FFT with zoom
- Optional STI-PA Speech Intelligibility function
- THD+N, RMS Level, Polarity

MR2 & MR-PRO Minirators
Analog Audio Generator

The MR2 & MR-PRO are the new standards for portable audio generators - the behind-the-scenes stars of thousands of live performances, recordings and remote feeds. Both pocket-sized analog generators include a new ergonomic instrument package & operation, balanced and unbalanced outputs, and a full set of output signals.

- Sine waves - Swept (chirp) and Stepped sweeps
- Pink & white noise
- Polarity & delay test signals

Plus the MR-PRO adds:

- User-stored custom signals & generator setups
- Phantom power measurement
- Impedance, balance measurement & cable tester
- Protective jacket

MiniSPL
Measurement Microphone

The precision MiniSPL measurement microphone (required for the AL1 Acoustilyzer and optional for the ML1 Minilyzer) is a precision reference mic for acoustics measurements, allowing dBSPL, spectrum and other acoustical measurements to be made directly.

- 1/2" precision measurement microphone
- Self powered with automatic on/off
- Omni-directional reference microphone for acoustical measurements
- Required for the Acoustilyzer; optional for the Minilyzer

MiniLink USB interface and PC software

Add the MiniLINK USB interface and Windows software to any ML1 or DL1 analyzer to add both display and storage of measurement results to the PC and control from the PC. Individual measurements and sweeps are captured and stored on the instrument and may be uploaded to the PC. When connected to the PC the analyzer is powered via the USB interface to conserve battery power. Another feature of MiniLINK is instant online firmware updates and feature additions from the NTI web site via the USB interface and your internet-connected PC.

- USB interface fits any ML1 or DL1
- Powers analyzer via USB when connected
- Enables data storage in analyzer for later upload to PC
- Display real time measurements and plots on the PC
- Control the analyzer from the PC
- Firmware updates via PC
- MiniLINK USB interface is standard on AL1 Acoustilyzer

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by Dave Moulton

Monitor Behavior: Know Your Loudspeaker

Relationships Among Frequency, Wavelength, Diffraction Can Cause Unexpected Problems for Engineers

Audio engineers are well aware of the problems that are encountered with directional microphones — cardioid and hypercardioid designs, to be specific — in terms of their off-axis frequency response.

If a directional microphone has a flat frequency response on axis, it will most definitely not have flat frequency response off-axis (i.e., it will probably sound bad). This is a given.

However, we tend to not think through about how loudspeakers really behave and to not consider the implications of their directional behavior, which often leads to problems in our work. I frequently see this with loudspeakers.

The physical problems are due to the relationships among frequency, wavelength and the acoustical behavior known as diffraction. Higher frequencies have shorter wavelengths. Sound waves can only bend around objects whose size is smaller than any given wavelength/frequency. Comparatively high frequencies cannot bend, while low frequencies can.

View this from the perspective of a sound-emitting tube (see Fig. 1).

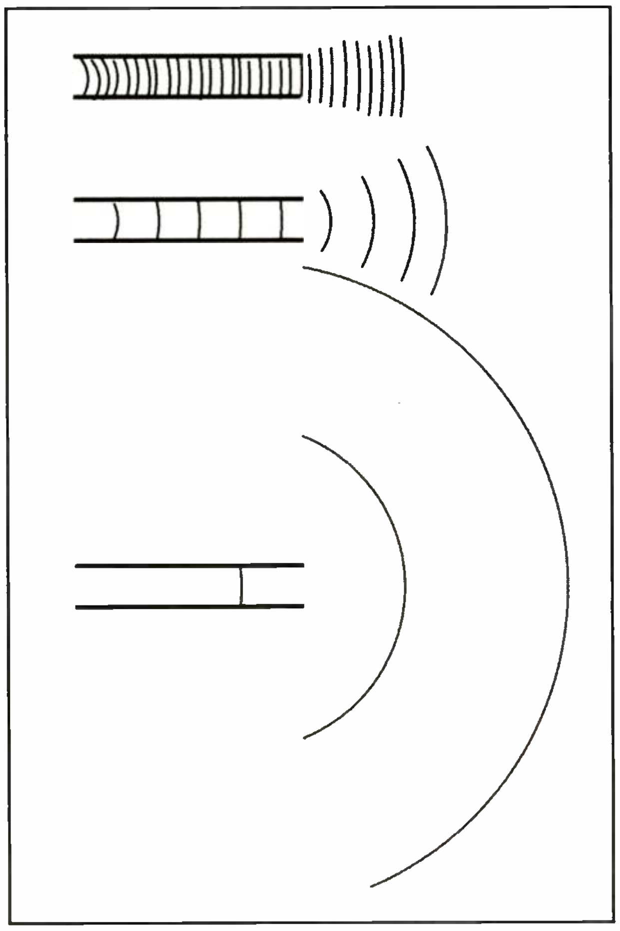

Fig. 1: Series of wavelengths — relatively long, short and equal to hole size — passing through tube. Upon exit into a free space, long waves disperse broadly; equal wavelengths disperse across approximately 45 degrees; short wavelengths are a beam with slight dispersion (15 degrees).

MULTIPLE DRIVERS

Loudspeakers, in general, have multiple drivers mounted on the face of an enclosure box.

The drivers vary in size, of course, in order to radiate frequencies of various wavelengths. However, because the drivers face in one direction and are mounted in a large plate (called a baffle), the combined frequency response of the drivers varies widely as a function of angle off-axis from the loudspeaker.

This behavior generally is severe, so that variations in frequency response easily are audible by 10 degrees off-axis and response is degraded seriously by 30 degrees off-axis.

What this means is that, simply, loudspeakers only work properly in one direction. This in turn has serious implications for loudspeakers in rooms, where they almost always are located, because the room is, strictly speaking, part of the loudspeaker system.

Human listeners integrate the complex array of sound artifacts that arrive at our ears directly and by early reflection paths from any sound source. We use this wondrous and complex integration process to localize and identify the timbre of any given sound, using the spectra from these reflections (from all directions) over about 50 ms.

Thus for sounds emitted by loudspeakers into a room, our perception of timbre is deficient vis-a-vis the source-recorded instrument because of the degraded early reflection information. Dang!

A LITTLE HISTORY

This apparently hasn't been much of a problem over the years. Sound that is lousy technically seems to pass muster generally. How can this be?

Part of it has to do with the behavior of microphones.

For instance, we admire elderly Neumann large-diaphragm tube microphones, especially for a variety of close-miking applications, such as lead vocals and acoustic guitars. What we don't bother to take into account is that such microphones were designed to have an average of flat response from all directions, which means that they have a high-frequency response peak (approximately 8–12 dB) up in the 6–12 kHz range for sounds arriving on-axis. They were not designed for close-miking applications.

Such a response, when combined with a loudspeaker with poor high-frequency response — as most loudspeakers built before ca. 1990, and virtually all tabletop radio speakers, offer — sounded way better than a more accurate response. Some years ago, I did a blind-listening comparison of vocal mics and found there was a clear preference for mics with such a high-frequency boost over flatter mics (see "Eight Vocal Microphones Tested and Compared" at *www.moultonlabs.com/main*).

Also, over the years, we have learned to indulge ourselves in overly bright mixes, simply to offset both the general and off-axis deficiencies of most loudspeakers. This practice probably is going to wind down over the next few years, for several reasons.

First, we are beginning to use surround sound, which allows us to distribute reasonable spectra where we want it much more carefully.

Second, we are beginning to incorporate room correction into our home theater loudspeaker systems. As we begin to approach some sort of reasonably flat and neutral response in end-user playback systems, we are going to have to back down on the overly bright mixes to which we have been historically prone.

LOUDSPEAKERS IN PRODUCTION

The process of monitoring, and the questions surrounding best monitoring practices, require at least a book. For our purposes here, I can only suggest a few simple practices that may help you obtain more consistent and effective results.

First, always listen on-axis. There is no other way. The speakers need to point directly at you and must be equidistant from you and at exactly the same levels.

Second, try to listen within the so-called "near field" of the loudspeakers. This really means within 3 feet of them, while hopefully the side and rear walls are more than 6 feet away (9 feet or more would be better).

Third, it really helps to have high-frequency absorption materials overhead and on the wall just behind the loudspeakers.

Fourth, it is nice to have hard sidewalls and rear wall (there is much more to this part of it).

WHAT DOES IT ALL MEAN?

For many readers, this may be pretty basic. For others, it may not.

I regularly notice compromised speaker placements in studios of all sorts and at different levels of the food chain. This is especially true for casually installed and placed monitors located on the meter bridge of a console. It also can be true for editing suites, wall-mounted speakers in broadcast studios and other hard-working, mid-level production spaces, along with a lot of semi-pro home studios and the like.

We depend on the loudspeakers to provide us with the predictive information about how our work will sound to our beloved end-users; I call it "listening ahead." The techniques needed to do this successfully are many and complex. The four points above represent a rudimentary first step. Just keep in mind that most loudspeakers (except mine, of course) don't work very well off-axis.

THE GOALS OF MONITORING

The term monitoring is audio-industry jargon for the idea of observing, in a reasonably neutral way, the quality of the signal(s) that we are sending out to our customers.

It sounds pretty straightforward, put that way. Unfortunately it isn't, for a variety of reasons.

The problems begin to accrue as soon as we begin to ask why we would want to do such a thing. The obvious answer is that we would like to verify and ensure that the quality of the signal is reasonably accurate, as well as acceptable and attractive to our beloved listeners.

Let's consider these vaguely incompatible characteristics in a little more depth.

