The Local Oscillator

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A Transitional Technology

I was listening to a conversation on a local repeater recently and heard one of the parties remark that HD Radio is a failed technology. This gentleman, a respected friend and colleague, based this on the pace of the rollout, particularly that of receivers. I was not involved in the conversation at that point, but couldn't resist responding to that.

Jumping in with both feet, I remarked that by comparison to other broadcast transmission technologies that have been introduced over the years, HD Radio is still in its infancy. If we were to liken HD Radio to color television, it would now be 1964 or thereabouts. If we liken it to FM stereo, it's probably about 1973. Sure, we have a long way to go, but we just started!

It's in this analogy that I can clearly see how much our attitude has changed over the years. We expect things to happen instantly. Our society is one that enjoys the near-instant delivery of email, the accessibility of wireless phones and the convenience of the microwave oven. We're not used to waiting for anything anymore. Fax is too slow. FedEx and other overnight delivery services are reserved for that which cannot be faxed. In our societal *impatience*, we expect HD Radio to proliferate overnight, and because it's taking awhile, some consider the rollout a failure.

I wonder what was/is the proliferation period of what is considered to be a successful technology. Take the personal wireless communications device, the "cellphone" for want of a better name. When was it first introduced? How long did it take to become more than a toy of the affluent? The cellular phone infrastructure first began to appear in the early 1980s. I got my first "bag phone" in 1993 or thereabouts, nearly ten years after the first cellphones appeared on the market, and I was the only one in my circle of friends and acquaintances that had one. By 1997 or so, just about that entire circle was cellphone equipped, but I still knew quite a number of people who were not. That's hard to imagine now that just about every member of the American middle class over age nine has a phone strapped to his belt.

What about the iPod? The MP3 player, whether in the form of the Apple trade name or something more generic, is held up as the media transport of the future. Lots of people of all ages have them, but an awful lot do not. I don't have one. Neither do my siblings or most of my friends. And yet the MP3 player/iPod is considered to be a successfully prolific platform.

Which brings us back to HD Radio. I have two. My wife has one. My daughter has one. Her boyfriend has one. My boss has one (his car came equipped with it from the dealer). Granted, we're probably not a typical cross-section of the populace, but we have more HD Radios than we do MP3 players. Does that say something?

As that conversation wound down on the local repeater, a remark was made that HD Radio is a *transitional technology*, something that will be here for some finite period of time before being replaced by something else. *I agree*. That's *exactly* what it is. I don't look for HD Radio to be much of a factor 20 or even 15 years from now.

But I also think that the MP3 player is a transitional technology. So is the cellular phone. So is the microwave oven. When you think about it, just about everything is a transitional technology. It didn't seem like it in the heyday of (insert name of technology here), but it was. Just try calling up Baldwin Locomotive Works or Alco and ordering up a new 4-6-0 steam locomotive today.

The point is, the only constant is change. If broadcast radio is going to survive as a viable medium for the long term, we've got to roll with the changes. The same goes for broadcast engineers (just

ask any old steam locomotive engineers, if you can find any left around – I don't think Union Pacific is hiring many these days).

If we're not prepared for the inevitable changes, we'll find ourselves rusting into oblivion on a siding somewhere while the world passes us by on the main track. I don't know about you, but that's not where I want to end up.

Amateur Radio

Like a lot of broadcast engineers, I was originally attracted to the business because of my involvement in Amateur Radio. Licensed since my early teens, I loved the big power, the big antennas and the long reach of broadcast stations. I was fascinated by the multiple towers, the glowing tubes and the singing coils at the local AM station near my home in the Texas Panhandle. It was just a matter of time before I applied for a summer job at that station, and when I did, much to my surprise, I got it! What a thrill that was!

Who would have thought that summer job changing automation tapes and running a board during baseball "re-creations" of away games (the station owner was too cheap to pay for a phone line or three-hour long-distance call to air the games live) would have turned into a 32-year career in broadcast engineering? But that's exactly what happened.

But enough about ancient history. How do people get into broadcast engineering *today*? I was asked that question recently during a guest lecture I gave at the Ohio School of Broadcasting. My answer, at least in part, was *Amateur Radio.*

While a ham ticket won't necessarily get you in the door at the local broadcast station, the underlying knowledge and skills remain foundational to broadcast engineering work. For example…

- *Basic electronics* – A good understanding of electronics theory is a prerequisite for broadcast engineering work. A person pursuing such a career path must understand about tubes, transistors, logic gates, op-amps, resistance, reactance, voltage, current and power. Amateur radio, especially the higher license classes, also requires such an understanding.
- *Propagation* – Broadcast engineers must know about radio waves, how they are generated, how they behave and are propagated at various frequencies. Amateur radio is all about radio waves and propagation.
- *FCC Rules* – A good portion of the broadcast engineer's work involves FCC technical and operating rule compliance. The same is true of Amateur Radio. A ham operator must know the FCC rules, on what frequencies his license class allows him to operate and with what modes. While the FCC rules for broadcasting are different, things tend to work the same way.
- *Station Operation* – A broadcast engineer must know how to operate the station for which he is responsible, from microphone to antenna. He must have a good understanding of the way equipment works and interacts with other equipment. Amateur Radio operators must know how their stations operate, what control or switch does what, and how to operate the station within the FCC rules and the limitations of the equipment.
- *Home-Brewing* – In years past, broadcast engineers had to build a lot of their own equipment simply because some things were not commercially available. That's less true today, but broadcast engineers still have to come up with ways to achieve a particular end with parts/equipment on hand, and occasionally they still have to build their own. Building one's own equipment, in whole or in part, is a staple of Amateur Radio. It's a passion with many hams.
- *Experimentation* – As broadcast engineers, we often find ourselves on the "bleeding edge," way out there in front of the pack, experimenting with some new technology or other to see what works and what doesn't. I thought a lot about this as we edged into HD Radio over the past five years or so. Ham radio is all about experimentation, trying new modes and methods, building and testing antennas and equipment.
- *Networking* – It's a rare thing for a broadcast engineer to work in isolation. Organizations such as the SBE and numerous online forums and list servers allow engineers to share their experiences, talk about what works and what doesn't and about how to deal with certain issues/problems. Tune in just about any evening on 75 meters and you'll find hams talking about these same things – networking with one another to share information.

The list goes on and on, but you get the

picture. I think it all comes down to *interest* and *aptitude*. Those who are interested in the technical aspects of Amateur Radio and have a knack for it will generally do well as broadcast engineers.

