THE HD DEBATE RAGES ON
Robert Savage replies to Guy Wire.
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NewBay Media

New Transmitter Building Requires Real Engineering

A Plan, Plenty of Help And Good Weather Keep A Complex Job on Track

PROJECT PROFILE

BY CRIS ALEXANDER

Assisted by Keith Peterson, the author pulls 7/8-inch transmission line off the spool.

How often do radio stations change transmitter buildings, apart from site moves and facility upgrades? Not very often, I suspect. In my 33-year career, I have never made such a same-site move — until recently.

Before we get into the meat of the project, let's get the boring background stuff out of the way.

Crawford Broadcasting Co. purchased KLVZ (then KLTT) in 1994 as a daytimer on 800 kHz. In 2005, we changed frequency to 810 kHz and upgraded it to a split-site day/night operation, increasing daytime power to 2.2 kW using the existing three-tower array. At that time, we installed a new phasing and coupling system including phasor and antenna tuning units but using the existing transmission lines.

When we purchased the station, we inherited a 1970s-vintage construction trailer as a transmitter building. The site is in the flood plain of the South Platte River, so the trailer was elevated on eight 6-foot concrete piers.

By 2007, the building was starting to crumble around us, the result of more than 30 years of exposure to Colorado winters and wind. I wouldn't have put money on such a trailer surviving that length of time on the ground, let alone 6

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A Life Dedicated to Shortwave Radio

We Chat With George Woodard, Transmitter Designer And International Broadcast Engineer

ENGINEER INTERVIEW

BY MICHAEL LECLAIR

The role of shortwave radio has been much debated by members of the U.S. international broadcasting community. Among those with a strong interest in the topic is George Woodard. I spoke with him about his life and experiences working with shortwave radio as both a manufacturer and an engineer for U.S.-sponsored broadcasts.

Woodard started out with Continental Electronics in the early 1960s in the midst of the Cold War, when shortwave radio was on the rise

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Fall Season of Shows Gets Under Way

East Coast Enjoys Range of Choices This Year

BY MICHAEL LECLAIR

It's August, and that means that the fall conference season is upon us. Unlike the spring with its big shows, the fall offers smaller venues and a range of different specialties. This year's calendar favors the east coast in particular.

Starting out is the NAB Radio Show, which this year is in Philadelphia. The location makes it a reasonable drive for those of us in the New York, New England and Washington areas as well as engineers coming from markets a bit more to the west like Pittsburgh and to the south such as Richmond. The conference dates are Sept. 23–25.

For radio engineers who missed the large NAB Show in the spring (and I know there were many who did not attend) the Radio Show is a chance to catch up on the radio industry and hear the latest technical information.

Once again, the NAB has assembled a good selection of sessions for their engineering program. For those who have been following the continuing debate over high-power digital broadcasting, there will be a two-hour session with industry leaders such as Milford Smith, Geoff Mendenhall, Jeff Detweiler, Gary Liebisch, Tim Bealor and Michael Troje to answer all your questions. Mike Starling of NPR Labs will also report on its long-awaited study to determine the impact of increased digital signal levels. In my opinion, this is one of the most important radio technical topics right now.

For AM engineers, Ben Dawson and Ron Rackley will be presenting a detailed tutorial on the tricks and techniques of the new method of moments modeling for directional AM arrays. MoM modeling, on which Radio World has reported extensively, represents a new and powerful way to prove a new AM directional stations that qualify, and offers potential savings for new and old stations alike.

Additionally, sessions on emergency operations, preventing tower failures, IP-based radio facilities and digital media strategies will be offered.

SOCIETY OF BROADCAST ENGINEERS

Next in line is the 2009 SBE National Meeting being held Oct. 6–7 at the Turning Stone Resort and Casino in Verona, N.Y.

The national meeting is combined with a day of presentations on broadcast engineering topics and an equipment exhibition hall produced by SBE Chapter 22. The list of presentations at this writing is heavy on television engineering, but this is the shortest of the fall shows and also the least expensive. For those in the upper New York state region there is little excuse not to attend.

AUDIO ENGINEERING SOCIETY

Just a week later we have the 127th AES convention, running Oct. 9–12. This conference is about everything audio and includes a special session track aimed just at broadcasting.

Some sample sessions from the broadcast track are "Studio Design and Acoustics Case Study"; "Innovations in Digital Broadcasting"; "Digital Audio Networks in the Studio"; and "Audio for Newsgathering." Another session that caught my interest is "Listener Fatigue and Longevity," featuring panelists such as JJ Johnston and Ellyn Sheffield.

But that only touches on the wide range of other audio sessions that will be offered. Paper sessions include research papers from all over the world on the most complex audio topics, such as the physiology of audio perception and new research on data compression. The AES convention is where the latest basic research and development on audio is presented. There are also day-length workshops on a variety of audio topics, such as live recording or statistical measurement of audio quality. These workshops can provide an in-depth treatment that is hard to find at other conventions.

This year's AES Convention will be held in New York (in alternate years it is held on the west coast in San Francisco). Again, this is a reasonable drive for engineers in numerous big and small markets in the region.

IEEE

Starting right after the AES is the 59th annual Broadcast Symposium of the IEEE, Oct. 14–16. While small, this features some of the best presentations and papers on the latest in broadcast research and development. Intended primarily for engineers, the symposium operates at a level that assumes an extensive background in theoretical engineering.

Scheduled to present on Wednesday the 14th is John Kean of NPR Labs with a tutorial on modern FM and IBOC signal coverage measurement techniques. On the same day is a presentation from Russ Mundschenk of iBiquity Corp. about the results of their field tests of IBOC at elevated carrier levels. On Thursday there will be presentations on AM modeling using NEC and a general presentation on the characteristics of monopole and vertically polarized dipole antennas.

This year's Broadcast Symposium will be held in Alexandria, Va., right outside of Washington.

TOO MUCH TO HANDLE

The fall is filled with opportunities to learn more about engineering and broadcasting with a different show just about every week for a month. And we have not mentioned regional events such as SBE Chapter 24 and the Wisconsin Broadcasters Association hosting the Broadcasters Clinic on Oct. 13–15 in Middleton, Wis., or Chapter 20's Annual Equipment Expo on Oct. 19–20 in Monroeville, Pa., or the annual Indiana Broadcasters Association's Engineering Workshop, which takes place Oct. 27–28 in Indianapolis.

Most of us will find attending all of these shows every year too much to fit into our busy schedules. But this wealth means that there is something for everyone out there. Go ahead and pick one — it's a great way to keep your knowledge up to date, and they count towards SBE re-certifications too.

Photo by Jim Peck

Getting up close to the gear is one benefit of being there in person. Wisconsin Public Radio's Steve Johnston checks out the 'big iron' in the power supply section of Continental's 44 kW 816R-7C FM transmitter at a recent show.

THIS ISSUE

AUGUST 19, 2009

TRANSMITTER

(continued from page 1)

feet in the air where the elements had free access to all six sides! It really is amazing that it lasted so long.

About 10 years ago, CBC began purchasing prefabricated concrete transmitter buildings rather than building our own. There are any number of manufacturers of quality precast concrete equipment shelters, and these buildings can be custom-ordered with HVAC, electrical, grounding, equipment ladders, lighting and security already installed. They are delivered by flatbed truck and set in place with a crane, ready to connect to power, telco and RF cables.

I chose a precast 12-by-20 shelter for KLVZ for all those reasons, and because we were able to get a brand spanking new surplus unit originally ordered by Nextel for 30 cents on the dollar. Getting the county approvals was no walk in the park because of flood plain issues, but eventually we prevailed, and in late November of 2008, the building was in place on its piers.

By February of this year, we had power connected. We were essentially ready to go except for the small issue of frozen ground! Knowing that we would have to wait for the spring thaw gave us time to plan out the move.

The old building was located at the base of Tower 2, the center and reference tower of the array. The new (2005) directional pattern featured all positive power flow towers, so adding an equal length of transmission line to all three branches would result in a phase budget that wouldn't require any ATU or phasor component changes. We would also add an equal length of sample line to all three branches of the sample system.

A location for the new building was chosen some 250 feet from the old building for a number of reasons. One has to do with power. We have plans to eventually upgrade this facility to 10 kW daytime, and three-phase power is required for that. The local utility charges by the inch to install new three-phase power line. Locating the building 250 feet closer to the road (and utility feeder) dramatically cut the cost of the upgrade.

Another reason is RFI. With the old building located so close to Tower 2, RFI and RFR have always been problems. We had to employ all sorts of screening to make the interior of the trailer both safe and equipment-friendly. Finally, by locating the new building relatively close to the county road, we would eliminate those long snowshoe treks in the winter just to check on things.

Challenge number 1 was to extend all the tower cables from beneath the old trailer to the new building. These cables included the transmission and sample lines, electrical power (for tower and security lighting and pattern switching) and control cables. We also found that the telco cable feeding the old trailer was not telco-owned — it was ours, and thus our responsibility to get it to the new building.

Challenge number 2 was, believe it or not, prairie dogs.

Colorado is home to lots and lots of prairie dogs. They are cute little critters, but they are terribly destructive. There is no such thing as a "direct burial" cable where prairie dogs live, and we have a large colony at the KLVZ site. All the cables would have to be sheathed in schedule-40 PVC conduit.

The third challenge was the phasor. Its width is 35-1/4 inches; the door opening on the new building was 34-3/4 inches wide from stop to stop. Had we ordered this building new, we would likely have specified a 42-inch door, but this was a surplus building and we had to take what they had. The steel door frame was actually part of the concrete mold and as such is secured and filled with concrete.

The final and overarching challenge was time. To minimize down time, this project would have to be completed in a matter of days. We were hoping and praying for good weather, but once we started the work, we would have to go on, rain or shine. Thankfully, we had dry (but hot!) weather for the outdoor parts of the project.

Even the best battle plans go out the window when the first shot is fired. I knew that going in. But that didn't mean that we didn't need a good plan. We had one, and amazingly we were able to stick to it, staying on track throughout the project.

We had a good crew consisting of CBC-Denver Chief Engineer Amanda Alexander and her able helper, Keith Peterson. Mark Smith and Shay Awedia of NRC Broadcasting were also on hand to help, and we had general contractor Mike Kilgore, electrician Ryan and some general labor as well.

Here's how it went.

Drilling through the telco-style splice pedestal. Cable splices were made with connectors and 90-degree 'elbows.'

The phasor is removed from the old building by forklift.