We would like our signals to be an accurate reproduction of what was captured at the microphone. The idea behind this is fairly obvious: We'd like to think that the more accurate our signal is, the more realistic and engaging it will be. Such a viewpoint is central to the rationale of things like high fidelity and high definition.

In the monitoring world, I refer to this as "listening back." We are observing our capture of a previous acoustic event in order to assess how realistic and close to the original it is.

We also would like our signals to excite, thrill, please and otherwise fully satisfy our end users, the listeners. To monitor our signals for the purpose of assessing the extent to which those signals will excite, thrill, please and otherwise fully satisfy, we need to know, and to some limited extent simulate, the conditions under which they will listen to our signals. It's another level of accuracy, perhaps — how accurately our listeners will think we've captured the previous acoustic event.

I refer to this as "listening ahead." It is probably the most important part of the monitoring activity, considerably more important than "listening back."

DEALING WITH PRECONCEPTIONS

"Listening ahead" runs counter to the intuitive notion of accuracy, which is a cherished if poorly considered princi-

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vulnerable to damage. Neither the T1 nor the POTS lines have been reliable, so we can't count on them. We still don't have DSL; we're using satellite Internet service for that and to provide a backup voice over Internet (VoIP) phone line. We are still using a Ku-band satellite channel for STL.

Remember the construction cranes that wrecked the daytime pattern of one of our Denver AM stations ("Check Out the Numbers on Those Pesky PCNs," June 13)? In late August, the FCC granted the augmentation application that we filed to fix the problem. The license application is still pending but we were granted an STA that allowed the station to return to full power. Start to finish, this process has taken us about four months. We can stamp this one "Case Closed."

We sure learned a lot from both these experiences, and we're still learning. Going forward, we'll apply all we can of this new knowledge. Hopefully, that will make the ride a little smoother.

Cris Alexander is director of engineering for Crawford Broadcasting Co., Denver. ■

Acoustics

CONTINUED FROM PAGE 6

pressure levels to the center frequencies of the bands. Each curve has a numerical value corresponding to the octave-band level at 1 kHz. With the use of one-third-octave-band sound levels, the entire curve shifts downward 5 dB.

Criteria are somewhat different, as are the recommendations issued by varying national broadcast authorities or international organizations. Permissible noise levels for radio studios usually lie in the NR 15 to 25 region, depending on the requirements of different types of programs.

Bearing in mind that digital audio equipment has a potential signal-to-noise ratio of 90 dB, expected overall signal-to-noise ratio at the signal output is 75 dB (90 – 15) or 65 dB (90 – 25) for studios with NR 15 or NR 25, respectively, at 1 kHz.

Both values exceed the limits of AM and FM transmitters but, for digital radio broadcasting, stringent criteria are inevitable, at least NR 15 or, much better, NR 10 (Fig. 3).

Permissible noise levels for radio control rooms are in general 5 dB to 10 dB higher than for adjoining studios, due to higher ambient noise levels produced by equipment, and also depend upon the requirements of different types of program.

However, in practice, figures up to 10 dB higher than these are often tolerated, in most cases for financial reasons.

If the sound is reflected by a flat surface whose dimensions are large compared to the wavelength of sound, a specular reflection of the source waves will result.

The resulting sound field in the studio will show variations from position to position, due to a limited number of discrete sound images.

At the opposite extreme, rough surfaces having protuberances comparable to the wavelength will give rise to a large number of reflected waves scattered randomly in all directions. Such a condition is known as a diffuse sound field.

Porous and fibrous materials are a special case, in which little sound energy will reflect from the surface and a large amount of energy may dissipate within the structure of the material thanks to viscous flow in the interstices.

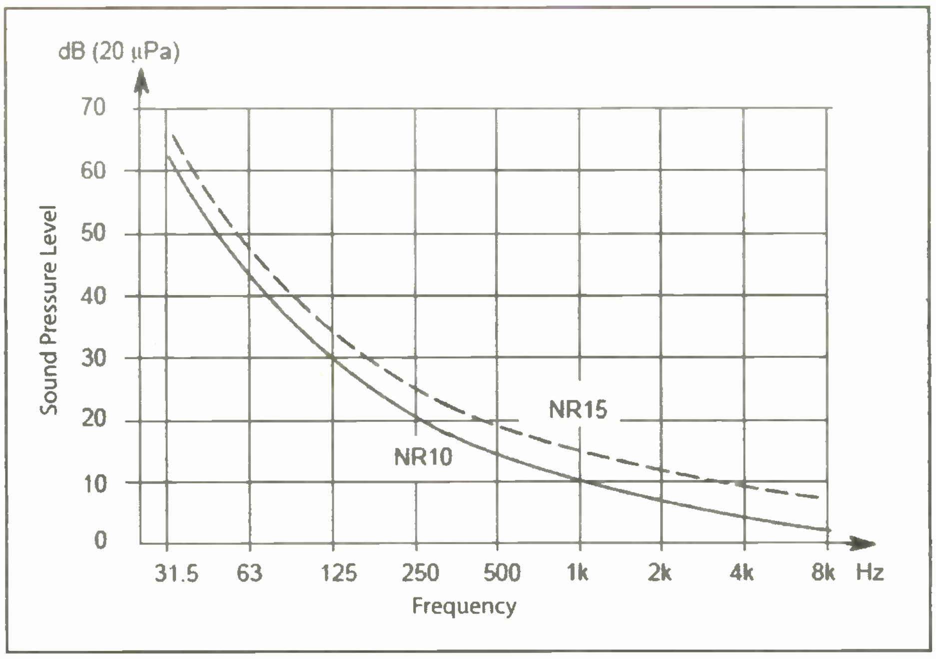

Fig. 3: Permissible Background Noise in Studios

These materials are particularly useful as acoustic absorbing treatment for interior studio acoustics.

REVERB TIME

Sound waves in an enclosed space reflect many times, with some sound energy absorbed at each reflection. The rate of decay of reverberation defines a characteristic for each studio — reverberation time (RT). This is the time it takes for a sound to die away to a millionth part of its original intensity, in other words through 60 dB.

Reverberation varies with frequency and depends, in part, on the distance sound must travel between reflections. Hence, large rooms generally have longer reverberation times than small ones.

In an empty room, with bare, stiff boundary surfaces that lack interior acoustical treatment, most soundwaves that strike the walls are reflected. Normal furnishings may include carpets, curtains and soft chairs. These, together with people, act as sound absorbers.

Tables, hard chairs and other wooden and metal objects reflect much of the sound striking them and break up the wave fronts. They act as sound diffusers.

Absorption and diffusion vary with frequency. Small objects only diffuse the sound of highest frequencies, with the wavelength compared to the dimensions of the object.

Sound waves that are long in comparison to their size simply pass around objects. It happens at low frequencies (long wavelengths) and, among other phenomena in acoustics, helping to explain why the thickness of a soft absorber affects its ability to absorb long wavelengths, as does its position.

At the hard reflecting surface of a wall, there is no air movement anyway. To have any effect on lower frequencies, absorbing materials must be well away from the wall.

Studio acoustics designers take into account the volume, the number of people working in the studio and the acoustical characteristics of the walls, ceiling and

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Loudspeakers

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ple of reproduction.

The idea that we must have as much accuracy as possible is closely and dearly held by many of us in the business, and we have real trouble letting go of it, except to admit that we also should have crummy speakers so we can tell what it sounds like on all the crummy speakers out there. The latter assumes, of course, that all crummy speakers sound alike and sound equally crummy, which is an unfounded assumption.

What I've found, in my mastering work, is that I need to check my work on a range of high-quality generic systems that represent such playback genres as stereo TV, 5.1 home theater, boom box and automobile, without adding specific nasty artifacts or spectral aberrations to color the reproduction.

This way, I'm able to head off any serious spectral or level problems inherent to the various genres, and to assess and balance out mix decisions to work on all of the systems, as well as on my reference monitor system.

Note there's nothing about accuracy here; it's all about getting the audio program to work, which means to sound natural, convincing and authentic. Whether or not it is accurate is more or less irrelevant.

At the same time, we have some powerful mojo working for us.

This mojo is called "the willing suspension of disbelief." The more I study loudspeakers, the more I am intrigued by this quality. We don't hear loudspeakers. Instead, we hear the imaginary sound sources that the loudspeakers are representing at any given moment.

This is not due to accuracy; it is due to our wish to be engaged in the illusion. The term "willing suspension" doesn't tell the half of it. We probably should call it "the absolutely determined refusal to perceive physical reality when there is an illusion to be had."

If we were to directly compare, for instance, a loudspeaker and a piano, we would notice that they sound wildly different and that a loudspeaker doesn't even begin to approach the sonic interest and beauty of a piano. However, when we listen to a recording of, say, Keith Jarrett, Oscar Peterson or Elton John, we have no trouble at all embracing the piano-ness of the recording, and we don't notice the loudspeakers at all.

As a result, audio engineers get away with a lot. An awful lot.

With that said, there is a variety of techniques we can use to make our work more effective, to massage that willing suspension of disbelief, and to make our loudspeakers that much more effective. Another time I'll dig into that toolbox a little bit.

Dave Moulton writes for Radio World's sister publication TV Technology. He says he is filled with unsuspended disbelief about almost everything, which makes him weird and hard to deal with, not to mention a little confused. ■

Write to RWEE

Send e-mail to *rwee@imaspub.com* with "Letter to the Editor" in the subject field; fax to (703) 820-3245; or mail to Reader's Forum, Radio World, P.O. Box 1214, Falls Church, VA 22041.