Perhaps one of the best indicators I have seen of this is a group of hams here in the Denver area that hang out on a VHF/UHF FM repeater up on Lookout Mountain. Paul Deeth, WA2YZT, transmitter supervisor for the local CBS-TV affiliate, owns and operates the repeater, and most of the hams that hang out and *network* there are broadcast engineers, AM, FM and TV. The discussions run from the usual talk about the weather, last year's vacation and ham radio topics to in-depth discussions about broadcast directional arrays, transmitters, STLs, studio equipment and the like. It's like having a broadcast engineering technical forum on the radio!

One thing that hasn't escaped my notice is that non-broadcast hams that frequent the repeater are getting interested in broadcast engineering as a result of their exposure to our trade in our on-air discussions. These folks have quite obviously picked up a lot of our jargon and knowledge of the trade just by listening.

So, is Amateur Radio the way to get into broadcast engineering today? Perhaps it's not *the* way, but it certainly represents a means of entry, a screening tool so to speak. As we are on the lookout for young people who we can recruit into our trade, perhaps we should make ham radio the first place we look.

The New York Minutes
By
Brian Cunningham, CBRE
Chief Engineer, CBC – Western New York

Hello to all from Western New York! The WDCX transmitter building move finally began on May 12th, after nearly seven months of delays. The foundation was poured on July 12, 2007, but delays in obtaining the approval of the Boston, NY town board for the site improvements kept us from making the move last year. By the time we received the final go-ahead from the city planning board, the winter months had already begun, and wintertime in Buffalo is certainly no time to begin a project of this size. MJM Electric began the installation of the conduit and electrical runs between buildings, along with a 3-inch PVC communication conduit that would allow us to send a composite signal along with TCP/IP, an analog stereo pair and AES/EBU between buildings. Having this run between buildings was important, as we had to stay on the air during the move.

Plan, Plan, Plan

To insure a smooth, efficient move, I began thinking out how we would be able to get this accomplished without having to go off the air. I began by listing what had to be moved and in what order, and what had to be done to keep us on the air while the move was in progress. I went over this list several times over the course of several weeks, and each time I revisited the list, I found something that needed to change.

Once I was satisfied with my final plan, and went over it again for the umpteenth time, I began to contact our contractors and meet with them on site to go over the plans and finalize their involvement. Co-ordination between all our contractors was a huge job, making sure that everyone was on the same page and that everyone understood where and when they had to be on site to perform their specific duties.

Except for the weather (rain) delays we had, everything went according to schedule with few surprises. All of the contractors we hired to assist in performing the move were outstanding and went above and beyond the scope of work they were contracted to do. I had worked with these contractors before and knew from experience that they were the best choice to use on our project.

But as happens in all projects of this size, there is always something that goes wrong, and that something was RFS Cablewave, which I will get into later.

D-Day Arrives

The first thing we had to move over on Monday morning was the main Continental transmitter and BE exciter, along with the auxiliary antenna's 3-inch air-dielectric transmission line. On Saturday night, I switched the main transmitter to feed the auxiliary antenna while I re-plumbed the aux transmitter to feed the main antenna directly. Once I had the plumbing completed, I began disconnecting the main transmitter from the 5-port patch panel, along with electrical and remote connections.

Next, I removed the patch panel along with a 4-port MCI motorized switch, which fed the auxiliary antenna either the HD or backup analog transmitter. The BE FMi-106 HD transmitter was disconnected also and moved out of the way to make room for the main transmitter move. In the new building, I had pre-manufactured the mounting brackets for the switch

and patch panel so they could immediately be re-installed when the main Continental was in place.

On Monday morning, the crew from Household Moving arrived and immediately began rigging the main transmitter for the move along with the HD transmitter. It took them about two hours to get the transmitters moved and in place in the new building. After they had completed their job, we began to move the auxiliary antenna feedline along with the 1 5/8" inter-city relay transmission line.

Don Boye of Western Tower oversaw the feedline move, re-connected the Andrew 3-1/8-inch EIA connector on the line and installed a new connector on the inter-city relay. At this point, Rick Sewell and I began the plumbing to get the main transmitter back on the air into the auxiliary antenna. In the meantime, Solly Heating and Cooling arrived to get the transmitter ducting installed on the main transmitter. By early Wednesday morning, we had the main on the air from the new building, with the composite feed coming from the composite D.A. in the old building. Once we were confident that all was okay, we began dismantling the backup transmitter for the move on Wednesday.

Weather reports were predicting rain throughout the day for Wednesday, so we postponed the auxiliary transmitter move until Thursday. This allowed us some extra time to get the remote control blocks punched along with the control/metering cables from the main transmitter. I had performed a lot of the pre-wiring of the rack equipment the week before the move, so much of the rack-mounted equipment only needed to be moved into the new racks and plugged in.

On Thursday, the moving crew began about 9:30 am and had the remaining transmitter in place by 11:00. Rick and I continued on the plumbing for the remainder of the day, and completed all we could do at this point. It certainly was a blessing to have Rick assist me in this project. He was a pleasure to work with, and I could not have asked for better assistance. Although Rick arrived in Buffalo Monday morning feeling a little under the weather, his work was superb. Thank You Rick, for a job well done!

Rain, Rain, Rain

We had planned to get the main antenna feedline and the STL line moved over the weekend, but inclement weather kept this from happening until the weekend of the 24th. While we were waiting for a

window to get these moved, I was kept busy inside completing wiring of the aux transmitter into the remote control, re-installing the manifold that feeds nitrogen to the coaxes and antennas, and completing the grounding of the ancillary equipment.

On Friday evening, we were able to get the feedlines moved, but not without incident. The main antenna transmission line was manufactured by Cablewave and is 3-inch air dielectric. When Don removed the old connector, he found that it was seized (the coax inside of the connector body).

Cablewave did not have a re-connect kit available, so we opted for a new connector, which they also did not have. I cannot comprehend why they did not have this connector in stock. They have sold literally hundreds of miles of this cable over the years and to not stock replacement parts is disappointing. I am told that Cablewave is now projecting more of their business overseas, and customer support is all but non-existent for broadcasters here in the USA. I would not recommend purchasing any Cablewave products to anyone, assuming they can get it in the first place! As of this writing, we are awaiting the replacement connector to arrive. An emergency order was placed for Cablewave to manufacture a connector for us, and they estimated about a week for us to receive it. So until then, we are broadcasting on our auxiliary antenna.