MONDAY

We started the project on a Monday morning by disconnecting the sample lines from the antenna monitor and pulling them out from beneath the old trailer. This was no easy task. While most of the excess line was (presumably) buried somewhere beneath the old building, there was a good bit of excess simply wound up in the floor joists and secured with conduit clamps. We removed all those clamps and carefully pulled each line so that it was straight from the point where it exited the conduit.

Next, we did the same for the electrical cables, which were 10-3 Romex, and the control wires, which were seven-pair 22-gauge cables (why did they use such small wires?).

Finally, we took the site off the air and pulled the transmission lines out of the phasor. Like the sample lines, the transmission lines (two 1/2-inch foam lines and one 7/8-inch foam line) also had excess coiled up in the floor joists. We had to remove the securing clamps and pull those out straight.

The next step was carefully to cut off the 3-inch PVC conduits containing all the transmission, sample, control and electrical lines a foot above ground level so that we could splice all those cables. We did this with a Dremel and a hacksaw blade, and we were successful in getting the conduit cut without damaging any of the cables inside. We had to do this for four different pipes — the ones containing transmission and sample lines, one containing electrical cables and one containing the telco cable. It was a lot like a doctor removing a cast!

The remainder of Monday was spent disconnecting equipment, emptying the racks and preparing everything for the 250-foot move to the new building. The general contractor was on site with a trencher, cutting a trench for the cable extensions to the new building.

TUESDAY

Day two of the project was perhaps the hardest. It was certainly the hottest!

We had a roll of 300 feet of 7/8-inch foam line, a roll of 600 feet of 1/2-inch foam line, a roll of 900 feet of 3/8-inch foam line, a roll of 1,000 feet of 10-3 with ground U/F electrical cable and a roll of 1,000 feet of seven-

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TRANSMITTER

(continued from page 4)

pair AWG-16 control cable. All that had to be pulled off the spools and cut.

We took particular care in measuring and cutting the 3/8-inch sample lines. The manufacturer provides a mark every meter of length, so it was a fairly simple matter of watching those marks go by, checking our math twice and cutting at the appropriate place. We did the same with the 1/2-inch line, cutting it into two equal-length pieces.

The electrical and control cables were pulled out to the same lengths as the transmission and sample lines and cut. Finally, we pulled out and cut two Cat-5 plenum-rated cables that we would use to extend the telco cable. While there was a 25-pair cable to the old building, only six pairs were terminated and only one pair was used (for ISDN). The two Cat-5 cables allowed us to extend eight of the pairs.

Pulling and cutting the cables was the easy part. Next, we had to sheath them with the schedule-40 PVC conduit. We had two 3-inch pipes and one 2-inch. There was no good way to pull transmission lines through the complete 250-foot conduits, so we didn't even try. We laid the cables out on the ground and grouped them. Next, we slid the 10-foot conduit sections over the cables, gluing up the joints as we went. By the end of the day, all three pipes were in the ground with the extension cables inside. That was one long, hot, tiring day.

WEDNESDAY

We had extra help on hand to assist with relocating the transmitter and phasor to the new building and it's a good thing.

The general contractor and I had spent some time noodling on how to get the phasor through the too-narrow door opening on the new building, and we came up with a plan: We would use a disk grinder to cut the striker-side stop off the frame from the floor to about 48 inches up. The GC did that while my helpers and I took the side panels off the phasor, not to make it narrower — the aluminum trim extrusions were not removable and they defined the width — but to keep us from scratching them up in the move.

Finally, we were ready. The fork lift was brought in and we loaded the phasor on it, transporting it to the new building. Once there, we laid the phasor cabinet on its back, raised it up to the new building and carefully threaded the needle with it. The phasor slid through the door with a couple of millimeters to spare! Once inside, we had to stand it back up, no easy task with the cable ladder overhead. We found a spot with enough headroom and put the phasor back upright. Whew.

The transmitter, a Nautel ND-2.5, was much easier to move (though it was a lot heavier than the phasor). We had hand-carried the rack into the new building on Monday, so it was already there.

We had an electrician on hand to help us get the extension cables into the new building. He and our helpers completed the conduit runs and building penetrations. It was no easy task, but they got those rather uncooperative cables all into the new building.

While all the moving was going on, Mark Smith was working under the old trailer splicing the cables. We purchased a 14-inch diameter telco-style splice pedestal for this purpose, and it worked out great. But just try buying only one of those … they usually sell them in lots of several hundred.

Finally, we completed the grounding. The new building includes a "halo" grounding system (those wireless folks are serious about grounding!). We installed an array of seven rods beneath the new building, tying them all together and connecting that to the halo system in the building. We also brought in a strap from the station ground system and tied it to the central point of the halo system.

THURSDAY

The electrician was back on Thursday, and I had a pretty good list for him. The new building was pre-wired, but the circuits feeding the transmitter, phasor, rack and towers all had to be routed and terminated. The tower light circuits also had to have current transformers installed for remote monitoring.

While the electrician was doing his thing, Amanda, Keith and I were wiring up the remote control, Ethernet connections, audio, etc. By afternoon, with the electrician gone and out of the way, I started on the transmission and sample lines. I used our network analyzer to "tune" the sample lines carefully to the exact same resonant frequency before installing connections. I had measured them before vacating the old building and made sure that they were all the same electrical length. Now all I had to do was get the new lengths equal. Piece of cake — our careful field cutting of the lines paid off. Keith got the STL up and running, restoring both audio and WAN connectivity to the site.

At about dinner time, all the sample and transmission line connections were made and we were ready to fire the site back up. It came back up just fine, and everything was in the ballpark. With just a little tweaking, I "nailed" the licensed operating parameters on the antenna monitor.

It was a long day but a good, productive one. The end was in sight.

FRIDAY

We ended the week with cleanup and important but non-air-critical items.

We had called the security contractor to have them come and move the fire/burglar alarm system to the new building, but they couldn't get there for several days. It occurred to me that we could move it ourselves, so we did (the contacts were already pre-installed in the new building). We later had the security company come back and check the system and installation over, but by the end of the day Friday we had the new building protected.

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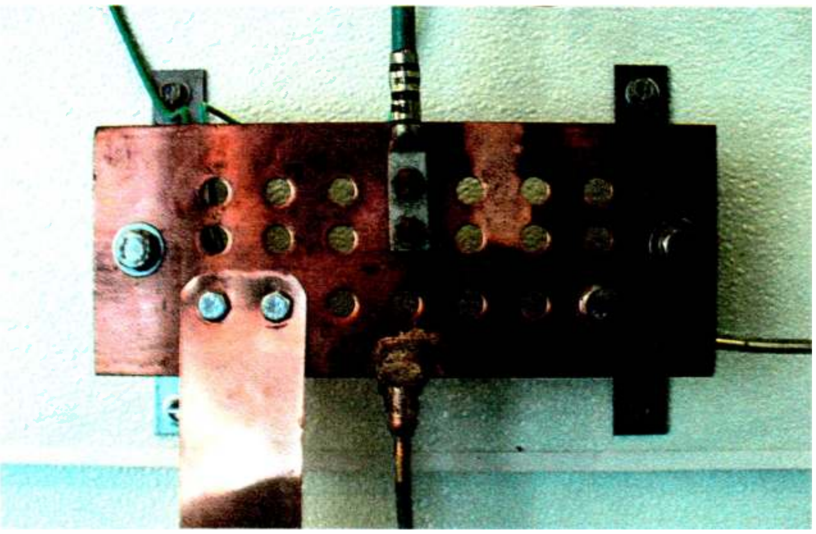
The 60,000 pound pre-fab concrete building is set in place on its elevated foundation with a crane.

A very tight fit!



Central ground point for the halo ground system. The brazed connection at the bottom center goes to the ground rod array. The strap connection ties in the building RF ground. The wire on the right ties in the bus bar for the transmission line entry grounds.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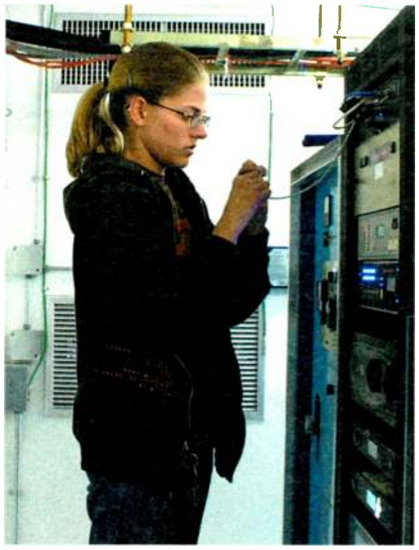

Amanda Alexander wires up the Ethernet switch.

Completed cable splices in the telco pedestal.

The 14-inch-diameter pedestal provides a secure, dry and accessible environment for the splices.

The supplied overhead cable ladder made cable routing and management a snap.

On the air from the new building!

TRANSMITTER

(continued from page 6)

A welder came and reinstalled that cut-off piece of the door frame. The GC ground the welds smooth and painted the frame. Now you can't tell that it was ever removed. We have created the classic "ship in a bottle!" Grinding off the stop turned out to be an excellent solution. The door frame is still secured in concrete and retains all of its strength.

Keith activated the video security cameras and DVR, restoring 24-hour video surveillance of the site.

I spent some time tweaking the IBOC operation. The transmission line extensions had produced a rotation of the load presented to the transmitter, and this shift was in our favor. In the move, we were able to eliminate a "line stretcher" network that had been used in the old building. I got good IBOC performance and a clean spectrum from the new facility.

FINISHING UP

As we prepared for this project, I had it in mind to license it under the FCC's new modeling rules. KLVZ's daytime array has long suffered from monitor point anomalies caused by nearby construction cranes. The cranes did not affect the far field, but they did play havoc with the MP field strengths. In 2007 I augmented the pattern to heavily fill the nulls and gain some breathing room at the MPs, but by modeling the pattern and licensing it under the new rules, I could forget about MPs forever.

Amanda and I took a couple of days the week after the project to wrap up the modeling part of the project. We had measured the base impedance matrix before the project began, and the sample lines had been measured during the project. What remained was calibration of the sample transformers (TCTs), adjustment of the array to the model parameters and measurement of the reference field strengths.

I removed the TCT from each ATU cabinet, carefully marking them as to which tower they came from, then took them all to the transmitter building. I then connected them all to the antenna monitor through short lengths of Andrew Sure-Flex cable and looped a piece of AWG-12 wire through them, connecting each end of that wire to a J-plug in the phasor. It was a simple matter to turn the transmitter on, calibrate the antenna monitor internally, then read the phases and ratios from the three TCTs on the monitor. After reinstalling the TCTs I adjusted the array to the model parameters. This really didn't take much — it required a two-degree shift on one tower and less than a 5 percent current shift on both non-reference towers. Keith and I spent a couple of hours tuning the ATU networks for a transmission line match while Amanda chased us with the phasor controls.