Time of Reckoning Nears for HD Radio

With a Stalled Rollout and Little Support From the Big Three, Are Industry Insiders Starting to Doubt HD?

It's beginning to seem like a long time ago when many of us started laying plans to add IBOC digital transmission to our stations.

The topic has dominated our industry as a seminal yet controversial issue since the early 1990s. Early adopters have been running HD Radio for almost five years. But the long ordeal of converting radio broadcasting from analog to digital in this country is still in its infancy.

THEN AND NOW

Early on, many of us concluded that in spite of various issues regarding its business model and technical limitations, Ibiquity's HD Radio was worth backing. I became a fan of the technology and I am still supporting it. After all, it was the only horse that really qualified to run this race. With the FCC's adoption of HD-R as our digital radio standard, the gates are now officially all the way open and we're off and running.

As the aging grandfather in a growing universe of glitzy multimedia consumer electronic alternatives, radio realized it would have to pull out all the stops to remain relevant and competitive. Back when Project Acorn was conceived, almost everybody agreed we needed some kind of digital transmission solution to keep pace with other media.

For better or for worse, HD Radio emerged as the industry's digital platform to modernize its legacy over-the-air delivery technology, all within the constraints of existing channel allocations. The collaborative efforts of present broadcast stakeholders along with the consolidated venture-technology companies that invented IBOC have brought us to where we are today.

DEAL WITH IT

By the time you read this, fulltime AM-HD IBOC operations will have commenced for many key stations. The early fallout from skywave interference will be raining down from the ionosphere and the FCC will be dealing with the first round of formal complaints. Except for real interference that falls inside protected contours, other complaints will undoubtedly be dismissed.

AM-HD has from the beginning been widely criticized as the noisy and disruptive neighbor a lot of folks hoped would not move in next door. Other than a few isolated cases, Ibiquity has assured us the problem will not be all that bad. Instead of worrying about the background hiss or losing fringe area listeners, we should focus on the benefits of high-fidelity digital stereo on AM for the first time.

When all is said and done it probably won't matter if AM-HD in the hybrid mode succeeds or not. The big signal AM newstalkers are the anchors saving the AM band and don't need 15 kHz stereo to remain successful. If anything, lost fringe area coverage hurts them more than any benefit that might be derived from HD.

PROMOTING THE PRETTY GOOD

FM-HD has largely proven itself a worthy successor to its analog-only host, offering cleaner reception, multiple channels and expanded data features. Adjacent-channel interference to its neighbors is nearly a non-issue. The HD car radio experience is for the most part an impressive improvement.

Anyone who has driven a car through an extended area of bad multipath and noisy analog reception quickly appreciates the ability of HD to deliver high-quality listening virtually equivalent to a CD.

We can only hope that all car companies, especially Detroit's Big Three, will start supplying OEM standard equipment radios in most vehicle models. Unless and until that happens, HD is not likely to gain real traction.

Multicasting essentially gift-wraps additional stand-alone programming services and profit opportunities to existing stations.

As more stations add HD transmission and HD2 channels, Ibiquity and the HD Digital Radio Alliance are urging stations to do all they can to promote HD Radio sales. Ostensibly, some $200 million in 2007 and $250 million for 2008 has or is being spent on ad schedules and promotions to create awareness of HD with all the new "secret channels."

Most of that money represents unsold inventory rather than hard dollars. It would appear that very few stations have committed real promotion budgets to independently advertise HD Radio. That's a tall order with bottom-line industry growth rates mired in single and occasionally negative digits.

MARKET MALAISE

Any consumer who becomes attracted to HD Radio and decides to buy in, usually has to pay a premium for an aftermarket car radio upgrade, as there are still limited OEM models being offered. BMW does offer HD-R as an option in their entire product line, as well as in sister brand Mini Cooper. Hyundai and Jaguar are offering HD-R as an option on select 2008 models. Ford just announced it will offer it as an option in their 2008 models. At long last, we finally have the first sign of an HD-R commitment coming out of Detroit.

If he or she buys the relatively expensive HD-R desktop, that individual often discovers that an effective external antenna needs to be added to make it perform reliably and lock in stations similar to analog. And that person is disappointed he or she can't find any pocket-sized HD Radios, although Ibiquity has said those are coming in 2008.

It hurts to admit it, but HD Radio and all of its marketing effort so far is virtually lost in the noise of all the other hype surrounding hot new consumer electronic "bling" offerings. Radio to most consumers is a familiar but low-tech commodity, just like water from the tap and electricity from the wall socket. It's very hard to put any glitz on the product and get the average person's attention. Is it any wonder HD Radio sales so far are pathetically low?

Ibiquity President/CEO Bob Struble stated over a year ago that its work developing and launching the HD Radio platform was essentially completed. All that needed to be done was the official FCC adoption of HD as the digital broadcast standard. That's now a fait accompli.

Ibiquity has made it clear that the job of marketing HD Radio to propel radio sales is not solely their role. The big marketing push, they say, must come from the stations and owners, along with radio manufacturers and retail stores. But without more OEM HD car radios, portables and desktops that don't need external antennas, dumping significant marketing money into a marginal or incomplete product line is proving to be a hard sell.

CHICKENS, EGGS & HD RADIOS

The HD rollout seems to have gotten caught in a bit of a Catch-22. With every passing month, I'm sensing a larger number of industry insiders growing more apprehensive about the rollout and whether HD-R technology can or will ultimately succeed.

Let's face it. Without car receivers, radio doesn't prosper or go anywhere. Only a very small percentage of consumers opt to buy an aftermarket car radio. The vast majority will undoubtedly have to encounter HD Radio not by choice but by accident, just like RDS text displays. When they buy a new car, hopefully HD will be included and they'll be pleasantly surprised to discover HD's advantages and additional features.

So far, few automobile companies have made a commitment to offer HD capability in any stock OEM-supplied radios in any car model. While BMW, Hyundai, Jaguar and now Ford are offering HD Radio as a surcharged *option* in 2008 models, neither GM nor Chrysler are even offering it as an option yet, let alone standard equipment.

It would appear the major Japanese manufacturers are waiting for the Americans to fully back their own country's official standard before jumping in. Clearly, the car companies are still hedging their bets with a wait-and-see attitude. That, my radio friends, has effectively stalled the HD rollout.

We can only hope that now, with the HD standard officially adopted, car companies, especially Detroit's Big Three, will step up quickly and start supplying OEM *standard equipment radios* in most all vehicle models. I'm now convinced that unless and until that happens, HD is not likely to gain real traction.

BEATING THE CLOCK

Beyond the receiver problem, conversion to HD also appears to be caught in a race against time.

It took 15 years for HD technology to develop, plus the long delay before the FCC finally made it the digital standard. During that time, the Internet, wireless and IP technologies were advancing at a much more rapid pace.

Radio's Web and streaming presence on the Internet has eclipsed HD as a digital marketing product and is proving to be a much more effective weapon to compete with other digital media. Web streaming is quickly gaining prominence as an important conduit to reach listeners, especially at work. Cell phones and other wireless devices will soon be delivering relatively reliable good quality audio streams in most population centers. WiMax is rapidly deploying in much of the civilized world.

RADIO MORPHING

As the "IP radio" is perfected and eventually becomes widely available, especially in car dashboards, consumers will have another alternative. And that includes terrestrial analog, HD, as well as satellite.

We're already hearing about the possibility that if XM and Sirius do not survive using their present platforms and business models, the SDARS 2 GHz spectrum might be converted to satellite-provided WiMax services.

WiMax has a long way to go technically, but everyone understands its enormous potential. The best brains on the planet are continuously improving its capabilities. At some point in the not-too-distant future, it is generally anticipated that the use of IP radios will likely grow to eventually surpass AM and FM use.

The legacy radio bands could be rendered less popular and ultimately obsolete when free or subsidized reliable WiMax services become widely deployed. It is probably more likely that both platforms would co-exist for quite a while and be integrated into the same receiver package.

With strong indications that radio's major point of presence will eventually be transported over to the Internet, owners will be faced with deciding if and when it will make good business sense to turn off their transmitters. A few of my colleagues think that could happen within 10 to 20 years. The death of AM and FM as we know it

SEE RECKONING, PAGE 26

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Acoustics

CONTINUED FROM PAGE 22

furnishings. They then calculate reverberation time for each studio by adding the necessary low-, medium- and high-frequency absorbers in the form of the final acoustical treatment.

The aim is to design a studio with, as far as possible, a linear frequency characteristic of reverberation time. Some low-frequency boost may be tolerable at frequencies lower than 200 Hz, with gradual roll-off at high frequencies.

The recommended reverberation time of a studio for speech is usually 0.3 seconds +/- 10 percent in a range from 125 Hz to 4,000 Hz.

A lower limit of 0.2 seconds is acceptable for a studio with dead acoustics and an upper limit of 0.4 seconds for a pretty live studio.

An example of the reverberation time frequency characteristic of a speech studio is shown in Fig. 4.

Music studios have considerably larger volume, in order to allow the musicians to have enough space to play and air to breathe. Due to the greater volume, longer reverberation times are expected, ranging typically from 0.8 to 1.8 seconds.

It is a common practice to use a concert hall as a studio too. For instance, a hall with RT_{60} = 2 seconds represents a perfect studio for classical music recordings.

There are different formulae for calculating the reverberation time. One of the most used is Sabine's formula:

$$RT_{60} = 0.161\left(\frac{V}{A}\right)$$

where:

RT_{60} = the reverberation time in seconds, defined as the time taken for a sound to decay by 60 dB after the sound source is abruptly switched off;

V = the volume of the room in cubic meters; and

A = the total absorption of the room in metric sabins.