The photos herein show the work in progress. I hope to include some *completed* photos in next month's column.

That about wraps up another month here in the Northeast. Until we meet again here in the pages of *The Local Oscillator*, be well, and happy engineering!

The Motown Update

By
Tom Gardull, CBRE
Chief Engineer, CBC–Detroit

We have made our decision about changing telephone service. I have written often about our troublesome dial-tones and other services. We are switching WMUZ to an alternate provider and method. We are getting more service, more features, and all at a tremendous cost reduction from FirstComm. All our normal service will be coming in on two T1 lines only, instead of the thirty-one individual lines now. Our new service is called "channelized T1," which differs from "PRI" service in that each T1 is broken out into 24 individual lines for us as tip and ring. We no longer buy number-lines; rather we buy a T1 and the numbers just come along.

Our alternate vendor supplies service without per-use charges, without near-zone or far-zone charges and without local (extended area) tolls. The service adds caller-ID on all lines and configures trunk-hunting as part of the setup. FirstComm supplies the routers which break out the 48 individual lines. We will have to make no alterations to our existing PBX.

Our new monthly bill will be less than half of what we pay currently.

Our second channelized T1 will give us excess numbers over the count we now have, so we will be able to remove some current sharing of lines in the building. We keep all our telephone numbers and any new numbers will have the same exchange prefix.

We are keeping two of our old single analog lines. The new vendor does not want to service our burglar/fire alarm POTS lines, which work by seizing dial tone on an incoming trunk. I thought they should have more confidence in their service, but they are afraid of liability. We will also use one of these lines for DSL Internet service. It will be prudent to keep a few copper lines around.

There is one potential down-side here, namely having all our service on only two lines where loss of carrier on a line cuts 24 lines and not just one. But the upside improvement is digital service that removes hum, static, and cross-talk which are the usual recurring problems. Our telephone talk shows will have cleaner lines, and Comrex Hotline connections should be more stable.

All of the several vendors who made proposals to us really tried to get our Inter-LATA long distance traffic, but we still participate in the company-wide Qwest arrangement. In fact, we now will be splitting some portion of our Detroit telephone services among five different companies for POTS, T1, and long distance, all at a much better price.

News From The South

By
Stephen Poole, CBRE, CBNT, AMD
Chief Engineer, CBC–Alabama

Here's a project that you'll enjoy: let's set up a digital link across many thousands of miles using off-the-shelf components. I'll be transmitting a 12 GHz signal toward you with a few watts of power. This link must be at least 99% reliable, because it'll carry important program feeds on it. But here's the best part: there will interfering transmitters only a couple of degrees to either side of mine, pointed straight at your antenna!

A ham might call this "extreme QRP." A marksman, if asked to make a comparably-tight shot with the best rifle manufactured, would demand that you sign all sorts of releases and waivers. But if you're a broadcast engineer, just call this what it is: a Ku Band satellite link. In fact, I had our own Crawford feeds, delivered via AMC-1 to a Radyne receiver, in mind when I wrote that.

On top of all the other fun that we've had lately – not the least of which is moving WDJC into its new transmitter building on Red Mountain – our CBC link began dropping out a few weeks ago. It eventually died altogether, and after discussing it with Cris, we decided to replace our aging ABR200 with a new ABR202A. As proof as our damper field is alive and well here, the new receiver was defective. As proof that the field has strengthened, we received a second unit, and it wouldn't work, either. We also had dish problems; we'd had a windy storm before it went out and suffice to say, we had a time running that one down.

This is another chapter in my book of, "What I Wish Someone Had Told Me Years Ago." Feel free to print it out and add your own notes. Share it with your assistants and just generally use it as a quick-and-dirty reference. Digital link problems can drive you crazy when you're not sure of the cause. How do you determine if it's the antenna, the coax, or the receiver? What if it's terrestrial interference?

Most of what follows can be applied to any digital link, from spread spectrum to STLs, but because it's fresh in my mind, I'll use satellite feeds as an example. I'll start with some working definitions.

Bit Error Ratio (BER)

When you send a stream of data from one location to another, you want all of it to arrive intact. That doesn't happen in real life, particularly not with wireless links, which are especially subject to fading, noise and interference. The measure of "bad" bits to "good" is called the Bit Error Ratio (or Bit Error Rate). This is usually specified in a form such as, "1 in 10E6" (i.e., 10 to the 6th power, or 1 million), which means one "bad" bit per million "good" ones. You obviously want this ratio to be as high as possible.

Error Detection and Correction

Dropped bits are a Bad Thing with digital audio. Even a *single corrupted bit* can cause an audible glitch in an MPEG-encoded program feed. That's obviously unacceptable, so virtually all real-life links use some form of error detection and correction. This is especially true of one-way communication. A two-way link can always ask for a resend if it doesn't get the data, but we don't have that option with a real-time satellite feed.

Do a Web search if you want more info on this; entire books have been written about it. Ma Bell did a lot of the groundbreaking work on this before the first T1s went on line many years ago. If you want to impress your co-workers, read all you can and start jabbering about "Reed-Solomon polynomials" and stuff in the break room. Have at it! I'm going to keep it simple and treat this in two separate steps.

The first is usually a Cyclic Redundancy Check (CRC), which is a formula that's applied to

each block of data. The transmitting end sends the data along with the result of its calculation. The receiving end applies the same math and compares the results; if they don't match, it will know that the data is corrupt and will take the next step: error correction.

Forward Error Correction (FEC) adds additional info that tells the receiver what the data should look like. The error correction at the receiving end uses that information to rebuild the bit stream if something is missing or corrupt. If you want an analogy, suppose I send you a list of all checks received today, with a grand total at the bottom. If any one of the check values or the grand total gets smeared by a coffee stain, you can just derive the missing figure with a little math. But if two or more slots get corrupted, you're out of luck. Error correction has analogous limits: as long as it can repair the data, you won't even notice. But if the errors become excessive, the link goes south in a flashing hurry.

You've seen this if you're ever watched a typical satellite receiver during a sun fade. When the event starts, the BER light may flash now and then, but there's no audible effect. As the fade worsens, the error correction has to work harder: the BER indicator starts blinking a lot and you'll hear pops in the audio. Soon the errors become so bad that the receiver gives up and mutes. This behavior is typical of all digital links, resulting in the common observation that they "either work great or don't work at all."