With all that done, we re-touched the IBOC settings, then hit the road to measure three points on each of the null and major lobe radials. I did the paperwork and filed the application. Job done!

On the surface, moving to a new transmitter building may seem like a relatively simple project. Trust me, it's not. There are many things to consider, especially with a directional AM. Arrays that employ negative power flow towers will likely have to undergo a complete phasing and coupling system redesign.

The secret to a successful move is good planning. Don't get in a hurry. Think things through carefully and plan for contingencies. There was much that we didn't know going in, but we were prepared. That planning and preparation paid off.

Cris Alexander is the director of engineering at Crawford Broadcasting and a recent recipient of SBE's Broadcast Engineer of the Year award.

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Stress Can be a Killer for Diodes as Well as Engineers

BY CHARLES S. "BUC" FITCH

SBE certification is the emblem of professionalism in broadcast engineering. To help you get in the certification exam-taking frame of mind, Radio World Engineering Extra poses a typical question in every issue. Although similar in style and content to the exam questions, these are not from past exams nor will they be on future exams in this exact form.

Our question from last time is shown in the box at right. The answer is (e).

Discrete components are getting smaller, reaching an extreme in the ultra-miniaturization of surface-mounted technology. Yet simultaneously they are becoming more durable. Present-day silicon diodes are a good example. They are amazing in their durability, frequency response and other qualities compared to similar devices of just a few years ago.

However the greatest stress factor assaulting all components remains the peak applied voltage across them. These potentials, sometimes just transients, are …

THE COMPONENT KILLERS

Diodes are not immune to transients, and the most dynamic conditions are usually found in power supply applications. In the case of rectifier circuits, highly variant voltages can be encountered in the conversion process of AC to DC.

Various rectifying arrangements are available. The question in this column looks at two of the most often encountered configurations, the full-wave center tap (Fig. 1) and the full-wave bridge (Fig. 2), and asks us to differentiate several qualities between them.

Very often we need to transform from line-level AC voltage up or down to an appropriate or optimal voltage level for electronic circuitry requiring DC power. This pedestrian need means that we will quite often have some sort of transformer and rectifier configuration to provide that DC.

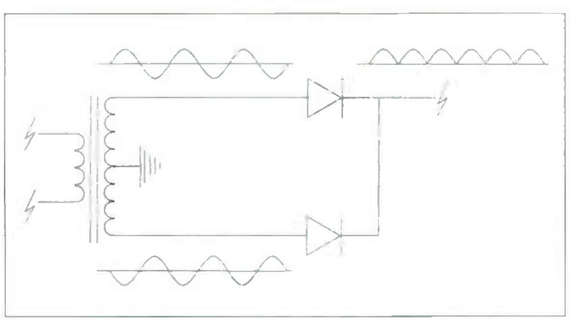

Fig. 1: Full-wave CT Configuration

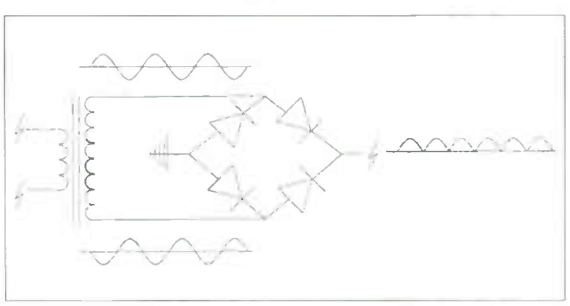

Fig. 2: Bridge Configuration

In comparing the two arrangements, three specific qualities under review are peak inverse voltage rating requirements for the rectifiers, power handling capacity of the supply transformer and voltage drop through the rectifier path.

If you were to sample the voltages with your meter, both of the above arrangements have the negative DC polarity present on the ground connection shown at the center tap of the transformer and at ground point of the bridge. Rippling DC would be present before downstream filtering (as shown) on the output side of the diodes.

For clarity, let's consider the conduction through two configurations in Figs. 3 and 4. If you follow the current flow through the AC cycle in Fig. 3 (a redraw of the full-wave center tap with directional arrows) when the voltage swings positive as marked on the waveform, you will see that a positive current flows through D-1; 180 degrees later, the reciprocal situation would occur and the current would flow through D-2. In both cases the current returns to the transformer through the center tap.

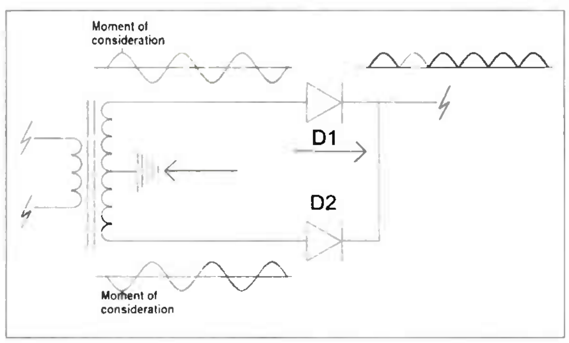

Fig. 3: Full-wave CT — D1 Conducts

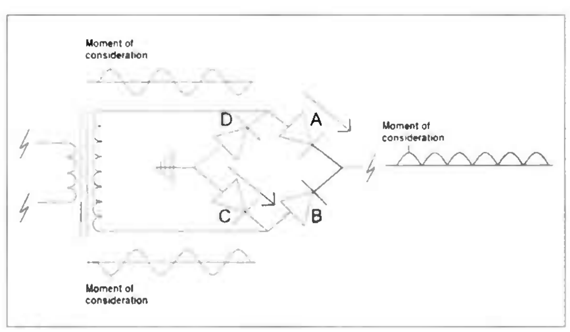

Fig. 4: Full-wave Bridge — Diodes A and C Conduct

As you can see, in this configuration the inverse voltage potential across each diode is the entire voltage from the transformer secondary.

In Fig. 4, the full-wave bridge, the current flows on the positive swing through diode A. The negative swing on the opposite arm of the transformer pulls current from ground through diode C. In this case the two diodes are in series and the inverse potential across each of them is half of the applied.

Fig. 5 shows the reverse with the positive current flowing through diode B and the negative current through diode D.

Component Killers
(Exam level: CBT)

What are the advantages of a solid-state bridge rectifier over a solid-state full-wave rectifier?

a. Reduced peak inverse voltage rating requirements for the rectifiers
b. Better utilization of the power handling capacity of the supply transformer
c. Reduced voltage drop
d. b & c above
e. a & b above

RESISTOR MODEL

When thinking of inverse potentials it's helpful to view each diode as similar to a resistor (Fig. 6). This drawing would coincide with the current flow shown in Fig. 4. In this analogy, two diodes in series would be double the resistance and hence half of the voltage drop would be impressed across each. The dashed lines represent the extremely low impedance of the conducting diodes, and the resistors the extremely high impedance of the reverse path through the diodes. The full-wave bridge is an improvement over the CT half-wave bridge topology in that the reverse voltage on each diode is reduced. So selection (a) is a valid advantage. We'll amplify on this virtue in a moment.

Again looking at the current flow, you'll notice that in the center-tapped arrangement, power is taken from either side of the transformer center tap alternately. This means that you have to provide essentially two alternate transformers, each working only half the time. That is a lot of extra copper.

In the bridge arrangement the entire secondary winding is used on each polarity of the AC power wave. On a practical level, although this does not translate into exactly half the transformer, a more efficient (smaller and lighter) power transformer can be specified for a

(continued on page 12)

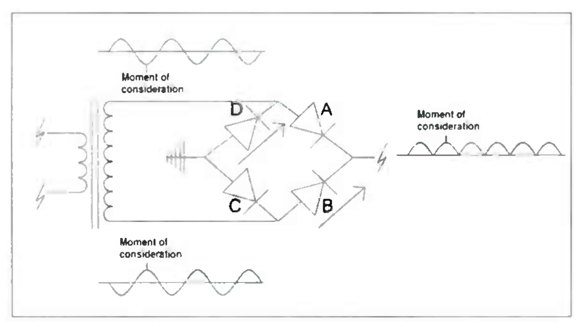

Fig. 5: Full-wave Bridge — Diodes B and D Conduct

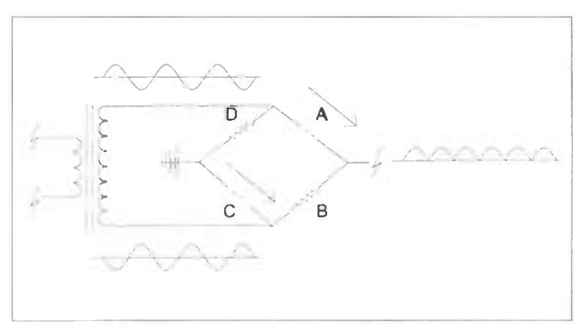

Fig. 6: Full-wave Bridge — Current Flow Analogy

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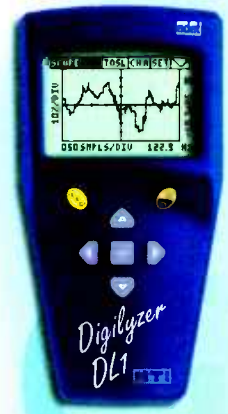
Digital Audio Analyzer

A handheld digital audio analyzer with the measurement power & functions of more expensive instruments, the DL1 Digilyzer analyzes and measures both the digital carrier signal (AES/EBU, SPDIF or ADAT) as well as embedded digital audio. In addition, the DL1 functions as a smart monitor and digital level 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 connect to an analog line. In addition to customary audio, carrier and status bit measurements, the DL1 also includes a comprehensive event logging capability.



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

DR2 Digirator
Digital Audio Generator

The DR2 Digirator not only generates digital audio in stereo & surround, it is a channel transparency and delay tester as well, all condensed into a handheld package. Delivering performance & functionality challenging any digital audio generator made today, it produces all common audio test signals with sampling frequencies up to 192 kHz and resolution up to 24 bit. The Digirator features a multi-format sync-input allowing the instrument to be synchronized to video and audio signals. In addition to standard two-channel digital audio, the DR2 can source a comprehensive set of surround signals.