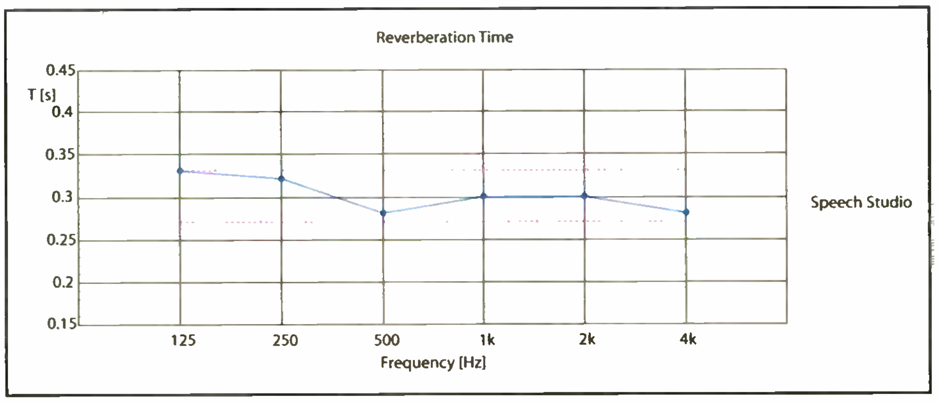

Fig. 4: Measured Reverberation Time of a Speech Studio

Sabine's formula gives a good indication of the expected behavior of sound in the room except in cases when a room becomes excessively "dead," when the boundaries become more and more absorbent.

For more complex RT calculations, acousticians also use Norris-Eyring's or Millington-Sette's reverberation formula, depending on the circumstances.

SOLID GROUND

The design of the radio station premises starts with the decision of what background noise level is necessary. This will have consequences on the acceptability of the site chosen and on the type of boundary structures.

When designing or choosing a building for a radio station, many factors must be considered.

It is important to avoid building near an airport, for example. Also, it is easier and more cost-efficient to build studios in an old-fashioned building with massive partitioning walls than in a modern steel-framed building with lightweight partitions.

It is advisable to build adjacent offices on the outside of studios and thus use them as acoustic screening from noisy streets in town centers. Studios then need only be insulated from one another and from the adjacent offices.

The best place for a studio is on solid ground. Otherwise, it is possible to float the whole massive structure, concrete floor, walls and roof on rubber materials or steel springs to ensure insulation against vibration. The resonance of the whole floating structure must be very low, for instance around 10 Hz.

It is important to prevent airborne noise from heating, ventilation and climatization systems in studio premises. Careful design and acoustical attenuation help reduce the passage of sound from one place to another as well as prevent air turbulence from vents.

Holes for wiring should be designed into the structure and as small as possible. They should not be drilled arbitrarily or without the approval of the acoustic consultant.

Observation windows between studio and control room should use double-glazing, with composition of different thickness sheets, for instance 6 millimeters and 10 millimeters.

Windows to areas outside the studio area should be triple-glazed. This would also be the case between studio and control room in which the loudspeaker will be switched to replay during recordings.

Studio doors should be double and with a pressure seal, and noisy machinery should be in a structurally separate area with anti-vibration mountings.

The author also is a professor in the Sound Recording Department of the Arts Academy at Univerzitet Braća Karić. ■

Reckoning

CONTINUED FROM PAGE 24

won't happen that soon, but certainly 30 to 40 years doesn't seem unreasonable.

Obviously that scenario suggests that even if HD takes hold, it will not sustain the long extended life span that traditional AM has enjoyed over the past 85 years and FM for over 55 years. Is HD worth the investment it now still requires for either broadcasters or receiver manufacturers if it's not going to offer long-term viability?

DOING OUR PART

With more than 80 percent of the U.S. population covered by HD broadcasts, and virtually all major and most large markets running many stations in HD, the transmission side has reached critical mass. Broadcasters have for the most part anted up to play and stay in the HD game. After the equipment acquisition and conversion costs are absorbed, keeping the HD transmission gear running and the extra power bills paid is mere pocket change.

The lion's share of radio listening and revenue produced is on FM, so HD Radio's future will be determined by FM-HD. In my view, AM-HD is really a less important sideshow. Certainly lower cost and better performing receivers in all classes will be needed, but multicasting is the main HD application that matters most.

In the end, HD's success will be measured by whether the multicast channels can be monetized into additional, compelling content providers. Cleaner reception is a nice bonus but not all that crucial for most consumers. Additional revenue generated by text and datacasting will be relatively trivial to most stations' bottom lines.

POKER, ANYONE?

Ibiquity is probably going to be faced with some tough decisions going forward in order to improve the chances of HD success and survival. The incremental cost of HD Radio chips and set production drops dramatically as the number of units produced increases to millions of units. But a significant part of the cost to build and sell HD Radios is the Ibiquity royalty fee.

It's the major car companies who hold the trump cards in this standoff and can afford to make Ibiquity blink first to ensure that HD can have a future. If HD Radio sales do not start making real headway, undoubtedly the car companies will want concessions to start supplying OEM HD Radios as standard equipment in large quantities. Without that, HD will continue to face an uncertain future. Ibiquity may be forced to change its royalty structure and business plan in fundamental ways to prevent an early demise.

Bob Struble is playing tough now to make money for his investors and himself first; but he should be smart enough to know when it's time to fold a hand and two so that other players will stay in the game. If not, the big brass of Ibiquity's invested broadcast partners may have to intervene.

Guy Wire is the pseudonym of a veteran broadcast engineer. ■

Back when Project Acorn was conceived, almost everybody agreed we needed some kind of digital transmission solution to keep pace with other media.

MARKETPLACE

USB-AES Matchbox Interface Ships

Henry Engineering is shipping its USB-AES Matchbox, a digital interface unit that provides AES/EBU digital audio input and output from a PC via a USB 1.1 (or higher) port.

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The USB-AES Matchbox also provides analog outputs at +4 dBu on XLR connectors for critical monitoring, as well as a monitor output for computer speakers with a muting facility. Output Confirm LEDs indicate the presence of audio, so that operation can be visually monitored as well. The USB-AES Matchbox is USB-powered; no external power supply is required.

For more information, contact Henry Engineering at (626) 355-3656 or visit www.henryeng.com.

Harris Has Its Eye On Tx Security

Site thieves and hoodlums, beware: Harris has a video surveillance application for its Intraplex NetXpress audio-over-IP platform.

Intraplex NetXpress

"Transmitter site security has always been a concern," said Chuck Alexander, director of Intraplex products for Harris Broadcast Communications. "The integration of sophisticated video analytics capabilities at these remote sites has made it possible to reliably detect unauthorized entry while only transmitting video on alarm or on demand."

Intraplex NetXpress sends multiple services, including audio, data and PBX telephone communications, over an IP connection. The video surveillance application uses low bit rate MPEG 4/H.264 video compression to send and receive multicast or unicast video, which can be viewed on one or more PCs on the IP network.

Video analytics software in the new video encoding module for the Intraplex NetXpress chassis automatically detects people entering designated areas, or objects taken or left behind, and sends alerts with still images or full-motion video over the IP network to alert personnel at the studio or security office. Alarm logs maintain records of these events along with associated images.

For more information, contact Harris Corp. at (941) 639-1889 or visit www.harris.com.

PROJECT PROFILE

by Thomas R. Ray, III

Swamp Thing: WOR Settles in N.J. Meadowlands

Transmitter Site Completes Challenging Move 2,500 Feet North, a Project Five Years in the Making

WOR is a legendary heritage radio station with a rich background of not only historic programming during the Golden Age of Radio, but also of being a pioneer in several technical aspects of broadcasting. As vice president/corporate director of engineering for Buckley Broadcasting, I have the responsibility of taking care of a legendary station and the largest, most prestigious in the Buckley family of stations.

When a move of this 50 kW AM directional facility — licensed to the number 1 market in the country, New York — was forced upon us, it became my responsibility to make it happen. And there were numerous obstacles to overcome in the process.

In 2001, the state of New Jersey decided to redevelop the part of the Meadowlands where the WOR Lyndhurst transmitter was located. The old site was built on part of a 5,000 acre dump and the state wanted it cleaned up. As I have discussed in previous RW articles, WOR entered into an agreement with the developer, EnCap Golf Holdings, to rebuild the WOR facility in 2002.