Design engineers have a lot of choices when building a system. If it's low-powered, they'll probably use more error correction. Link reliability is a prime consideration when budgeting how the bandwidth will be used. If you know the link will only drop an occasional bit, you don't need as much correction and can budget more for actual data. So how do you calculate link reliability?

Eb/No

"Eb/No" stands for "the ratio of bit energy to noise power spectral density." It's most correctly pronounced "eee sub bee over enn sub zero," but people in a hurry (like me) just say "eb-no." You probably know that this is simply a digital signal to noise ratio, normally reported in decibels, and that you want it to be as high as possible. But what is it, really, and how can we use it to troubleshoot a link?

Once again, you can do a Web search (or go to Qualcomm's excellent Website, www.qualcomm.com) for more information on how the coding/modulation scheme and other factors determine the minimum Eb/No required for a given BER. All we need to know is that system designers use Eb/No as Gospel when planning a link, so it's important to us, too. It's related to the analog-era "carrier to noise" (C/N) ratio by the formula

$$C/N = (Eb/No) \times (R/B)$$

... where "R" is the bit rate and "B" is the channel bandwidth. This is important: the bitrate/bandwidth is included in the calculation. In fact, Eb/No can be considered the "signal to noise ratio *per bit*." Whether you're sending 64 kilobits over a 128 kilohertz channel or 256 kilobits over 512 kilohertz, the numbers work out the same.

More to the point, Eb/No is *receiver agnostic*. If you were going to most accurately measure it, you wouldn't even use your receiver. You'd do it with a sophisticated analyzer connected directly to your antenna. You'd isolate your specific data channel and then measure the bit energy against all noise *in that channel.* This is why we're told to tweak for highest Eb/No and not for signal strength. We're adjusting that dish for the least interference to *our desired channel(s)*, resulting in the best bit energy to noise ratio.

Of course, most of us don't have the kind of analyzer that's used to evaluate this; we have to depend on the receiver to accurately calculate and report the Eb/No to us. Because of variations and tolerances in manufacture, different units will report slightly different values, too. But the principle still applies: Eb/No is most correctly considered the digital signal to noise ratio, per bit, at the receiver's input terminals.

Here's another key point: a low Eb/No causes the BER to worsen and *the effect is not linear*. At lower Eb/No figures, the link will deteriorate *exponentially*. This is why your receiver might sound OK with an Eb/No of 6 dB, start dropping out at 5 dB and be completely unusable at 4.5 dB – a spread of only 1.5 dB. On the other hand, a change from, say, 8 dB to 13 dB, will probably be inaudible.

We can sum all this up very simply: high Eb/No good, low Eb/No bad! This also has practical implications for maintaining a link in the field:

- You do not have to re-tweak dish alignment if you're just changing receivers.
- If two receivers give notably different Eb/No figures on the same antenna, the one with the lower figure is probably defective (and one very likely cause is a noisy power supply).

Here's an idea: we broadcasters tend to use the same satellites – AMC-1 (ex., our own CBC feed, AP Radio, and others), AMC-3 (Christian Radio Consortium and AMB/OS) and AMC-8 (all the Starguide network stuff), and so on. There's probably another station nearby that would let you try your receiver on their dish just to confirm that it's okay. Offer to return the favor.

Some More Practical Tips

When aligning a dish, don't hurry. Eb/No is averaged over time, so when you tweak your antenna, you have to wait to see the result of each change. Check your receiver's manual to see how often it updates the Eb/No report. You should wait at least twice that long between adjustments. Don't stand in front of the dish while tweaking, especially not a smaller one. When adjusting the LNB, for example, make a change, then move away to one side while the receiver digests it.

Here's the big tip: *don't try to aim a dish from scratch with the receiver!* It can be used for fine-adjustments, but not for the initial aim. It probably won't even give an accurate AGC report until after you've at least found the bird (this is true of our Radynes). You certainly won't get a useful Eb/No figure until you get a lock. Therefore, step one is to ensure that the dish is at least pre-aligned correctly.

If you have to align from scratch, here's the way I do it. Start by finding the required dish azimuth and elevation ("az-el") for your location on the Web. There's a good calculator at www.dishpointer.com; it even gives you the correct magnetic compass heading and LNB skew for your area, based on zip code. Once you have those values, start with the elevation. Remember that dish elevation is in relation to the horizon: if set to 90 degrees, your dish would point straight up. Clip a magnetic-base inclinometer to the back of the dish and adjust it up or down as needed.

Now use a good compass to set the azimuth. The aforementioned website will give you the correct magnetic bearing; subtract 180 from that, because you'll be facing the dish. Walk around slowly until you hit that calculated bearing while the compass is pointed directly at the dish's mounting pole. Stand very still and have an assistant turn the dish left and right until the LNB appears to line up directly over the center of the dish, and you're there.

Finally, make sure the LNB polarity is correct: horizontal or vertical. With a rectangular LNB, you may be able to just eyeball its physical orientation ... "side to side" is horizontal, "up and down" is vertical (in relation to the dish, not the ground). Once you have the dish and LNB as close as you can get them, you're ready to proceed with fine adjustment for the best Eb/No.

1. Connect a "sat finder" meter and tweak very slightly (no more than 1-2 degrees in any direction) for maximum signal. If you have a spectrum analyzer and know what your satellite's "signature" looks like, that's better; by all means, do it that way. You can try rotating the LNB a bit for maximum signal at this point, too, but be careful not to cross polarities. Don't go more than 45 degrees from true horizontal or vertical.
2. Once you're on the bird, connect the receiver, set it up properly and wait for it to lock. It may need to be programmed first (once again, our Radynes are like this).
3. Once you have a lock, use the receiver's Eb/No report to carefully tweak the dish for the highest number. You shouldn't need to move more than a half degree or so in any given direction.
4. Give the LNB one final fine adjustment: rotate it very slightly either way for the highest Eb/No, then lock everything down.

Here's one final tip: with smaller dishes becoming common, the receiver and LNB manufacturers are really cranking up the gain. It's possible get an overload on a short run of coax. If it's really bad, the receiver just won't work; but if it's a modest overload, it can fool you. You might have a high Eb/No (15dB or better), but the link will still drop out at random for no obvious reason. The clue that we got with our Wegener Unity4000 C-band receiver was a brief, occasional, "Warning: High RF Input" on the front panel. Adding a 100' coil of RG-6 in line to increase the losses solved the problem. That's it for this month; next time, Lord willing, I'll have some pictures of the new WDJC transmitter building. Until then!