- AES3, SPDIF, TOSLink, ADAT outputs
- 24 bit 2 channel digital audio up to 192 kHz SR
- Sine wave with stepped & continuous sweeps; White & Pink Noise; Polarity & Delay test signals
- Dolby D, D+, E, Pro-Logic II, DTS and DTS-HR surround signals
- Channel Transparency measurement
- I/O Delay Measurement
- Sync to AES3, DARS, word clock & video black burst
- User-generated test signal files

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Acoustics, Audio & Intelligibility Analyzer

The AL1 Acoustilyzer features extensive acoustical measurement capabilities as well as 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)
- Delay measurements
- High resolution FFT with zoom
- Optional STI-PA Speech Intelligibility function
- Automatic Distortion analyzer (THD+N)
- Frequency, RMS Level, Polarity measurements
- Requires optional MiniSPL microphone
- Includes MiniLINK USB interface & Windows PC software for storing tests and PC transfer

MR-PRO Minirator
High performance
Analog Audio Generator + Impedance/Phantom/Cable measurements

The MR-PRO Minirator is the senior partner to the MR2 below, with added features and higher performance. Both generators feature an ergonomic instrument package & operation, balanced and unbalanced outputs, and a full range of signals.

- High (+18 dBu) output level & <-96 dB residual THD
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- Polarity & delay test signals
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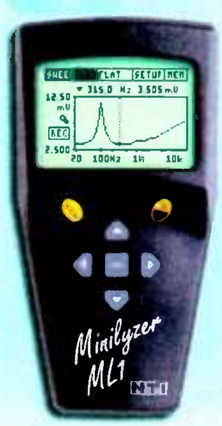
- Cable tester and signal balance measurement
- Protective shock jacket

ML1 Minilyzer
Analog Audio Analyzer

The ML1 Minilyzer 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, plus VU+PPM meter mode, scope mode, a 1/3 octave analyzer and the ability to acquire, measure and display external response sweeps generated by a Minirator or other external generator.

Add the optional MiniLINK USB computer interface and Windows-based software and you may store all tests on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.

MiniLINK



- Measure Level, Frequency, Polarity
- Automatic THD+N and individual harmonic distortion measurements k2 – k5
- VU + PPM meter/monitor
- 1/3 octave analyzer
- Requires optional MiniSPL microphone for SPL & acoustic RTA measurements
- Frequency/time sweeps
- Scope mode
- Measure signal balance error
- Selectable units for level measurements

MR2 Minirator
Analog Audio Generator

The MR2 pocket-sized analog audio generator is the successor to the legendary MR1 Minirator. It is the behind-the-scenes star of thousands of live performances, recordings and remote feeds.

- Intuitive operation via thumbwheel and "short-cut" buttons
- New higher output level (+8 dBu) & low distortion
- Programmable Swept (chirp) and Stepped sweeps
- Sine waves
- Pink & White noise
- Polarity & Delay test signals
- Illuminated Mute button

DIODES

(continued from page 10)

bridge vs. a center-tap configuration. So selection (b) is a valid advantage of a bridge over a center-tap configuration.

Incidentally, the above discussion is described and quantified with a wonderful phase that should roll off your tongue like poetry to impress folks with your erudition at cocktail parties, school reunions and the like: *transformer utilization factor*.

Practice saying this a few times … doesn't that sound profound?

All solid-state "junctions," whether they be in transistors or diodes, have a barrier voltage. This barrier creates a voltage drop across the barrier which varies with construction, fabrication material, count of barriers in parallel, etc. In power diodes such as would be used in these applications, the barrier voltage would typically be around 0.5 volts for each diode. Obviously the simple physics is that the lower the barrier voltage, the lower the power dissipation in the device, and newer junction materials and compounds bring this value down even more in newer premium devices.

The center-tapped rectifier has a single diode in the circuit for each polarity swing and the bridge has two. Not a world-shaking difference numerically (IR drop of 1.0 for the bridge instead of 0.5 volts for the center tap) but measurable just the same and, in some low-voltage circuitry, this drop could be a notable design issue.

So reduced voltage drop is not a quality of a bridge over a center tap and selection (c) is not an advantage.

Answer (e), the advantages of (a) and (b) together, is therefore the correct answer.

RECTIFIERS AND DIODES

Let's strive for some precision and clarify definitions.

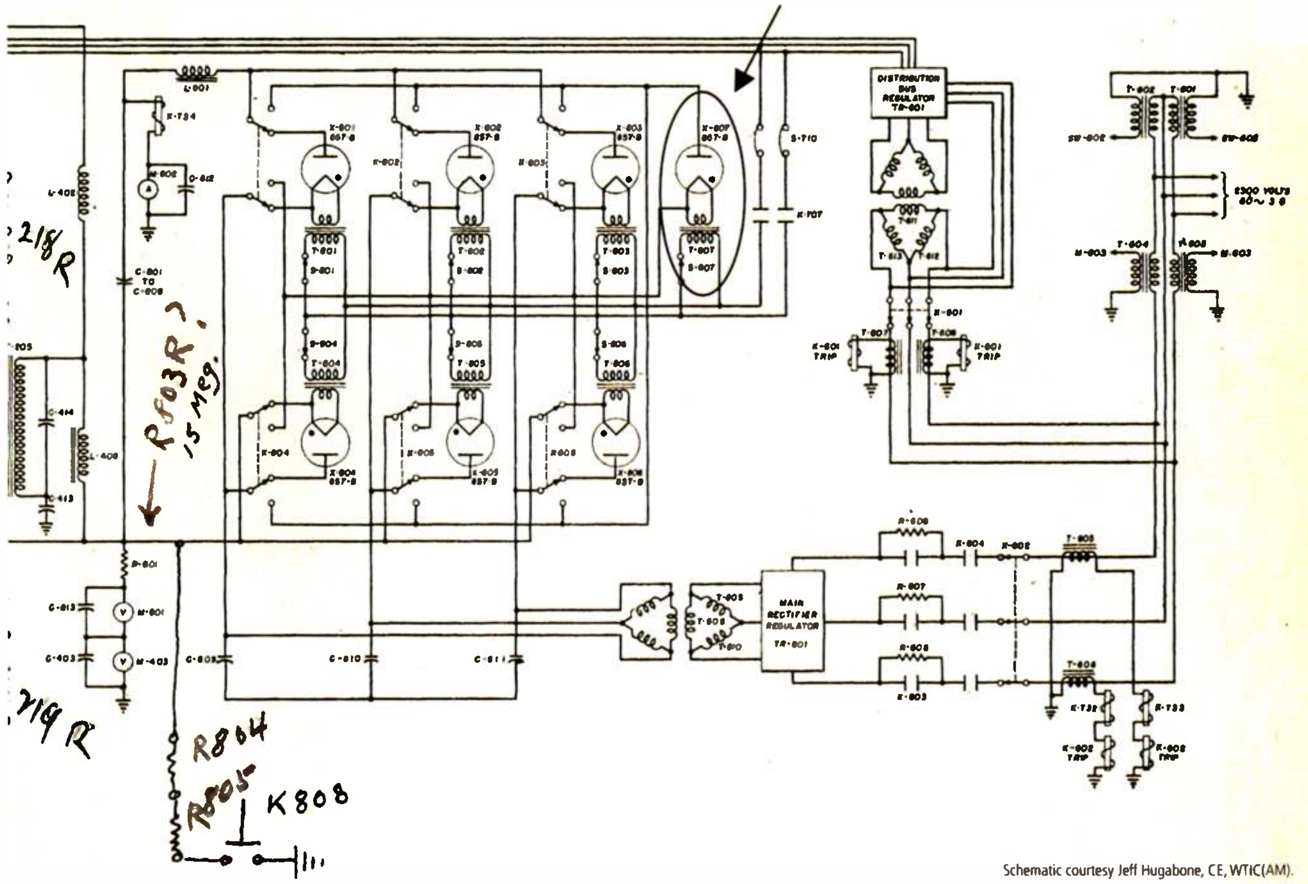
A rectifier is a device that converts AC into DC voltage, usually by allowing current to flow *mainly* in only one direction.

A diode is a device that allows current to flow in *only* one direction.

We said earlier that we would elaborate about inverse voltage. In early broadcast equipment most rectifiers were gas-filled tubes or selenium (sometimes copper oxide). Both of these had two serious limitations: low inverse voltage capability and low inverse resistance. The ratio of forward and reverse current flow was not all that high, resulting in increased ripple, usually mandating increased filter complexity.

For the former case, you can immediately see why in high-voltage applications a bridge circuit of multiple gas rectifiers would be desirable to lower the inverse voltage demands on each of the tubes or rectifiers.

Even now, what's inside the typical high-voltage "brick" diode in your FM tube transmitter is a string of diodes connected in series to lower the reverse voltage on each individual diode junction. An interesting (and actually wise) check upon receiving a new "brick" is to measure the barrier voltage drop.



Schematic courtesy Jeff Hugabone, CE, WTIC(AM).

Fig. 7: The tube and relay components shown occupied an entire cabinet in the transmitter. Because this 50-HG-1 was among the first delivered, a handful of 'improvements' were added over time; those were penciled onto the drawing.

Place a pair of 9 volt batteries in series as a voltage source along with about a 2 k resistor to limit current and then note the voltage drop through the barriers of the "brick" in the forward direction. Divide that voltage drop by 0.5 and you have the approximate number of series diodes inside. If you have any future high-voltage power supply issues, you can recheck the bricks out of the circuit to determine if any of the internal diodes have punched through. Whether you have a standby transmitter and/or your station can tolerate an outage for repair dictates whether you need to replace bricks preemptively with punched-through sections. An imbalance in the count of sections between bricks in a bridge rectifier in a transmitter with minimal filtering will start to show up in increased PS ripple.

WE'LL BE ON THE AIR IN 20 MINUTES …

On a historic note, I was surprised to discover that Westinghouse's innovative 50 kW AM transmitter model 50-HG-1 (first supplied to WTIC here in Hartford in 1947, the year I was born) had "solid-state" bridge rectifiers on supplies up to 3000 volts. Above this voltage level, gas-filled rectifier tubes (model 857B) in bridge configuration were used for the final high-voltage supply.

See *http://tinyurl.com/rwtube*, which will open a PDF, if you have an interest in this tube's parameters.

One of the first high-level, plate-modulated 50 kW transmitters capable of 100 percent modulation, this rig had many leading-edge innovations. However, as an indication of how iffy the gas-filled rectifiers were under the severe high-voltage stress, the transmitter featured a "hot standby." This model 857 rectifier tube was literally hot, as it took 20 minutes to warm up the rectifiers and distribute the mercury gas evenly in the envelope.