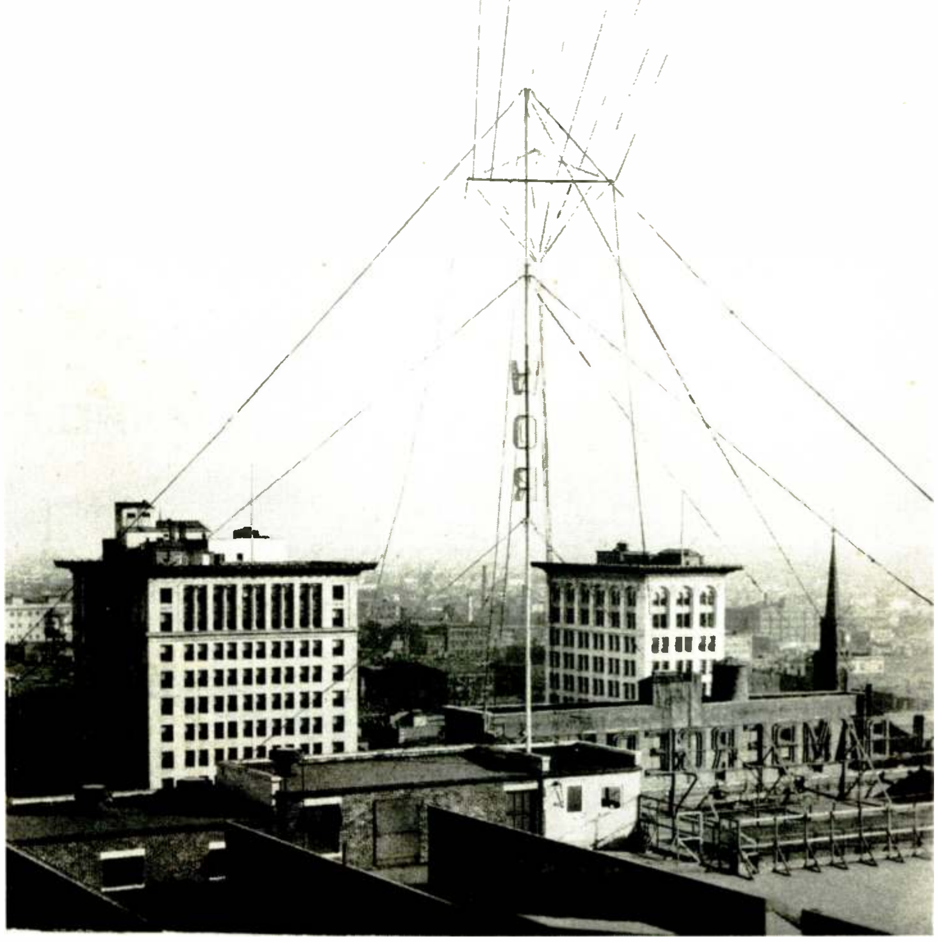
HISTORY OF A LEGEND

WOR's first transmitter facility was on the rooftop of Bamberger's Department Store in Newark, N.J., in 1922. This site utilized a Western Electric 500 watt transmitter feeding an open-wire horizontal antenna. Around 1924, WOR's power was increased to 5,000 watts and the site moved up the street from Bamberger's, still using an open-wire horizontal antenna.

In 1936, WOR moved to a state-of-the-art facility in Carteret, N.J., increasing power to 50,000 watts and utilizing a three-tower, in-line directional antenna, one of the first in the United States. This produced a figure-eight pattern with one lobe towards Manhattan and the other towards Philadelphia.

In the late 1950s, New York City was growing, and the additional tall buildings and electric gadgets started causing trouble for the WOR signal in Manhattan. The Carteret site was 18 miles or so from Manhattan and utilized quarter-wave towers. Around the beginning of the 1960s, a rather large dump was closed in an area of New Jersey known as the Meadowlands. This area was only 6 miles from Manhattan, and a site in Lyndhurst, N.J., was chosen.

The Lyndhurst site used a "dog-leg" three-tower directional antenna and half-wave towers. The dog-leg design allowed a large lobe of power directed over Manhattan and Long Island, and a smaller but respectable lobe directly towards Philadelphia.



WOR's first antenna on the roof of Bamberger's Department Store in Newark, N.J.

Dump trucks bringing fill material to the WOR property.

Cutting the Phragmites was the first order of business before conducting a survey of the location for the new WOR transmitter site.

This site gave WOR the most concentration of RF over Manhattan of any New York radio station. It also featured detuning networks and traps in the tower-tuning houses because of other AM transmitters nearby. This site served WOR from 1967 until Sept. 2006.

HOW TO CHOOSE A NEW LOCATION

WOR needed about 40 acres of land to accommodate our three-tower dog-leg array. The good news is that the Jersey Meadowlands area is very wet — great for an AM ground system. The bad news is that this area is congested and there is potential for re-radiation everywhere, so finding property is a challenge.

I traveled around with the representatives from EnCap for two weeks. I was presented with sites that weren't big enough. I was shown land that simply wouldn't work because of the potential re-radiation sources. EnCap sighed and pointed me to a section of land just north of our Lyndhurst site that was virgin swamp, which it had intended to keep completely natural as a buffer. I was able to carve out a 40 acre site to make the system work and we were off and running.

There was only one problem. EnCap wanted us to start work then, in 2002. We had not yet filed with the FCC. We were building in a protected wetland and did not yet have the Army Corps permits. There were many questions to be answered.

Carl T. Jones Corp. was chosen to design and commission the new antenna system. To the FCC's credit, we received a conditional approval on the application within nine months, pending FAA action. That is when the trouble started.

FIGHT OVER FLIGHTS

The WOR Lyndhurst antenna system was designed to be overly efficient due to the traps and detuning networks required. There are three other AM facilities within 1-1/2 miles of the WOR antenna: 620 kHz (WJWR), 1190 kHz (WLIB) and 1010 kHz (WINS).

In the 1960s, when the antenna was designed, there were no methods for computer modeling and it was difficult to tell how the detuning networks and traps would affect the efficiency of the system. So it was designed with 177 degree towers, at 681 feet tall. It was found that the detuning networks and traps really did not affect the efficiency, and the system was grandfathered as overly efficient.

The new facility would need to meet the RMS requirements of the pattern, and was designed with slightly shorter towers 658 feet tall (171 degrees). However, the new location was 1/2 mile north of the existing WOR Lyndhurst facility, and therefore was 1/2 mile closer to Teterboro Regional Airport.

Interestingly, even though most traffic into New Jersey's Newark Liberty International Airport goes straight over the WOR facility (and most planes begin dropping their landing gear at that point), Newark was not the issue.

The FAA came back and told us we needed to shorten our tower height by 30 feet. This would have put the efficiency of the antenna system below that required for a Class A AM facility, meaning that WOR

SEE MEADOWLANDS, PAGE 30

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Meadowlands

CONTINUED FROM PAGE 28

would lose its Class A status. This clearly was not acceptable. We decided to fight the FAA. Carl T. Jones Corp. hired an airspace consultant.

What the consultant found was interesting. The Rate of Climb for a missed approach at Teterboro had been set at 300 feet per nautical mile, meaning that a plane that needs to abort its landing for any reason must be able to climb out of the airport clear of any obstruction at 300 vertical feet per nautical mile. Just about every other airport in the country has a Rate of Climb set at 400 feet per nautical mile. Increasing this Rate of Climb would make the proposed WOR tower heights fine. There was no justification found as to why the Teterboro Rate of Climb was at 300 feet.

During this process, the FAA agent with whom our consultant was working had undergone emergency kidney surgery and would be out for three months. We needed to wait for the agent to return from sick leave.

Upon the agent's return it was agreed that there was no reason the Teterboro Rate of Climb could not be set to 400 feet per nautical mile. A circular was issued to the pilots who frequent Teterboro for comment. There were no negative comments, and the Rate of Climb was changed 30 days later. The FCC issued WOR's construction permit within two weeks of the FAA's approval, in March 2003.

CONSTRUCTION BEGINS (OR NOT)

Waiting for the FCC and FAA, we were able to perform certain tasks before the paperwork was completed.

The area in which we were building was a swamp, so we were allowed to drill test borings to find out where bedrock was, as we would want the tower bases, guy anchor points and transmitter building to be sitting on something solid. Our tests showed that bedrock was at 150 feet deep. We also were able to get our drawings made and approved and obtain building permits.

Having paperwork in hand, we were ready to start construction. The contractor mobilized and was on site. He was then told to stop because the funding mechanism from EnCap was not in place, and no funding was available at this time. This was May 2003. We would not be able to start until April 2004.

CONSTRUCTION REALLY BEGINS

When spring of 2004 came around, we started in earnest. A total of 1.45 acres was to be filled to a height of 12 feet above swamp level (100 year flood stage is 9 feet) for the transmitter building, tower bases/tuning houses, guy anchors and roadways to get to the towers. Because of the height and the fact that the fill actually sunk 2 feet, we used more than 80,000 cubic yards of fill material.

After the filling was done, we needed to put in piles to the bedrock for the transmitter building, the guy anchors, the tower bases and the tuning houses. The bedrock depth varies across the 40 acre site. In the area of the transmitter building, the depth is 165 feet. As you move east, the depth decreases to 110 feet.

At the transmitter building, I had the contractor braise 4-inch copper strap to the piles in all four corners of the building, a pig tail for inside the building and one for outside

A guy anchor location. Note the angled piles on the left, toward the direction of guy wire pull.

Workers from Northeast Towers remove sections of Tower 2 from the delivery truck.

the building. WOR now has 165 foot deep ground rods going through wet, sticky muck. Perfect.

At the guy anchor locations, a set of piles was put in straight down and a second set was put in angled. The angled piles were set so they sloped downward in the direction of guy wire pull, so the pulling force would be pulling towards the bedrock rather than pulling against a pile driven straight down.

After the piles were in place, the foundations were formed and poured. The slab for the transmitter building alone took 11 trucks of concrete. Bolts to hold the guy anchors and the tower insulators were placed in the forms and welded to the rebar before concrete was poured.

UP GOES THE BUILDING

To save time, WOR decided to put up steel buildings in all locations.

This would significantly cut down on the time needed to erect a building, and would provide some shielding in the harsh RF environment that is the New Jersey Meadowlands. It's bad enough that WOR's 50,000 watt transmitter is on site. We also have 3 volts per meter of signal from WINS to contend with, as well as signal from other stations in the area. While the building does not provide complete shielding, it cuts down the RF and I have not experienced an RF problem with any of the equipment.

At the time the superstructure of the transmitter building was put together, we had the Onan 300 kW generator delivered and placed on the slab with a crane. I guess you could say the building was built around the generator.

The first contractor, who underbid the job, walked out before the building was complete. This slowed things down, and time was not a luxury.