Gateway Adventures
By
Rick Sewell, CBRE
Chief Engineer, CBC–St. Louis

During the middle part of May, I spent a week in Buffalo. I helped Brian Cunningham with a project to move the WDCX transmitters from an older cinder block building to one of those new prefabricated buildings. I am sure that Brian's column this month will give all the details, so I will leave that to him. I will say that I came away impressed with his dedication to getting a very professional-looking installation. The work was fun, and it has been some time since I had touched anything to do with an FM station, so that was a welcome change for the week. I also got a chance to make a quick visit to Niagara Falls for a couple of hours one evening. I hadn't been there since I was a teen. I am always amazed by the power of God's creation.

One of the funniest moments of the week came when I was waiting to board the plane at the Buffalo airport. I looked up from my laptop and down the concourse a bit was Richard Simmons exercising, in his shorts of course. Apparently this was an attempt to garner attention, the only problem… nobody was paying him any mind.

The good news in St. Louis is that the Canopy system that was installed to replace the KJSL T1 for that station's STL/TSL seems to be stable now that a proper installation of the four foot dish on the KSTL tower was accomplished. We had a day with some 50 mph wind gusts, but all remained steady without any loss of data through the Canopy system. We are also changing our backup audio STL to both transmitter sites.

For the last four years, we have been using ISDN. This has been a very good substitute for the T1 when it went down occasionally in the first couple of years. The main problem then was the monthly cost and even worse, the long distance charges that were run up anytime we used it. Since our studio is in Missouri and both transmitter sites are in Illinois, any call from the studio to the transmitter sites would incur long distant charges at about twenty cents a minute. Any lengthy outage of the T1 would get very costly.

The other obvious problem with the ISDN became very apparent over the last year. If the T1 went down due to a Telco cable being cut – like it did ten times in the last year due to copper thieves, the ISDN would not be there as well since it was running on the same cable. This is why we needed to make a change, not just replacing the T1 at KJSL, but a backup that would not be so subject to the copper thieves. After all, even with the Canopy in place, both stations are still running through the KSTL T1, and although that has not been hit by the copper thieves, it could be just a matter of time.

We decided that wireless Internet was the best way go for a backup STL under these circumstances. We had wireless Internet service installed at the KJSL transmitter site with a guaranteed bandwidth and some static IP addresses. This service is also available to the KSTL transmitter site because of the high speed Ethernet service we installed using the Canopy system.

To get the audio from the studio to the transmitter sites, we installed a pair of APT Worldcast Horizon Ethernet codecs for each station. We are using the studio's existing DSL Internet service to send the data to the transmitter sites.

Using this path has the advantage of not being as subject to the copper thieves. The disadvantage is the data is subject to vagaries of the Internet, including packet loss, jitter and variable latency. So far, it seems that we have not had any problems with dropped data, at least when I have been observing. The other great advantage is that we are no longer subject to the costly long distance charges that we saw with the ISDN dial-ups. The cost for the newly-installed Internet services is about the same as the ISDN, so we are actually creating a savings using this method.

The Horizon units that we purchased have AES digital audio input/outputs. Since we are still in the analog world for almost the entire audio chain at

the studio, we needed to convert the audio to digital. We deliberately ordered the Horizons as digital transports (they are available with analog I/Os as well, but it's either/or) because we want to be ready for all-digital studios. We decided to not go with a traditional standalone converter but instead purchased the new Broadcast Tools ADMS 44.22 converter/switchers, again as a concession toward future digital studios.

We have been using the Broadcast Tools ACS 8.2 audio switcher in our automation systems as the main ASU switchers. We replaced them with the ADMS 44.22 so that we can gradually switch from the world of analog audio to an all digital audio chain. The switchers come with four analog audio inputs and four digital inputs. They also have two analog outputs as well as two digital outputs. This allowed us to switch our current analog audio sources, still feeding the current analog chain, but also convert the audio to digital to feed the Horizon Ethernet codecs.

Thanks to Denver chief engineer Ed Dulaney for blazing the trail on these new switchers and making them work with our current automation system. The backup audio STL system is now in place and working. We now are ready to face possible copper theft of on the Telco cable that carries the KSTL T1 or problems with the Canopy system. Hopefully, we won't miss a beat.

Catalina Tales

By
Bill Agresta
Chief Engineer, KBRT

They Walk Among Us…

Greetings from Santa Catalina Island!

Just to make a point, I am going to begin this month's column off with the same subject I have for the last three months, our satellite Internet system.

Now understand that things are known to move very slowly here on the island most of the time, but this project is just going in circles and has become extremely frustrating. In our latest episode, the satellite Internet provider has decided to hire our local dish installer to "commission" the system. This comes after the rest of their contingent of Southern California installation contractors now refuses to work for them, a situation that makes it pretty obvious that this company has some big issues.

Our local island installer aligned the dish with my help, but as we began to work with the company's installation department to polarize the waveguide assembly, things got really bizarre. We got a high EbNo on the receive side but a very low signal on the transmit side. Since they are analyzing everything remotely on their side, we are left blind, only knowing what they tell us over the phone. So we are basically at their mercy; after a short time, we knew that was a big problem.

They first told us that we used bad cable, so we replaced it. Then they said the cable must be too long, so we took the modem off the 65-foot run of RG11 and hooked it to a 5-foot length of RG6, running the modem on an extension cord right next to the dish. Still no transmit! Then they began telling me that the dish must be bent. I disagreed since we were getting a great receive signal, but I took the time to carefully check the dish and it certainly is not bent.

Finally, after going back and forth and with them even asking us to replace the cable again (we said no), it got to some "do-it-or-else" emails, and a few days later, we get a box with a new waveguide assembly including the BUC and LNB already mounted, tested and ready to go. Next, we took off the old waveguide, installed this new one, and surprise! Same problem.

Then this guy in their installation department, not knowing I was standing next to the speaker phone, starts telling our local contractor that he cannot get this system going because I won't let him send us the necessary parts. Our local contractor called him on it and asked him what parts are there that we need that I am not letting him send. He replied that his system is telling him we need a new dish, so our local guy asked him to just send it to his

address. At that point, he got yet another excuse. Now he doesn't know if he can send a dish or not because he needs some kind of corporate approval. I have just been asking him to send another modem since that seems like the next thing in the chain, it is small and easy to ship and replace, but I guess that is somehow not possible, either.