A seventh spare tube was kept "hot" and could actually be relay switched nearly instantly into the circuit by the transmitter engineer as a substitute for whichever of the other six had failed through a nifty set of substitution relay switches. See schematic of the rectifier section, Fig. 7. The dot inside the tube signifies that it is gas-filled as opposed to a vacuum, as would be maintained in a 5U4 rectifier for example.

By contrast, when was the last time you saw a "hot standby" 1N4008?

Our next question appears in the box on the left.

The deadline to sign up for the next cycle of SBE certification exams is Sept. 18 for testing to be given between Nov. 6 and Nov. 16 in the local SBE chapters.

Buc Fitch, P.E., CPBE, AMD, is a frequent contributor to Radio World. Missed some Certification Corners or want to review them for your next exam? Find past questions at the Certification Column tab under Columns at radioworld.com.

A CBRE-level question for the next Certification Corner.

About FET transistors, which of the following is most accurate?

a. The drain is the normal input element akin to a grid in a tube.
b. The gate is the normal input element akin to a grid in a tube.
c. The source is the normal input element akin to a grid in a tube.
d. The screen is the normal input element akin to a grid in a tube.
e. None of the above because an FET is a transistor and so a current amplifier unique to itself.

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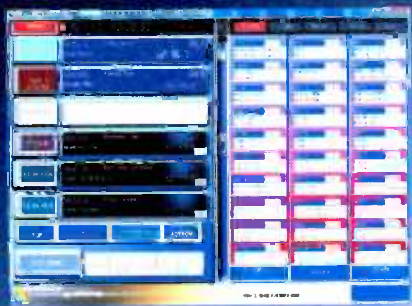

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How Do I Know I'm Winning the Argument?

Answer: When HD Proponents Start Attacking Me and My Station

BY ROBERT C. SAVAGE

The author is president/CEO of WYSL NewsPower 1040 in Avon, N.Y.

In reference to "Guy Wire's" most recent commentary ("A Critic Lashes Out at HD Radio," June 10):

Question: How do I know I'm winning an argument about HD Radio? Answer: When HD proponents start attacking me. And my radio station. (As opposed to defending the "merits," such as they are, of HD Radio.)

Only two weeks after HD-AM was authorized for night broadcasts back in September 2007, Citadel engineering chief Martin Stabbert succinctly summed up HD Radio's problems while ordering it shut off, citing "lackluster performance, limited benefit and … significant interference."

Since that time, anyone daring to step forward and point out the butt-naked emperor of HD Radio typically invites ad hominem attack, but "Mr. Wire's" latest is a little over the top even by HD-proponent standards. Presumably Stabbert is too big and too august to attack publicly — but HD-pushers reserve special high-derision treatment for little guys, not unlike the classic neighborhood bullies who always seek out those they think will be the easiest targets.

FANTASY CONCLUSIONS

Before we get to a few general observations, let's unpack the latest space-walk from "Guy Wire" point by point. (This won't take long.)

GW on analog first-adjacent interference to WYSL from WBZ: "Much of WYSL's Rochester coverage was already getting clobbered by WBZ's analog upper sideband skywave signal."

False. Our coverage was perfectly suitable prior to WBZ(HD)'s unleashing the I-JAM wall of noise in September 2007. You see, "Guy," there is this interesting thing called "the NRSC mask," which for 17 years has kept first-adjacent stations from stepping on their neighbors. (Unless, of course, you transmit with HD at night, in which case you can apparently now help yourself to 30 kHz of spectrum with impunity.)

GW on the multiple complaints filed against WBZ(HD) by WYSL: "WBZ engineers performed the same set of measurements (as WYSL) and concluded Savage's data or his measuring methodology was flawed … the FCC apparently agreed with WBZ and did not grant WYSL any relief."

Nonsense: Neither WBZ nor the FCC did anything of the sort. Yes, CBS Radio Northeast did sneak into Rochester one night to hastily perform — over a 12-hour period — a total of 13 "measurements" when WYSL was operating in emergency mode at greatly reduced power due to an antenna problem. (WYSL's data, by contrast, was gathered over 19 weeks in varying weather, a total of scores of measurements in all three patterns.)

Contrary to "Guy's" fantasy conclusion, the truth is the FCC has never ruled on the WYSL vs. WBZ case. In fact, the FCC has never acted on any of hundreds of IBOC complaints (this from a Mass Media Bureau source in the commission). Nor is the commission likely ever to rule on any IBOC interference case.

"Guy," apply logic and legal reasoning to the HD Radio issue: If the FCC grants any station (including WYSL) relief on IBOC interference complaints, they've just killed HD, because nobody is going to invest in a system the commission could eventually order them to turn off. If they rule against stations suffering interference, they've handed the injured station a cause of action to pursue the interferer, iBiquity and possibly the NAB and the HD Alliance in federal court for damages — which will kill what's left of HD Radio while the case wends its way through the courts. ("It's time to upgrade … to an interference lawsuit!")

Photo by Bruno Sniders

Robert Savage

GW sneers "Earth to Bob" as he declares, "Other than a handful of stations like WBZ and WOR there really aren't that many AM-HD stations on at night in the Northeast."

This is wrong on two levels: Yes, there are; and anyway the issue isn't how many stations are on with HD in the region, but how many signals are being received and how much interference there is.

Presumably "Guy" is aware that AM signals travel great distances due to a thing called "skywave" and thus, in the Northeast, you regularly hear the cacophony of IBOC sideband noise from (take a deep breath): 660, 670, 680, 700, 710, 720, 760, 770, 780, 810, 830, 880, 890, 1000, 1010, 1020, 1030, 1040, 1060, 1080, 1090, 1100, 1110, 1120, 1130, 1140, 1170, 1180, 1190, 1210.

"Guy" questions my observation that IBOC has "greatly increased the noise floor" by pointing out there is already noise "caused by the myriad of power lines and other noise-generating sources." So apparently "Guy's" illogical solution is making the AM noise problem even worse with HD. This is akin to prescribing firing squads for swine flu patients because, heck, they're all sick anyway — where's the harm?

SEDUCED AND SORRY?

I won't dignify "Guy's" snide denigration of WYSL as "a rimshooter … [having] problems serving Rochester" with a defense of our station, other than to point out his ludicrous suggestion that I was somehow "seduced" into building a station that comprises "a challenging ownership position."

Yep: that's me. I was seduced into turning profits year after year and creating a station that's gone through four major expansions, grows every year, has launched scores of radio careers and which has earned the admiration of colleagues locally and across the country who actually know something about WYSL.

Presumably "Guy" would have approved of WYSL more if we had sold stock, amassed billions in debt buying — and overpaying for — more stations, brutally axed hundreds of quality radio people "to save money" and were now careening towards default on loan obligations and likely bankruptcy. You know: just like the perpetrators of HD Radio.

"Guy" smugly suggests "ya gotta feel a little sorry for Savage and stations like WYSL."

Absolutely. Much in the same way you would feel sorry for me if — presumably because I had been struck in the head by a flying object — I started writing anonymous and inflammatory engineering commentaries while dressed up in a Lone Ranger mask and cowboy suit like some "radio-engineer" washout from The Village People.

"Guy" refers to my alleged "insinuations I'm in the tank for HD Radio and iBiquity." It would be revealing if "Mr. Wire" quoted where I wrote any such thing (don't bother, I never did) but — hey, "Guy," if you're so worried about your credibility, why don't you take off the dopey mask and write under your real name? Then RWEE readers could openly assess whether or not you represent an objective viewpoint based upon your experience, qualifications and associations.

NO PRACTICAL SOLUTIONS

"Guy" defends the digital power increase proposed for HD-FM by citing — evidently with a straight face — "a real-world test case" (!).

Yep, that would be a one-market, one-station test involving an STA for KROQ(FM), which cranked digital up to –10 dBc. "Wire" breathlessly assures us he's "checked with CBS and other L.A. engineers who cite no instances … of interference." Wow. Would that, by any chance, be the same CBS whose CEO Dan Mason and engineering exec Glynn Walden are former iBiquity executives, and which is heavily invested in the HD Alliance and HD Radio? Pretty darned convincing, no? (Umm … no.)

Back to "Guy's" commentary: I'm going to note his absolute failure to respond substantively to my challenges about proof that listeners demand digital radio, resolution of interference controversies and the highly implausible and inconsistent arguments about the need for, and specifics of, an HD-FM digital power hike as tacit admission that — like the endless parade of other HD concerns — there really aren't any practical solutions.

Interference, no demand for the system, high costs, impracticality of installation in many if not most transmitting plants, reduced coverage, limited benefits, virtually no receivers available any more, shoot-yourself-in-the-foot-self-competition-and-audience-fragmentation on FM subchannels — I guess these issues are what "Guy" would variously include in "superior scalability, manageability and problem resolution capability" (and good luck deciphering that little dose of corporate Velveeta. I'm not any more sure what that means than you are, but I suspect most of us "would like to buy a vowel, please").

It's self-evident that if HD Radio were even a reasonable approximation of the claims its dwindling band of fans make for the system, the controversy wouldn't exist. For one, I believe HD's "problem resolution capability" is far outweighed by its "problem creation capability."

And I, for one, can dispense with the nastiness and intellectual dishonesty I find to be typical on the pro-HD side of the aisle. In fact, one of the great tragedies of HD Radio is how it divides radio operators into opposing factions and pits us against each other at a time when the industry desperately needs unity.

RW welcomes other points of view. Write to radioworld@nbmedia.com.

WOODARD

(continued from page 1)

as a means to provide an alternate news source for people in the closed Soviet Union. He'd been drawn to radio as a boy, attended Texas Tech and received a degree in electrical engineering in 1962.

During his years with Continental, he helped develop many of the high-power shortwave transmitters that were an important part of radio and politics in that uneasy era of simmering conflict.

Years later, in 1985, Woodard left the manufacturer to become associate director for engineering for Radio Free Europe/Radio Liberty and was promoted to VP of RFE/RL Engineering in 1987, just before the conclusion of the Cold War.

After jamming of shortwave broadcasting by the Soviet government ceased in 1988, Radio Free Liberty reached a peak of nearly 35 million weekly listeners, bringing news about the West and democracy to the countries of the former Eastern Bloc.

Woodard eventually worked his way up to director of engineering for the United States International Broadcasting Bureau. He returned to Continental as its vice president of engineering in 2000 and retired from the company in 2003. He now lives in McKinney, Texas, with his wife Christina. He continues to play an active role in the broadcast industry through his research and writing.