TOWER CONSTRUCTION

Tower construction in a swamp is difficult. The crew can't simply walk out into the swamp to do things like pull guy wires because they sink in up to their waists. What should have taken six weeks took five months.

A boat had to be used to take the 500 pound guy anchors out to the anchor points. The crew had to be creative in how they ran their load lines, as they couldn't achieve the optimal angles they wanted (and didn't want their winch to sink into the swamp). A crane was used to set the first 100 feet of tower on the base insulator. This 100 foot stub was guy wired in place, and the rest of the tower was built with a gin pole.

What really amazes me about things like towers is that here we had a 100 foot stub sitting on top of a ceramic insulator with guy wires attached. The weight of the tower sections was approximately 15,000 pounds, and you could probably tack close to 5,000 pounds onto the weight for the dead weight of the guy wires. Yet, if I grabbed onto the tower and yanked to one side or the other, I was able to twist the tower on its pivot point.

Another problem the tower crew had was the RF in the area. The site was hot and the tower crew was getting zapped at various times. It was interesting that the tower wasn't very hot at all until it hit around 300 feet. It was very hot from 300 to 500 feet then was okay again. And then there were the skirts that had to be put on the towers.

Each of the WOR towers has two wire skirts. The purpose is to minimize current flow in the tower at 1010 kHz and 1190 kHz, effectively shortening the electrical length of the tower at these frequencies. Of course, no matter where you jumped the skirt to the tower, which was grounded, they were still warm. Tower 2 was complete around the first of November 2005.

Meanwhile, after much arguing with the second general contractor, who couldn't seem to get the attention of the electrical inspector or the power company, I stepped in and got power turned on to the building so we could power the tower lights. I also had dial tone installed in the building so we could monitor those lights.

MOTHER NATURE HAS HER SAY

Our other two towers were to be delivered to Rutherford on Nov. 7, but Mother Nature had other ideas. The towers had not made it out of Evansville, Ind., on Nov. 4 as they were supposed to.

My wife had the CBS Morning News on TV on Nov. 7, and they were showing images of a tornado that went through Evansville and Newburg, Ind. Our towers, at Central Tower (now Tower Innovations), had been destroyed by a tornado. We immediately filed with the FCC for "tolling" of the construction permit, effectively stopping the clock due to an act of God entirely out of control of the radio station.

Things had slowed down on the completion of the building because, with our last two towers destroyed, the pressure was off to get everything done. Our contractor asked if it were okay if he took on a two-month job building a high-class dog boarding facility, and I said yes. There were things I could do, like getting equipment racks in place, putting the phasor together, getting transmitters put together.

But when those two months were done, in January 2006, it was getting hard to get the contractor's attention. By this time, I had a delivery date for one of the towers for the end of March, so I needed to ramp up and certain things needed to be done, like power needed to be run to the transmitters so I could start testing into the dummy load and align the HD signal.

After much arguing and cajoling, I was finally able to get the electrician in to wire the transmitters. Then the tower came in and erection began.

SEE MEADOWLANDS, PAGE 32


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Meadowlands

CONTINUED FROM PAGE 30

I was wiring the audio racks and transmitters. Verizon put in the fiber and the two T1 circuits to our studios at 111 Broadway, the tower company freed up a crew member to hang the STL dishes on a 50 foot section of Rohn 40 it provided and ran the cables inside (there is a 2 degree aiming difference between Lyndhurst and Rutherford, which provided great STL signal). Then, it started becoming even harder to get the contractor's attention.

As it turned out, he had gotten himself into financial trouble. Our construction permit tolling stated that the clock on the CP would start running again when the second tower was on site. With the FCC having a New York office, I did not want to have the tower delivered and not inform them it was on site, only to have someone come out and see what was going on, so everything was done on the "up and up."

I was given a date for delivery of the second tower that coincided nicely with the completion of the tower known as Number Three. The tower showed up and was brought around to the peninsula, the home of tower Number One.

To get there, we needed to travel down the New Jersey Transit railway right of way, and it took almost two days to bring the tower sections over to the location, as we needed to be conscious of trains. I managed to reach our contractor and told him I needed a crane on a particular Friday morning at 8 a.m. He told me he had no money. I told him again I expected to see a crane at 8 a.m. Friday and hung up.

On Thursday, I called the crane company. No crane had been reserved, which was no surprise to me. So I made arrangements with the crane company to supply a crane the next morning with an operator.

On Friday, the crane showed up right on time at 8 a.m. Within an hour, 100 feet of tower Number One was standing. At 9:10 a.m., the contractor decided to show up and had a conniption. I apparently had "no right" to get the job done. He was given his walking papers right then and there. As it turns out, he had not paid the electrician or the crane company when tower Number Three went up, so we took care of the electrician and crane company. When you do that, it's amazing how cooperative people become.

As of that moment, I was the general contractor.

I spent the next several weeks getting things ready to start the proof. By the end of June, I was ready to bring in John Hidle of Carl T. Jones Corp. so we could "fire the mother up."

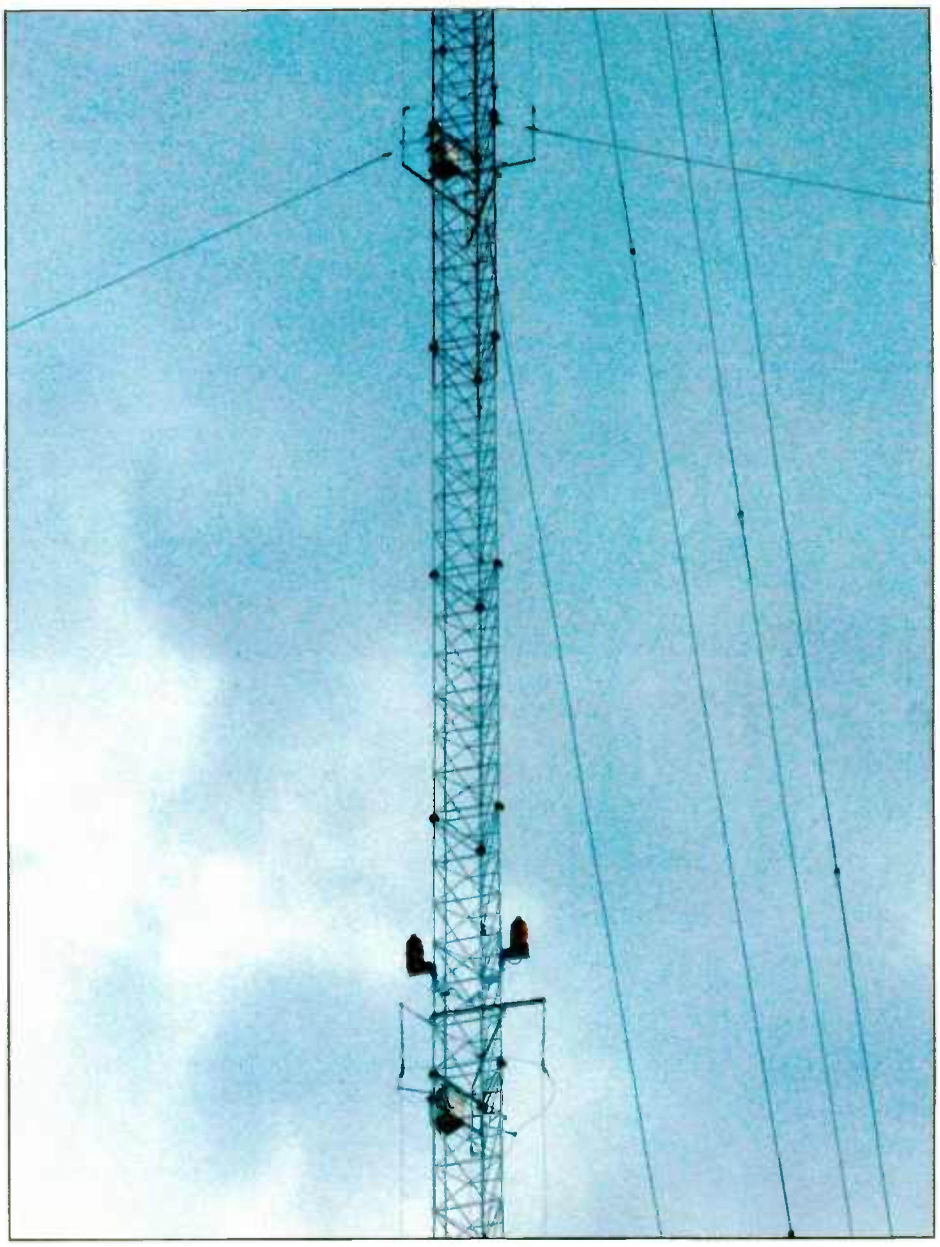
TUNE AND MATCH

Hidle and crew arrived and started putting the finishing touches on the tuning component cabinets in each tuning house. We needed to be a tad creative in getting at least one transmission line into the tuning house and its first cabinet, but overall this went smoothly. The next item on the list was adjustment of the detuning skirts on each tower.

Remember, each tower in the array has

SEE MEADOWLANDS, PAGE 35

The first 100 feet of Tower 2 stands as the crane is lowered.



The detuning skirts can be seen, one below the center beacons, one just above where the orange section starts above the beacons. Also notice the capacitor boxes.

Products & Services SHOWCASE

Meadowlands

CONTINUED FROM PAGE 32

two tuning skirts made of copper-weld cable held out 18 inches from the tower legs on insulators. These skirts are joined together and bonded to the tower on one end. They are attached to a capacitor enclosure that is bonded to the tower on the other end.