KBRT's Non-Working Satellite Internet Antenna

I have no idea how this company stays in business. Their installation department does nothing but throw wrenches into anything anyone does, and when everyone give up and asks them, "What should we do next," they blame everyone and then do absolutely nothing to resolve the problem….go figure!

Fire Preparedness

Fire danger here on the island has become a very serious issue this year. After the wildfire last year, we got some pretty good rain, and now the weeds have grown taller and thinker than they were before the fire. The dry summer season is now approaching and our island LA County fire chief is on high alert. He paid a visit to me recently and we discussed the high fire danger and some plans to take further steps, doing more than usual here at KBRT to be extra prepared this year.

Though we have always gone above and beyond in regards to fire protection here at the transmitter site, this year will be like nothing that has ever been done here before. We have purchased a large DR brush mower, like you see in those TV commercials, that we will use to cut down the weeds in our entire tower field, not just around the towers as usual. We are not just cutting firebreaks around buildings this year, but we will be looking at our entire property as a firebreak. We are working with our local fire protection contractor to add more length to our existing fire hose as well as add a lot more pressure with a boost pump. Along with respirators and other equipment we had on hand during last year's fire, we are hoping to do as well as or better than we did last year if we do find ourselves in a wildfire situation once again.

Another part of my disaster planning (including this threat of wildfire) of course is the sustainability of our on-air presence during a disaster. Since last year's fire, we have made quite a few changes here, including the use of satellite for our STL and the addition of a large portable diesel generator to supplement our stationary propane generator. Having learned a whole bunch going through the horrible aftermath of last year's wildfire, I feel it's safe to say we would do even better if faced with the same situation again. Having a second generator and an STL that does not rely on our frail Telco system is a major step for us in this area. Now let's just hope we don't really have to go through another disaster here again, at least for a very long time.

A Sad Day

We had a very ugly beginning to our Memorial Day weekend here on Catalina Island, as many of you may have heard on your local news. It was a beautiful but overcast Saturday morning, and I was taking a nice morning hike with my dog in the hills over Shark Harbor. At about 9:30, I heard a sound I can only describe as a faint thump. I did not think anything of it at first, but within a few minutes, I noticed smoke coming over the hills from Two Harbors. I ran as fast as I could back to the truck, made a call to LACO fire then headed towards the smoke.

Only a few days prior to this, I had been talking to our fire chief about the high fire danger and the fact that the area around Two Harbors was where some the most overgrown areas and highest fire danger now exist. As I arrived, there was already quite a crowd present, and after I realized that a helicopter had crashed and that the fire had been almost contained, I decided not to go any closer than the hill I was on. I decided to head back to KBRT before long, but returned later with some LA market radio news crews.

It was a very eerie site to behold, with bodies still strewn about over the burned field. The helicopter had hit the ground so hard that not much of it could even be recognized. I am still amazed that anyone could have survived this horrible mess, but I understand three are still holding on in an ICU on the mainland.

Thanks to a very quick response of the Two Harbors volunteer fire fighters, that fire was

contained before it ever had a chance to grow or we would be dealing with a much lager disaster that this. The helicopter crashed in probably the best area he could have. If he would have gone down sooner, he would have landed in a crowded harbor, and if he would have gone just 35 feet more, he would have hit power lines and taken down power to Two Harbors and the remaining west end of the island. Only about 60 feet from the crash and fire was an overgrown hillside, and another 75 feet up that hill sits the historic Banning House Lodge, the only hotel in Two Harbors. The Lodge was filled to capacity for the Memorial Day weekend.

My prayers go out to the families of those killed or injured as well as John, Ken and their staff at Island Express. But when you look at the whole picture here, the pilot (who died in the crash) and those who responded to fight the fire did very well to stop a much larger disaster. We have lots of beautiful things to see here on the island, but this was one of the most horrifying sites I have seen since I have been here.

Until next month, the Lord bless you and keep you; the Lord make his face shine upon you and be gracious to you; the Lord turn his face toward you and give you peace.

Valley Notes

By
Steve Minshall
Chief Engineer, KCBC

Wow! *The Local Oscillator* deadline really came quick this month! Not much to write about this month anyway. We have had some strong winds out here and the result was several fence boards blown off of one of the tower fences. I nailed them back up the way my grandfather showed me about 45 years ago. He said to always put the nails in at an angle, otherwise they will just come out again.

We have had some issues with our old ABR-202 receiver, or so we thought. Cris was able to find out that there is actually some interference to the satellite channel and has us moved to another channel temporarily.

Since I am totally out of time and inspiration I will send along the following Ham Radio article I put in *Electric Radio Magazine* a while back. I hope you enjoy the diversion…

The transmitter presented here was inspired by a March 1968 Electronics Illustrated magazine article by the late W5LET. The article was "A Bare Bones Transmitter" and it was bare bones indeed. The W5LET transmitter used a pair of rectifier diodes and a couple of capacitors to achieve 300 volts directly from the line cord. The transmitter was a simple keyed oscillator using a 50C5 tube and built on a flat board with nails used for terminal tie points.

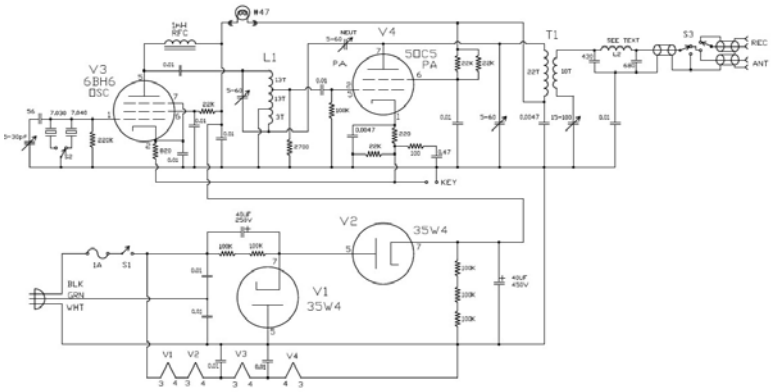
In 1968, I was only eleven years old but I was fascinated with the article. It would be several years before I received my ham license, and the article was to lay dormant in my mind for several decades. Fast forward to the year 2006 and I am a long-time licensed ham radio operator and find myself longing for the simplicity of early amateur transmitters. Playing around on the Internet one day, I did a search for "50C5 transmitter" and much to my surprise, I found a number of references to the W5LET article.