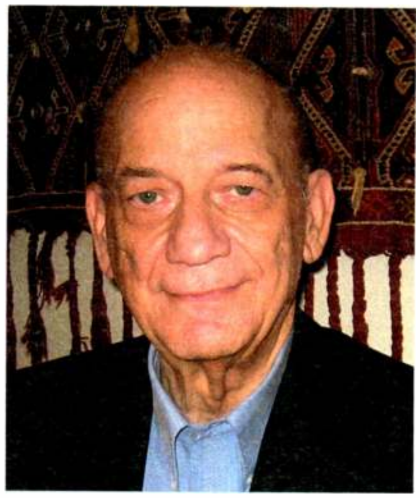
How did you come to work for Continental Electronics upon graduation from Texas Tech?

My mother and father were church friends with Mark and Catherine Bullock, and Mark Bullock was VP of engineering at Continental Electronics when I was in about the 7th grade in 1952. I remember Mr. Bullock taking me on a visit of Continental one weekend when I was in high school, and I saw the two huge curtain array antennas there that would ultimately end up at the Voice of America station in Greenville, N.C.

My dad was an electrical engineer for Southwestern Bell Telephone Co., and he got me interested in basic electronics, but it was Mr. Bullock who first introduced me to high-power electronics, broadcast and amateur radio, and I was hooked.

What was it like working at Continental in the 1960s?

Continental was founded in 1946 by James Oliver Weldon, who had been technical director of the Office of War Information, the predecessor of the VOA, during World War II. Mr. Weldon's interest had always been in super-power AM broadcasting, and it was his idea to concentrate on that market for the U.S. government and international broadcasters



George Woodard

with some success at the beginning.

However, it soon became evident that the broadcast market alone would not be enough to provide and sustain the desired company growth, so alternatives were pursued and Continental Electronics won an award to build a high-power radar system for the Ballistic Missile Early Warning System, with great success. That success led to Continental Electronics becoming a consistent and viable competitor for any high-power radio or radar system for the U.S. government without regard to frequency range or purpose, and since then, Continental has participated in more U.S. military radar systems than I can recall.

I came to Continental Electronics in June of 1962, and the first project I worked on was the Nike-Zeus Anti-Ballistic Missile Acquisition Radar, a direct and natural response to the highly successful Ballistic Missile Early Warning System effort I mentioned. This program, however, was canceled by the Pentagon in 1963 when it realized that the total scope of the project was beyond the technology of the time. Even today, almost 50 years later, it is only marginally feasible at a reasonable cost!

Then, as fate would have it, I became involved in high-power shortwave transmitters.

What drove Continental into that arena?

In about 1963, the Voice of America had stated their intent to buy perhaps up to 100 250 kW shortwave transmitters in the next 20 years, and had issued a new technical specification for this planned procurement.

Continental Electronics, under Mr. Weldon's guidance, had produced 12 250 kW shortwave transmitters for the VOA in the 1950s, four of which had been diverted to upstart Radio Liberty for their dedicated broadcasts of truth and freedom to the citizens of the Soviet Union. But these 12 transmitters, while basically successful, were also not without their problems. The new VOA specifications ruled out the use of a Doherty-type amplifier system, which the original 12 transmitters used. The new specifications allowed only plate modulation of the final amplifier, requiring Continental to go back to the drawing board for a new design.

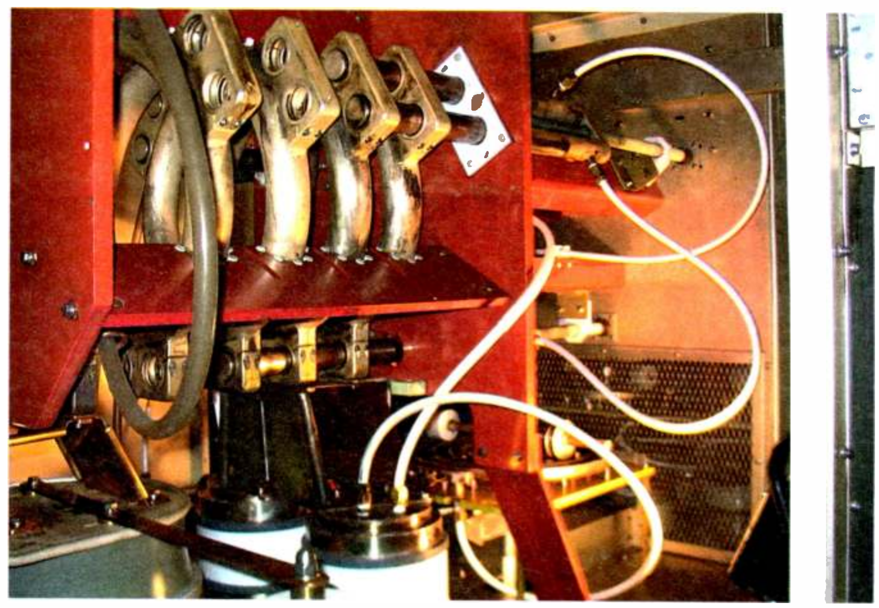
I was assigned to work on the project, and we built a prototype transmitter designed to meet the new VOA specifications and sold the prototype to Trans World Radio, at cost, for use at their newly acquired Bonaire, Netherlands Antilles relay station.

To make a long and miserable story short, the transmitter never worked well — perhaps because I worked on it — but nevertheless, due to brilliant and dedicated work by Trans World Radio staff over the years, it managed to provide at least a degree of service toward their mission.

Continental Electronics did not win any part of the pending VOA transmitter procurement, which was split instead between Collins Radio and Hughes Aircraft, neither of which had ever built a super-power broadcast transmitter.

It turns out the Collins transmitter was basically a superior design with one major, though debilitating, fault; and the Hughes product was an even bigger disaster than the one Continental Electronics came up with. Rumor has it that Collins Radio, recognizing their debilitating mistake, offered to correct it with a truly superior design to the U.S. government, at cost, and was rejected. This was my first foray into U.S. government procurement practices, where incompetent technocrats, legalcrats and bureaucrats, were calling the shots. It would not be my last.

Woodard was principal design engineer and project engineer for Continental's 418B/C/D, 419F/F-2/and 420C model 100/250/500 kW transmitters, all of which are still in its product line. He was also a principal design engineer for its one-half and one megawatt medium-wave transmitters with screen-modulated Doherty amplifiers used in Saudi Arabia, Jordan and Egypt. Shown above are a 419F's final amplifier tube, tuning capacitor and 45 kV protective ball gap (added by the RFE/RL technical staff). Shown below is the four-turn Pi network output inductor for this 250 kW transmitter.



(continued on page 18)

The Dial and Beyond

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WOODARD

(continued from page 16)

What projects did you work on next?

As any design engineer I think will attest, we learn from our mistakes as much if not more than from our successes. I have often looked back on the disastrous Trans World Radio transmitter — it was not so easy to joke about it in real time — and jokingly said that I learned 90 percent of what *not* to do on that one project. My next project was for four 100 kW transmitters for the international broadcasting arm of the government of Portugal, Emissuora Nacional.

The problems with the aforementioned Trans World Radio transmitter were myriad, but one of the most egregious was the choice of the final tubes. The VOA-selected Collins Radio transmitter used newly generated Eimac 4CV100000C tetrodes, which were the brainchild of my marketing mentor Jack Quinn, marketing director at Eimac. Rumor had it that the last "C" in the part number stood for Collins. I can't confirm that. Nevertheless, I wanted to use the tetrode tubes in the 100 kW design, and after a little political maneuvering, I won. The transmitter was the 418B, Continental Electronics' nomenclature for an HF-100 kW, Model B. The highly successful, though not perfect, Model B replaced a Model A version that was being built for Pakistan, circa 1966. It is still being produced today some 44 years later with a solid-state modulator and is capable of digital modulation for use with, for example, DRM.

In 1978, I was privileged to be able to build the 418's big brother, the 419C, a 250 kW shortwave transmitter for Radio Free Europe/Radio Liberty. Radio Free Europe/Radio Liberty purchased 19 of the 419s, 15 at Glória, Portugal and four at Holzkirchen, Germany.

The 418B, 419F and later 420C transmitters had basic similarities. They all had single-tetrode final Class-C RF amplifiers. The 418s and 419s originally had tetrode Class-AB modulators, the Eimac 4CV100000C in both, and both later employed amplitude crossover pre-distortion, which essentially converted the modulators to Class-B for improved program efficiency. The 500 kW 420C, circa 1984, which I never saw completed before I left Continental Electronics, used a single-tetrode pulse-width modulation modulator. All three, the 418D, the 419F and 420C, were converted to Continental Electronics' patented and quite remarkable solid-state modulator system in the late 1980s.

The 418B and the 419D, and later models, employed a quite unique band-switched coil of my design which "massacred" back-turn spurious resonances that can be so harmful and potentially destructive in high-power RF circuitry. The 420C used an equally unique design first used at Collins Radio for their highly successful 250 kW shortwave transmitter — a coupled distributed variable transmission line network that inherently reduced spurious and harmonic resonances.

Holzkirchen Station

George Woodard stands in front of one of the four 419F transmitters at Holzkirchen, Germany in 2003.

Continental Electronics bought the Collins Broadcast Division in about 1980. Collins Radio engineers pioneered the use of tetrode amplifiers for use in their high-power single-sideband linear amplifiers, and with that effort promoted the grounded screen for increased amplifier stability. However, the grounded screen arrangement made it difficult for AM transmitters, which employed anode and screen modulation.

As a result, my good friend and colleague Tom Lowrey and I developed a practical way to bypass the screen to ground and RF frequencies, with equal stability to the grounded screen approach, while still allowing the screen to be modulated at audio frequencies. This same technique of bypassing the screen grid was also used on the very successful one-half and one megawatt medium-wave Screen Modulated Doherty transmitters, Continental Electronic models 320 and 323, in the Middle East in the late 1970s and early 1980s. All three shortwave models, the 418G and DRM, the 419G, and 420C and D are all still in Continental Electronics' product line after more than 40 years since the 418B was first built.

In addition, the 420C/D, without a modulator, forms the basis for a highly successful 500 kW over-the-horizon radar transmitter employed by the U.S. Air Force.

Are there special design considerations that come into play when working on super-power transmitters?

There are special design considerations for high power, of course. As with almost every discipline, experience is the best teacher. The first thing is that mistakes are more expensive. I remember well tests we did on the Nike-Zeus program. The Varian high-power klystrons cost $120,000 each and operated at 140,000 volts DC. They were "crowbar" protected against internal gaseous arcing, and one crowbar failure could mean $120,000. This was in 1962/63 when the average entry EE salary was around $6,000, so $120,000 was real money!