To adjust these skirts, Carl T. Jones Corp. constructed a giant toroidal transformer out of PVC hose. The hose was wrapped with 14 gauge wire, and the diameter is roughly 9 feet, enough to fit easily around the tower and detuning skirts. The ends of this wire were attached to a BNC adaptor, which was connected to a Potomac FIM-41 that the tower crew had hoisted up the tower. NEC modeling showed that the maximum current point in the tower was roughly 250 feet up, right under the sample loop.

The tower crew then set the FIM-41 for the correct frequency, either 1010 kHz or 1190 kHz depending on which skirt they were tuning, then cranked on the capacitor in the capacitor enclosure until they reached minimum indication on the FIM-41. It took two days to adjust the skirts.

The next step was to detune the towers for 620 kHz, 1010 kHz, 1190 kHz and 710 kHz, our frequency. While it sounds strange to detune for our frequency, it makes sense not only for the non-directional Proof of Performance, but for the fact that we can operate non-directional off of any of the three towers in the array for maintenance.

While the detuning skirts minimized the current flow in the tower at 1010 kHz and 1190 kHz, the job wasn't finished. What this accomplished was that the electrical height of the towers was reduced at these two frequencies. We still needed to detune at the tower base.

The phasor, where many a night was spent making adjustments.

The WOR twin Harris 3DX50 transmitters, with HD rack in between.

To detune, the tower was grounded and the FIM-41 connected to the sample line running down from the sample loop on any given tower. The FIM-41 was set to the correct frequency, and the detuning adjustments made to minimize signal on the FIM-41. We were able to achieve close to a complete null on the frequencies. Ungrounding the towers had little effect on the signals being received on the FIM-41, and we took this to mean the detuning was good. Incidentally, the final settings were not that far off from the theoretical settings.

FIRE IT UP

Carl T. Jones had preset the phasor networks and tower-tuning networks. We decided to bring the system up in directional mode slowly, starting at 1 kilowatt. We saw that we had ratio and phase on tower Number Two, but nothing for tower Number Three. After verifying that the antenna monitor was working correctly by moving the Tower Two cable to the Tower Three position, we called it a night.

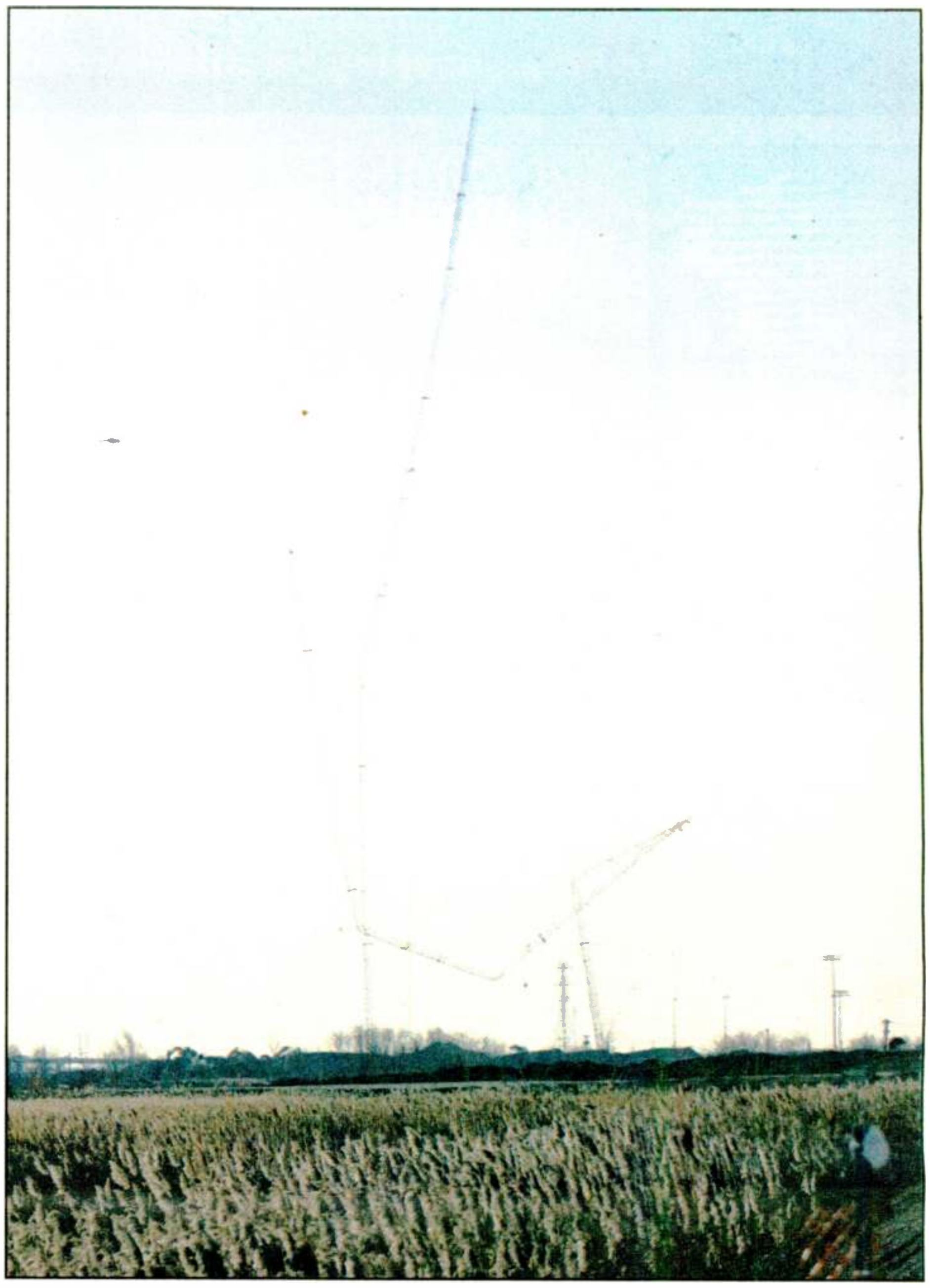
The following day showed a short on the Tower Three sample line. I had a spare coil of sample line, and the tower crew began preparing to remove the sample line from the tower to install a new one.

When John Hidle and I attempted to remove the sample line from the feedthrough bowl on the output cabinet in tuning house Number Three, we found we couldn't budge the cable. We disassembled the bowl, and it took two strong tower guys pulling on the cable and bowl assembly to yank the sample line out. It appears we took a lightning strike the day before; it arced over the sample line and welded it to the bowl feed-thru, shorting the cable.

We came back that night and fired the system up again. Considering we didn't have the final cable run lengths when the system was designed (and the installed version varied slightly), the system came up with Tower Two being about 10 degrees off in phase and about 15 percent low in ratio. Tower Three was roughly the same. Common point impedance was 54 + j20 ohms. Not bad. A little cranking brought the parameters right in and the common point to where it should be.

We then brought the system up to 12.5 kW and let it cook for about 30 minutes. When all was well, we brought it up to 25 kW and let that cook. Finally, we brought it up to 52,650 watts. All looked good.

Then we tried modulating it. The transmitter was most unhappy.



On Jan. 11, 2007 at 11:01 a.m., the WOR Lyndhurst towers fell gracefully to the ground. (Photo courtesy of Leader Newspapers, Rutherford, N.J.)

TX ISSUES

WOR purchased two new Harris 3DX50 transmitters for installation in our Rutherford location. These transmitters unfortunately had some minor issues that I needed to work out.

First, they were far too sensitive to VSWR, and did not care for the HD signal. I put at least 30 hours into adjusting the output monitor boards on both transmitters before they would operate reliably with HD.

Additionally, what we call Transmitter A had a bad backplane for its exciter modules. Once the problems were ironed out, they have performed flawlessly.

MORE ANTENNA SETUP

The next nights were spent balancing the system and setting the impedances looking into the tuning units to 50 + j0 impedance on both directional and non-directional operation. After this was done, we proceeded to measure every conceivable parameter under operational conditions and made a record of them.

Rather than disconnecting the transmission line between the transmitter and phasor and connecting a very low power oscillator to perform an impedance sweep, we simply changed the operating frequency on the 3DX and ran the sweep at 1 kW. We found that the VSWR +/- 30 kHz was less than 1.4:1, which meets the IBOC specifications.

SEE MEADOWLANDS, PAGE 37

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Meadowlands

CONTINUED FROM PAGE 35

We tuned the system up with sample loops, then performed the non-directional proof. We went out and did a rough proof on the directional. We found that the pattern appeared it would satisfy the CP, so we went to work finalizing the sample system.

Normally, the sample line comes off the tower and goes through an isolation coil such that the outer conductor at the top of the coil is at tower potential and the bottom is grounded. The bottom then feeds the sample line to the transmitter building.

In the case of the WOR system, however, the isolation coils prove problematic. Leaving the coils in the circuit causes two things to happen. First, the detuning on 1190 kHz is not as good as it can be. Second, it narrows the bandwidth of the WOR signal; not good on any count.

After getting the system set up with the sample loops, we then needed to transition from the sample loops to toroidal transformers to feed the antenna monitor. This would take the isolation coils out of the circuits.

We went one tower at a time, and put temporary toroidal transformers over the output pipes, then made minor adjustments to the phasor to compensate for the stray capacitance added by the toroids. We then disconnected the sample loop going to the building from the isolation coil, and connected it to the temporary toroidal transformer. We turned the system on and measured the parameters on the antenna monitor. We did this on each of the three towers so that we now had the system running on the temporary toroids and also had a complete set of readings.