I was fascinated with what I read. Evidently there were quite a number of people who built the transmitter as described in the article, and for some it was what got them started in the hobby. Today, people are still building the transmitter. Great job W5LET!

I had no choice but to build the transmitter myself, decades after reading the original article at the public library. It worked, but it had an awful chirp. There was no way I would put that signal on the air. I tried all sorts of methods to stabilize the beast, but nothing was completely successful. I

finally came to the conclusion that the 50C5 was just not suited to run as a keyed oscillator. I suspect that my problems may have been do to the use of tiny cheap crystals as compared to the large FT-243 crystals used by W5LET and that I used a different, tighter, output coupling. I will give him the benefit of the doubt and assume that his original transmitter sounded reasonably okay.

I took a step back and looked at the project from a new perspective. I would keep the breadboard construction and the 50C5 tube. It would still be powered directly from the line without a transformer, but I would use a pair of 35W4 tubes for rectifiers in the voltage doubler circuit and add an oscillator tube. The transmitter was redesigned and evolved away from the original W5LET design and became a design of its own.



I experimented with 12AT7A and 12AU7A tubes in various oscillator configurations and was almost happy with the results, but they never fully satisfied my desires. I needed an oscillator tube that would be very stable, have enough power to drive the 50C5, and have a low voltage heater that runs at .15 amps so that all of the heaters could be wired in series and powered directly off the line voltage.

I pulled my old RCA receiving tube manual off the shelf, went through it page by page, and wrote down all of the tube types that might work. My first choice was the 6BH6. The tube is a sharp cut-off pentode with a 6.3 volt, .15 amp heater that was designed for use in ac/dc receivers. It has a controlled heater warm-up just like the other tubes in my circuit. The heaters would all heat up evenly, a much desired feature for series-wired filaments. Now I just had to buy one of the tubes and give it a try. I went to eBay and soon had several 6BH6 tubes on the way.

The 6BH6 tube turned out to be ideal for my oscillator. After some experimenting with component values, I had a stable keyed oscillator with enough drive for the 50C5. The oscillator is not sensitive to voltage changes, so no VR tube is required. This tube works so well as an oscillator that I intend to use it as my first choice in future projects.

The power supply uses a pair of 35W4 rectifier tubes as a voltage doubler and supplies about 250 volts (key down) to the oscillator and PA tube. Solid-state rectifiers could easily be employed here, but I wanted to use tube rectifiers for nostalgia's sake. The voltage doubler is a half-wave design so the low side of the power supply output is at the same potential as the line neutral wire. The same components could be wired up as a full-wave voltage doubler, but the low side of the power supply would be at a high voltage compared to neutral and ground. This would create additional hazards as well as difficulty in interfacing a key safely.

The first numerals of the tube types used indicate the filament voltage. If we add up all of the filament voltages (35+35+50+6) we get a total of 126 volts. This means that we can wire all of the heaters in series and operate them directly from the line voltage as done here.

The oscillator circuit is very straight forward. This is a simple tuned-grid, tuned-plate oscillator, the crystal being the grid tuning element. The value of oscillator cathode resistor was found experimentally to provide good keying characteristics. The plate tank circuit inductor is 29 turns of number 22 magnet wire wound on a 1-1/4 inch length of, 7/8 inch outside diameter, PVC pipe. The inductor is operated at dc ground potential.

The power amplifier tube's grid is driven from a tap point on the oscillator's plate inductor. The position of the tap was just a guess, but since the transmitter's performance was better than expected, no further experiments with the tap position were tried. The purpose of the 2700 ohm resistor is to reduce the Q of the tank circuit and is essential for stable operation of the power amplifier. The inductor has three turns on the "other side" of ground, which is

used to neutralize the power amplifier by adjustment of the neutralizing capacitor.

The power amplifier is grid-leak biased by the 100K grid resistor and self-biased by a 220 ohm cathode resistor. The self-bias is not necessary for operation of the amplifier, but it provides protection for the tube during fault conditions, tune up, and during stability checks as described later. The power amplifier plate and screen voltages pass through the number 47 lamp. The lamp is used as a plate current indicator and is mounted by leads soldered to its base that are inserted into fanstock clips. The fanstock clips allow for easy removal of operating voltages from the power amplifier to facilitate neutralization adjustments. A milliamp meter can be inserted in the fanstock clips in place of the lamp for accurate measurements of current.

The power amplifier is transformer-coupled to the antenna. The transformer windings are wound on a pill bottle with an outside diameter of 1.3 inches and spaced with a 3/8-inch gap between windings. The primary of the transformer is 22 turns of #22 enamel wire close wound, parallel-resonated by a compression trimmer, the PLATE TUNING control. The secondary of the transformer is 10 turns of #24 red telephone wire series-connected with a larger compression trimmer, the LOADING control.

Before sending the signal on to the antenna, it goes through a PI filter comprised of L2 and the 430 and 680 pf capacitors. Inductor L2 is made by winding eight turns of #22 enamel wire around a 35W4 tube (remove the tube after winding) and spacing it about an inch long. The values for two capacitors in the PI network were junk box values; I was shooting for 500pf each. The addition of the low-pass filter cleaned up the harmonics and improved the power output of the transmitter.

The construction was done on an 8 X 12 inch piece of ¾-inch plywood. I used a router to put a fancy edge on the wood which reduced the working area on top to 7 X 11 inches. The plywood is what is called “paint grade,” which has a much nicer surface than shop plywood. I sanded and stained the wood. I followed that with several coats of clear lacquer.

Components are mounted to the tube socket terminals and to terminal trips. The terminal strips and tube sockets are mounted to the plywood using #4 sheet metal screws and flat washers. The switches and jacks are mounted using 1 x 1 x 1/8-inch aluminum angle stock.

A transmitter like this requires a discussion on safety. Since this is powered directly off of line voltage without the isolation of a transformer, there are additional hazards. The line cord must be a three conductor cord. The cord I used was a standard computer cord with the female end cut off. The black wire is hot and has 120 volts relative to ground. The white wire is neutral and may have a volt or so in relation to ground depending what loads are running on the house circuit. The green wire is a safety ground which is at ground potential.

In this transmitter, the black wire from the line cord is soldered directly to a one-amp fuse. The fuse and wire are covered with heat shrink tubing so that there is no exposure of the un-fused 120-volt line. If this transmitter is connected directly to a telegraph key, the low side of the key is connected directly to the neutral circuit of the electrical supply. This may be deemed by some to violate electrical safety rules. Being cathode-keyed, the hot side of the key has about 45 volts with this transmitter. If something goes wrong in the transmitter circuit, a much greater voltage, as much as 300 volts, could be placed on the hot side of the key. In the old days, these things were taken in stride, but today we are all much more concerned about safety, as we should be.