Besides the cost factor, there are the basic and obvious high-voltage and high-current factors to deal with. The textbooks say that 1 inch in air should hold off approximately 80,000 peak volts, but practice yields something much different when reliability of operation is a factor. Voltage breakdown is affected by humidity, dust, air pressure, frequency and many other factors. If the goal is 99.99 percent reliability or 1,000 hours mean time between failures, a lot more spacing than 1 inch per 80,000 volts is needed.

The skin depth of current is the same, of course, as in lower-power equipment operating at the same frequency, but power losses in conductors are related by the square of the current. This causes the conductors to become quite large to avoid excessive loss, and hence the conductors and capacitors can no longer be treated as "lumped" inductor or capacitor components, but rather as distributed networks with transmission line characteristics.

That is the answer in a nutshell. Working at the 100 kW level at VHF or 1000 kW at HF or medium wave is similar to low-power microwave applications in many respects, with the added factor of increased heat load and voltage breakdown. It is fascinating and challenging.

Why did you decide to move to Radio Free Europe in 1985?

The complete reason for the move is complex and multi-faceted. I had known of Radio Free Europe/Radio Liberty from having sold, installed and periodically serviced the 100 and 250 kW shortwave transmitters Continental Electronics sold to them. I dropped in on them whenever I was traveling to and from the Middle East for megawatt medium-wave projects Continental Electronics was involved in, and I got to know and respect their engineers as well as journalists in Germany, Spain and Portugal. And they, in turn, knew me.

They made me an offer of employment, and as the saying goes, I couldn't refuse. Not money-related, but rather, I couldn't pass up the opportunity for my family to experience Europe as I had experienced it, and it turned out to be the best career decision I could possibly have made. Ronald Reagan was president; he understood the value of communicating ideals and truth, and he had expanded the technical modernization budgets of both the VOA and Radio

Free Europe/Radio Liberty. It was the correct decision at the correct time and turned out to be more correct than I could ever have imagined.

Radio Liberty was originally called "The American Committee for the Liberation of the Peoples of Russia from Bolshevism." Several iterations of name changes finally ended with Radio Liberty. I am forever indebted to Radio Free Europe/Radio Liberty Presidents Gene Pell and Kevin Klose for their support of me in the U.S. international broadcasting arena — to Gene for first appointing me as engineering VP for Radio Free Europe/Radio Liberty, and to Kevin for keeping me there and allowing me to follow him to the U.S. International Broadcasting Bureau. Both are giants in international political broadcasting with accomplishments too numerous to mention.

Woodard with Holzkirchen manager-to-be Wilhelm Rüther and Senior Maintenance Supervisor Hans Stöckl in front of a 419F. Stöckl was a fan of American western movies and Woodard brought him the Stetson hat on one of his visits to RFE/RL in 1981.

Why is shortwave still important and what should we be doing today to preserve it?

That is a very good question that our leaders in Washington should instead be asking.

The immediate preliminary answer is that it's not as important as it once was, though still very important. Our leaders in Washington have been unable to get beyond the first half of the above answer since 1989 and the collapse of Soviet-style communism. It is still very important.

Washington, driven by incompetent technocrats and bureaucrats at the IBB and the U.S. Department of State, who are experts at saying what they perceive people want to hear rather than the truth, has taken a wrong turn on shortwave broadcasting since about 1989. The result has been a kind of self-fulfilling prophecy. As we close down most shortwave broadcasting to parts of the world, it is no surprise that 20 years later we find fewer people are listening!

My advice is to pursue vigorously all new technological means to communicate accurate world news to the parts of the world that do not have that blessing of their own. Expand Internet, TV, local AM and FM, Wi-Fi and cell phone broadcasting, but do not significantly reduce shortwave. In many instances, as has been recently seen in Iran, Belarus, Georgia, Pakistan and other places, and chronically seen in parts of Russia, China and North Korea, increased shortwave capability is critical.

The cost of shortwave broadcasting is often brought up as a concern. Let me close with some perspective on that argument.

The cost of operating a nominally large shortwave station is approximately $15 million per year. Ten stations cost about $150 million to operate annually. With modernization and a degree of automation, it could be reduced to approximately half that. If shortwave broadcasting could contribute to reducing our global military effort by just 1 percent, we, as a country, would still save approximately $4.85 billion annually, assuming a $500 billion annual military budget, not to mention the lives of American soldiers.

I think it would perhaps be wiser for the American government to spend the little money on shortwave to help keep us out of shooting wars.

So You Want to Be the Chief Engineer

Seek Out Education and On-the-Job Training

BY GUY WIRE

A young remote broadcast tech recently asked me what it would take for him to become chief engineer one day. The simple answer I gave him was this: Learn all you can about the job and the technology of radio from the engineers working around you. Then become a "go-to" guy for getting things done to serve the technology needs of the station. Management will take notice and promote you into the CE position when it opens up.

While this is one approach that worked for me, and no doubt many others, there are many different paths to fulfilling the role of a successful CE. Every chief should rely to be fully engaged and prepared for dealing with ever-changing technology.

Installing, optimizing and properly troubleshooting the electronic equipment used in broadcasting requires a solid understanding of Ohm's Law, circuit design fundamentals, computer systems and networking skills. That knowledge can be acquired in various ways.

THE LEARNING NEVER STOPS

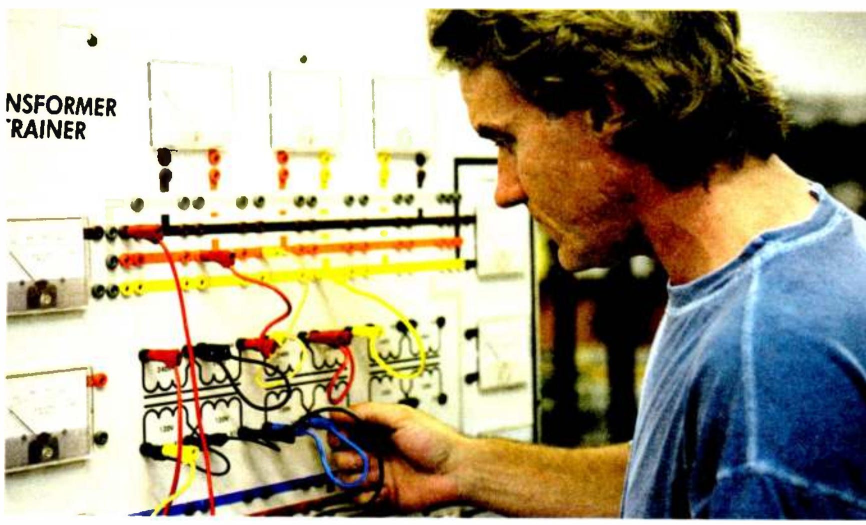
Formal courses in these disciplines at a community college, tech school or in the military, or via the Internet and correspondence, is certainly one of the best ways. Those with a BSEE or ASEE degree or working in the business will have a unique and sometimes unusual story of how they advanced into the job. Most will tell you they had a knack for things technical and got involved with computers, electronic gadgets, ham radio or music and sound recording while in school.

Understanding how any piece of equipment works on the inside and being able to fix it gives you a much better ability to pick and choose new equipment as the need arises.

In the days before consolidation, personal computers and the Internet, the chief engineer was charged primarily with keeping the transmitter and studios running smoothly. The job has evolved over the years, and it now demands additional talents beyond fixing things. Good administrative and people skills have become vital prerequisites for a well-versed and effective CE.

Most station managers want their chief engineer to be a fully engaged department head. Working with spreadsheets, vendors and business departments, along with serving the needs of program directors and talent, requires lots of human interaction. A good "bedside manner" is probably just as important to the GM as the ability to coax a piece of malfunctioning equipment into acceptable behavior.

Some companies have found it preferable to appoint an operations manager to oversee their station's technical needs without a CE. In many smaller stations and markets, the GM serves that role by default. Equipment repairs and transmitter plant maintenance are outsourced to contractors. A corporate engineer or financial officer makes all the equipment replacement and construction project decisions. This model tends to be employed where finding a suitable and affordable local market chief engineer is more difficult.



iStockphoto/Lisa F. Young

A continuing education student learns about transformers. Understanding the fundamentals of technology is a key part of your career development.

ELMER AND OJT

Most chiefs will acknowledge they had an "Elmer" or a mentor as they learned and perfected their skill sets while coming up the ranks. Often it was the CE they eventually replaced or another engineer who took the time to help and tutor them along the way. Many started out in a small market and moved up to larger markets, pursuing better pay and more fulfilling opportunities.

Learning by doing with on-the-job training and help from others certainly is a core component of acquiring the skills needed to execute competent radio engineering support. But it should not be the only resource on which an aspiring CE MCSE certification have a distinct advantage in our profession. At a minimum, completing a course of study through to a degree recognizes commitment and perseverance, both valued traits.

Everyone learns at different rates, using different resources and methods with varying degrees of efficiency. Some of the smartest engineers I've met in this business have no engineering degree or formal training. Along with OJT, they were able to learn and master the underlying theory and fundamentals through their own study.

Unless you spend the effort acquiring this basic knowledge, you will be forever handicapped in trying to become a truly qualified and effective CE. You may be able to hook up gear, do complicated remotes and work wonders on a PC, but unless you can use test equipment to evaluate operating parameters, signal flow and waveforms, it's almost impossible to troubleshoot and repair failed hardware properly.

THE WORK IS NEVER DONE

Competitive and successful stations typically expect their chief engineer to be the point person for all things technical that affect their ability to compete and succeed. Keeping the stations sounding good and always on the air is, to be sure, still job #1, but there are a myriad of other challenges today's CE is charged with, as shown on the accompanying list. You no doubt can add more.

Certainly the CE is able to delegate a fair amount of the actual hands-on effort to others in his department and to contractors to keep everything listed here under control and running smoothly. But it's almost always up to the CE to deal with all significant issues and crises first to determine if they can be resolved without engaging additional help or outside resources. The work days (and nights) can often be very long. Balancing work with personal and family time is another challenge all by itself.

THE RIGHT STUFF

If you ask GMs to identify the qualifications they are looking for, the foremost prerequisite is demonstrated tech-

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WHAT DOES THE CE DO?

Keeping the station sounding good and on the air is a chief engineer's first task. Here are some others.