We then went to all of the towers, and one by one removed the isolation coils and made slight adjustments to the phasor to return to the readings we started with.

Finally we transitioned the sample lines to the permanent toroids located in the antenna tuning unit. Once this was done and readings were logged, we removed the temporary toroids and made slight adjustments to the phasor to bring the parameters back in. Mission accomplished.

PROOF

Doing proof measurements in northern New Jersey is a challenge.

The close-in points for the non-directional proof were a real challenge, as most of them were in the redevelopment area around the transmitter building. It's difficult to dodge dump trucks while you're trying to make measurements. All of the close-in points were done with GPS because there are no landmarks if we had to do them over again.

The other challenging points were down the train tracks, and one that was only accessible by walking one-quarter mile out into the swamp. It was 90 degrees that day, and it was a load of fun stomping out in boots, holding an FIM-41, a GPS unit and a notebook.

Then there is the simple density of population which makes it hard to move around efficiently, and the suspicious nature of most people.

I had a point on a public sidewalk near a house. After the third time I was there, the owner of the house came out and told me to get lost. I handed him my business card, told him what I was doing and informed him that I was on a public sidewalk and had every right to be there. He said he would call the cops. I said "Go right ahead."

Lyndhurst Tuning House One was hit by guy wires. The other two tuning houses survived without a scratch.

So when the police showed up, I handed them my business card and told them what I was doing. The officer happened to be a listener and said to the homeowner, "He has a right to be here and isn't hurting you." Score one for the little guy.

The proof came out fine, and we needed to do a bit of augmenting because of the nature of re-radiation in northern Jersey.

TOWER REMOVAL, TAKE ONE

A date of Sept. 20, 2006 was scheduled for demolition of the towers in Lyndhurst. Meetings were held.

WOR had not owned the Lyndhurst property for two years, so even though we were the licensee of the towers, it was not our responsibility to make notifications of the demolition. The New Jersey Turnpike is only 3/4 of a mile from the location, and the towers were a landmark along the Turnpike. There also is a 100-year-old water main for Jersey City that travels not far from the site, a gas main pipeline and New Jersey Transit railway. I was assured that notifications would be given, and we scheduled the date.

On Sept. 20, we had 50 members of the press in New York City and New Jersey assembled, along with Society of Broadcast Engineers members and invited guests. The towers were to be cut down at 10 a.m. WOR was on the air all morning talking about the event, and would be broadcasting it live.

The police chief in Lyndhurst walked into his office at 9 a.m. to a ringing phone. It was the New Jersey Meadowlands Commission, who had heard us talking about the tower demolition on the air. "Who the hell OK'd this, and who issued an explosives permit?" The chief took off across town to the tower location and put a stop to it. Incidentally, we were not using explosives, and no one seems to know where that came from.

After several months of meetings, building officials, safety officials and the police were satisfied. All notifications went out.

TOWER REMOVAL, TAKE TWO

On the crisp, clear morning of Jan. 11, 2007, the guy wires were cut on Lyndhurst Towers 2 and 3. All the Lyndhurst towers were 689 feet tall, were 42 inch face and had dead weights of over 85,000 pounds with guy wires attached.

The reason both Towers 2 and 3 were taken down at the same time is that one set of guy wires from each tower interlaced. The tower crew did not want either tower to lose momentum on the way down by getting caught in the wires, or snapping the wires on the opposite tower, which could have been catastrophic. So they cut the guy wires on both towers on the legs away from the center of the tower field.

Both towers fell gracefully into heaps in the tower field. Total time for all three towers was approximately 35 seconds.

The crew then moved onto tower Number One. It did a graceful fold-over, hit the ground lawn-dart style and proceeded to collapse.

It is interesting to note that the tuning houses for Towers 2 and 3 did not have a scratch on them. Tuning house Number One was hit almost dead center by guy wires and looked like a tin can that had a cherry bomb placed under it.

CONCLUSION

Completely rebuilding one of the country's heritage radio stations in a period of two years was a challenge. It is not for the faint of heart.

WOR is now new from the tips of the microphones to the tops of the towers. The studio facility is digital and state of the art. The audio produced in that facility is superb.

The WOR transmitter site was designed from the ground up with digital in mind, and in fact signed on with an HD signal (we did the proof with the HD on, as well). The transmitter site has several audio paths from the city, and a studio, complete with call-in lines, just in case.

WOR is prepared for whatever may come down the road in the future. I'm glad I was able to be the one to make it happen.

Tom Ray is vice president/corporate director of engineering, Buckley Broadcasting, New York. ■

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—Next Issue of Radio World: October 24, 2007
Radio World Engineering Extra: December 12, 2007—

For address changes, send current and new address to Radio World a month in advance at P.O. Box 1214, Falls Church, VA 22041. Unsolicited manuscripts are welcomed for review: send to the attention of the appropriate editor.

by Barry Blesser

Does Innovation Drive Use Of New Technology?

Why Did Some Inventions Change Our Society While Others Became Historical Footnotes?

HD Radio is a wonderfully elegant technology that is on the minds of many professionals in the broadcasting industry.

Many of our brightest engineers and scientists spent years making it a viable technology. From the perspective of technical wizardry, digital broadcasting is as novel as television and FM were in their time.

And like many of these engineers, I am proud of the radio products I have invented during the last four decades. Technology innovation creates careers, wealth and culture.

Studies about the history of technology almost always focus on the creativity of a few brilliant inventors. We are thoroughly familiar with the history of the airplane, internal combustion, semiconductors, contraception and computers, just to name a few. Many of these are connected to epochs: industrial revolution, information revolution, biology revolution and atomic energy.

Academic researchers, popular journalists and bestselling authors write extensively about these magic periods. As a culture, we admire those unique people who were ahead of their time in conceiving that which did not yet exist.

However, not only is their perspective limited but it may only be a minor part of the full story. Hidden beneath an analysis of technology is a set of assumptions and questions that are seldom articulated.

Does the inventive process really drive our culture? Do we really understand why some innovations changed our society while others became historical footnotes?

WHO'S DRIVING?

Think of the millions of patents that describe inventions that were never built. There are thousands of companies that produced novel products for a short time before they disappeared. How many of the original dot.com companies are still around? Do you remember the hula hoop?

Although there are already thousands of articles about HD Radio, I rarely find one based on fieldwork — living with listening audiences.

On the other hand, some technologies appear to last forever; new technology does not necessarily bury the old. The pencil as we know it, and still used today, was created in its current form in the 14th century. The bicycle appeared in the 1870s. Albeit continuously improved, our modern automobile was invented in the late 19th century.

The sheets on my bed are made with the same basic methods of weaving that have been used for thousands of years. While adventurous travelers move rapidly from city to city on magnetic levitation trains, policemen in New York City still move through crowds and traffic on horseback.

How can we explain the longevity of the lowly pencil and paper in the face of seven centuries of technical progress?

In his book "The Shock of the Old: Technology and Global History Since 1900," David Edgerton provides a refreshingly simply alternative to our preoccupation with the elegance of new devices. We should think of technology as being driven by its use, not by its creation.

Use-based analysis assumes that the old and the new always exist at the same time and that the behavior of users determines whether technology will spread. While inventor, engineers and manufacturers can put new choices on the table, users determine the relevance of any particular choice. Innovators have surprisingly little influence on how users will integrate an invention into their lifestyle. More than one technology has been used in ways that were never expected.

USERS RULE

HD Radio is a perfect example of a new technology that exists in parallel with dozens of earlier technologies. Marketing and advertising have only a limited ability to make a product successful if the users do not wish to choose it. Novelty is short-lived. The user is always king. If history is a guide, users simply will vote with their feet, as they did with iPods, automobile CD radios and live concerts.

Edgerton goes on to comment, "A use-centered account also refutes some well-established conclusions of innovative-centric history. For example, it undermines the assumption that national innovation determines national success; the most innovative nations of the 20th century have not been the fastest-growing."

Innovation takes place at the very beginning, but long-term success is influenced by culture, lifestyle and personal preferences. Over the life of a technology, continuous improvements that adapt to the evolving needs of users prolong the value of that technology. Improvements may be minor.

This view contrasts with the image of the brilliant engineer dreaming up a new revolutionary product. Flexibility and adaptability to an ever-changing value system determine success.

We might think that the experts in a use-centric view would be those professionals who specialize in marketing. But many of them sit in their offices reading reports from massive surveys without ever actually meeting the natives. Consider that Margaret Mead was only able to describe the values of life-style of the people of Samoa by living with them.

This now brings me to my favorite question: Where are all the applied anthropologists and sociologists who are willing to live with our audience and report back to us on their values and choices? Although there are already thousands of articles about HD Radio, I rarely find one based on fieldwork — living with listening audiences.

TECHNOLOGIES COEXIST

While new technology sometimes obliterates the old, such as the CD ending LP records, more typically old and new coexist for very long periods of time.

In western Ireland, people still perform traditional music in their local pubs on classical instruments. While riding the bus to work, these same people may well listen to popular music on synthesized electronic instruments from their iPods. A primitive headphone exists in parallel with an expensive surround-sound home theater.

We should think of technology as being driven by its use not by its creation.

Innovation creates choices. Even with its incredible sophistication, the computer has not replaced the pencil in certain situations. The pencil survived but it never returned to its kingly status of the 14th century. And like the pencil, terrestrial radio, with or without HD, is likely to remain a viable choice for centuries if it adapts to the shifting use patterns of our audiences. Will broadcasters embrace flexibility in order to remain relevant to the lifestyle of our user-audiences?

Dr. Barry Blesser is director of engineering for 25-Seven Systems. ■

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