- FCC technical rules compliance
- Technical department purchasing, planning and budgeting
- Studio equipment maintenance and updating
- Transmission systems and transmitter plant maintenance and updating
- HD Radio transmission systems installation, maintenance and updating
- Digital storage and automation system maintenance and updating
- Web streaming systems maintenance and updating
- RBDS and HD-R text scrolling systems maintenance and updating
- EAS systems logging compliance and equipment maintenance
- Arbitron PPM encoding and monitor systems installation and maintenance
- Satellite downlink systems installation, maintenance and updating
- Personal computers, servers, printers and LAN systems maintenance and updating
- Software platforms installation, maintenance and updating
- Telephone and voicemail systems maintenance and updating
- Remote broadcast systems maintenance and updating
- Promotion vans and station-owned vehicle maintenance
- Training and helping operations staff with equipment and computer issues of all kinds
- Building and physical plant HVAC, electrical and plumbing systems repair and maintenance
- Anything else of a systems or hardware nature not listed here, which no one else is able to deal with or resolve

What else? Tell us at *rwee@nbmedia.com*.

ANT HILL

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TIME IS NON-LINEAR

A more important principle is that of measuring time. It is neither linear nor consistent; it should not be measured in years but as the percent of a cultural life cycle. For the previous example, each ant lived for 10 percent of the ant hill life cycle, a relatively small percentage.

Until the 20th century, the same was true for people. In a small village, many generations would follow a slowly changing life cycle. You and your grandfather might have both been blacksmiths or farmers. In the late 20th you were unlikely to have had the same career as your father.

I have experienced more than a half-dozen cultural life cycles, which for the ant, corresponds to repeatedly leaving a familiar ant hill and starting a new one. My life span corresponds to 500 percent of a career system life-cycle, thus being an immigrant five times over.

How does this apply to a broadcast industry? What is the relevant cultural system that requires a rapid adaptation speed?

We can understand the consequences of such cultural shifts by examining one particular cultural choice that began with the 19th century English middle class: consumerism on a large scale. This branch and the corresponding sub-branches have produced dramatic changes in our cultural system.

Over the following centuries, large-scale material consumption has become the economic engine that replaced the traditional economies of food, clothing, shelter and capital goods. In fact, historically, objects were almost always treated as capital goods to be preserved, maintained and passed along to successive generations.

Stay with me for a few more paragraphs. Mass consumerism requires an infrastructure that can manipulate people into adapting to a buying mentality. And advertising is a prerequisite for maintaining such an economic system.

In 1950, my parents used their electronic appliances for 20 years. Now we (including me) routinely replace and upgrade electronic systems; we collect DVDs, games, computers, televisions, automobile entertainment systems and so on. The life span of objects has changed from multi-generations to a few years at best. To support an economy based on consumption requires a culture to capture the attention of potential consumers: advertising.

During previous stages of our social ant hill, all transactions were based on paying cash for goods and services. Transactions are now based on selling head-space.

Think of all the new business models for which valuable services are nominally free, Google being the obvious example. At one time, radio and newspapers were the only examples of selling head-space in exchange for something useful. A large percentage of our economy is now based on the transaction of exchanging head-space for goods and services.

The theory is that once you have sold your head, you will buy goods, and that cash is then used to support the system of capturing head-space. The transaction is indirect.

The radio industry has become one of head-space farmers, harvesting the ears of helpless (or willing) animals to be herded into consumption arenas. Broadcast engineers simply make the farming process efficient.

Unlike a century ago, there are now many companies engaged in head-space farming; newspapers and broadcasting have found themselves to be at a competitive disadvantage compared to new farmers using more sophisticated tools. Some farmers simply are more efficient than others.

As long as our head-space farmers are sufficiently productive, broadcasting can afford its traditional functions, such as paying reporters to risk their lives to cover major events around the world such as Hurricane Katrina or the war in Iraq. But when the economic margins of our farmers get too thin, our industry has trouble affording the "luxuries" of an ant hill. Decades ago television news departments were terminated, and those functions were placed under entertainment executives. News and documentaries are still relevant but only if they contribute to the farming process. And sometimes, activities are simply loss-leaders to make our listeners incorporate radio into their lives. But directly or indirectly, executives focus on selling head-space.

IMPLICATIONS

Having set the stage for this alternative viewpoint, we can begin to see that the implications are vast and sweeping, influencing all aspects of modern life. While waiting for the next article on this theme, try to analyze how the disruption of "free" in the current economic storm has been rippling through every cultural system. Broadcasting is simply one element in that very complex system.

Barry Blesser is director of engineering for 25-Seven Sytems.

CHIEF ENGINEER

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nical competence dealing with radio station systems, hardware and infrastructure, with a successful track record of experience doing the job elsewhere. After that, personal traits such as honesty, integrity, reliability, good people skills and communication skills are important. Also desirable are good administrative skills with the ability to stay organized and prioritize tasks.

We could add more qualifications, but anything else is really less important. Degrees and certifications, including SBE, are always desirable and would be tiebreakers where several qualified candidates for a given opening are being considered.

GMs will almost always look for positive and supportive recommendations from other managers they know and trust in the industry before hiring a new CE. Be very careful how you forge your reputation. If it ever becomes tarnished for whatever reason, fixing it will be difficult.

The Great Meltdown of last year witnessed staff reductions everywhere, and engineers were not spared. Managers whittled down the ranks of radio engineers to those who are the most capable and willing to handle an increased workload. As a result, there are a lot of qualified folks still on the beach. Many would like to find an opportunity to get back into the business.

CHIEFLY ADVICE

That means supply and demand is forcing down salaries and benefits. If you are looking for a CE opening, be prepared to temper your expectations. Most important, realize that stations with openings will have multiple applicants, and can pick the best fit for their situation. Since the finalists will all be technically skilled and competent, the choice will no doubt be decided by how well the winner scores on the other qualifications deemed most valuable by the hiring manager.

For the aspiring staff engineers and remote techs looking to move up, I offer the following:

If you haven't already done so, find and commit to a program best suited to your hours and personal situation that will enhance your technical education. There are good electronic and computer technology two-year programs at many community colleges. And there are various tech schools around the country that offer more focused programs. Very few offer specific curricula for broadcast engineering, but there are communications systems technology tracks used by telephone, cellular and cable companies for training their techs.

As you go about your present job duties, ask lots of questions and pay close attention to how the senior engineers do their jobs. Be a self-starter. Don't just wait for a supervisor to tell you something needs to be done. Look for things to do and folks to help. Offer to help the chief when he needs extra hands for transmitter site visits. Be trustworthy and reliable.

The current crop of CEs is aging, retiring, moving to other industries or being laid off somewhere almost every day. We've heard this question asked by many for a long time: Where is the next generation of CEs coming from? The telecom, cable, computer and Internet industries have seduced much of the potential talent that may have pursued careers in radio in earlier days.

Our business really is just as exciting and challenging as it was 20 or 30 years ago. Every day offers a different set of problems to solve and obstacles to negotiate, whether they be hardware, software or peopleware. Changes in business practices and technology innovations have merely added to the list of challenges. There are still young, aspiring techs who have fallen in love with radio. If they are given the proper mentoring, incentives and encouragement, they will become our chief engineers of the future.

Guy Wire is the pseudonym for a veteran radio broadcast engineer.

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Broadcasters: Head-Space Farmers in a New Ant Hill

Can We Adapt to a New Business Life Cycle?

BY BARRY BLESSER

When I left the MIT faculty in 1978, I had the dream that I would return as an emeritus professor when I was retired. A few days ago, I met an old colleague who had stayed on the academic career path during the 35 years that I went off being a technical and management consultant. As we talked about how our lives had diverged, he described the MIT of 2009, where students did not come to classes, where research was about money, not intellectual creativity, and where the value system of teachers and students was nothing like I remember.

An image came to mind: If I went back to MIT, I would be like an immigrant in an unfamiliar culture. The MIT of 1969 now only exists in my mind. It is no longer a real place.

Another question came to mind: What happened to the good old days? That common phrase has the wrong emphasis. They were not necessarily good days, but they were familiar and comfortable. We had adapted to a world, and like the fish in water, we did not recognize the comfort that comes from a successful adaptation to our social medium.

If you have the opportunity to read biographies of immigrants who moved from one country to another in the 19th century, you might notice that those of us who are older share a lot in common with these people even though we have not moved to a new country. I have lived my entire life in two northeastern cities in the United States. I did not move, yet the culture changed under my feet; now I, too, am an immigrant.

My observations are not new, but they highlight a more interesting concept; namely, we live in changing social and cultural systems. They may be company systems, industry systems, family systems or economic systems.

What do I mean by a system? In some sense, the answer is simple: a collection of small elements (people or modules) that, when connected and interacting, create a personality for the collection that is not located in any of the individual elements.

THINK ABOUT ANTS

A good example of such a system is that of an ant hill, a system composed of thousands of individual ants. For one species, each ant has a one-year life cycle, even though the ant hill itself has a 10-year life cycle from initial founding to final abandonment. This raises a question: Where is the age of the ant hill "located"? How does each ant know to behave differently depending on the age of the hill even though each ant is biologically identical to every other ant?

> **I have lived** through some dozen life-cycles of the 'ant hills' of a changing world.

The answer is both simple and complex. An ant that is born when the ant hill is two years old responds to that ant hill system in a predictable way. During the following year, this generation of ants gradually changes the ant hill system such that at the end of the second year, the system is in fact different from the beginning of that year. The next generation of ants is born into a different system and thereby behaves differently.

The same holds for people. Each baby appears at a different stage of our cultural system and adapts to a different world. This adaptation makes them different when they become adults. Your kids, even if biologically identical to you as a kid, adapt to a different world with a different cultural system.

The broadcast industry is a perfect example. An engineer entering that industry in 1920 joined the early stage of founding an "ant hill." Those entering in 1950 were contributing to growing and expanding a stable hill. Those entering in 2009 are now contemplating abandoning the old hill to create a new one someplace else. These periods are all unique life stages of the broadcast ant hill, requiring different skills and adaptations.

The ant hill story does offer another insight. Each ant only lives for a short amount of time and the system is relatively stable for that year. For people in the 21st century, the reverse is true. I have lived through some dozen life cycles of the "ant hills" of a changing world. Hence, I become an immigrant as I move to new ant hills.

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TECHMART

IF YOU THINK THE DASHBOARD IS COOL, JUST WAIT 'TIL YOU HEAR WHAT'S UNDER THE HOOD...

VORSIS AM-10HD

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It's drive time! Introducing the 2010 Vorsis AM-10HD.

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