It is imperative that the line cord is correctly wired and that it is plugged into a correctly wired socket, otherwise the low side of the key could have 120 volts AC on it! An isolation transformer could be used to isolate the transmitter from the line, and that would increase safety.

The power supply produces in excess of 300 volts DC, so the open breadboard construction has lethal voltages exposed. An enclosure, Plexiglas for example, could be fabricated to cover the guts of the transmitter and eliminate the potential of accidental contact with high voltage points. With some minor redesign, the transmitter could be built in a conventional aluminum chassis. Lastly, an open circuit like this must be kept out of reach of children and even curious adults.

The initial tune-up is done by removing the #47 lamp, turning on the power, and allowing the tubes to warm up. While tapping on the key, adjust the oscillator plate circuit for highest output along with good keying. Once the oscillator is working properly, an oscilloscope or other sensitive indicator

is placed on the output along with a dummy load. The PA plate tune and load capacitors are adjusted for maximum indication, then the neutralization capacitor is adjusted for minimum feed-thru.

The next step is to disconnect the line voltage and discharge the power supply capacitors. The #47 lamp is inserted in the fanstock clips and the transmitter powered up. Using brief key down times, the plate tune and load controls are adjusted for maximum output. If the keying has any chirp, it may be necessary to adjust the oscillator circuit.

It is a good idea to go back to the neutralizing adjustment procedure once more to make sure it is as good as possible. I was able to reduce the feed-thru power to zero as indicated on an oscilloscope.

The final check is done with all voltages applied but without a crystal. While watching the output on an oscilloscope, tap the key and look for any waveforms to pop up. If any signals are observed on the oscilloscope, then further work should be done to make sure the rig is stable.

As can be seen, there has been considerable attention given to the purity of the signal in all respects. I wanted a transmitter that was completely useable and not just a novelty to use a few times and put on a shelf. The final product is a transmitter that has clean, chirp-free keying and a clean RF signal free of excessive harmonics and spurious emissions.

The RF output was checked using a spectrum analyzer. The second harmonic was 58 dB below carrier and the seventh harmonic was at -68. No other spurious or harmonic energy was visible. These measurements were made after tuning the rig as described above without touching up for the spectrum analyzer.

I used the transmitter on the air with no other instruments to tune other than the #47 bulb and a wattmeter. After a number of contacts, I decided to do some actual measurements of the operating parameters. The results are listed below:

PA plate voltage…….....253 volts
PA plate current…….....44.6 mA
PA plate input power…11.3 watts
Power output……..…8 watts
PA plate dissipation…3.6 watts
Plate efficiency…..…..71%
PA screen voltage…...162 volts
PA screen current…..8.4 mA
PA screen input…..1.36 watts

I was quite surprised to see that the plate and screen dissipations were within the maximum specifications for the tube. It appears that this rig could be run key down indefinitely. That being said, it might be interesting to hook up a modulation transformer in place of the #47 lamp and see how well it works in the AM mode.

While writing this article, I noticed that I neglected to bypass the filaments. I put in the two bypass capacitors on the PA tube as shown on the schematic. The capacitors are soldered directly between the tube socket lugs and the tube socket metal ring which is used as the ground for the screen and cathode bypass capacitors as well.

The transmitter worked well before the addition of the filament bypass capacitors, but there was significant interaction between the oscillator and PA tube despite the neutralization. After the filament was bypassed, all interactions between the stages were eliminated.

The variable capacitor in the crystal circuit is used to vary the operating frequency over a range of about 3 kHz. Two crystals yield 6 kHz of the band to operate on and provide many more opportunities to answer CQs than without the variable. The fixed capacitor was chosen to limit the range to where the keying is good.

Using the rig on the air is pretty simple. I use this transmitter with a vintage Heathkit SB-300 receiver. To transmit, flip the T/R switch to transmit, then send a couple of “V”s or “R”s while you adjust the receiver gain for a nice side-tone level.

My first contact was far from spectacular. I called CQ and then heard a station that pegged my S meter as he tuned up. He came back with a QTH of “MODESTO, CA.” That’s where I live, but he was not only in the same town but almost the same neighborhood. It turned out to be a nice opportunity to meet a local ham in person.

Subsequent contacts were more impressive with distances in hundreds and then over a thousand miles. I find it quite rewarding to work distances like that with some parts mounted on a board and with a signal that I can be proud of. One of the most enjoyable contacts was working a station using a homebrew 6AG7/807 transmitter; working homebrew to homebrew is the way it should be.
The original W5LET transmitter put out about one watt. This redesign pushes my power-meter to 8 watts! The 50C5 tube seems to be excellent RF amplifiers. Other tubes to consider for rectifiers and PA would be the octal-based versions such as the 35L6, 35Z5 and 50L6. The use of direct line power for the filaments and B+ supply is an interesting way to build small and simple circuits albeit safety concerns abound.

The Chicago Chronicles

By
Art Reis, CPBE, CBNT, AMD
Chief Engineer, CBC–Chicago

I have to admit that if brevity is the soul of wit, then for the purposes of these pages, Tom Gardull is the wittiest guy among us and I'm the least witty of all. But as usual, events have conspired to relieve me of a good old fashioned case of writer's block, so let's go!

STL Blues

We've been involved recently in two cases of *potential* STL interference. The bottom line is that, when it comes to STL issues, more folks than not are asleep at the switch. The first case is really egregious. A nearby station had a studio, a transmitter site, and for several decades, a bona fide STL license, coordinated as was the way of the world many years ago, with less than stellar position. But it was there and it was licensed.

Then around ten years ago, the station was sold. The new owner, as his first act, both to reduce the rent and because the original studio building was sold to new owners (the local city fathers, as it turned out), moved to a new location several miles away. He moved the STL along with the studio, re-set the aim of the antennas, and then failed to re-license it. Worse, *he failed to re-coordinate.*

Fast forward to a couple of years ago, when we at Crawford had had enough of the failures of our existing telco T-1 service to Beecher. We made the decision at that point to switch WYCA to a new, over-the-air STL, and we got it both coordinated, and licensed – *on the first station's STL frequency!* The thing is, had the first station *not* moved, there wouldn't have been any potential interference issue since the two STL transmitters would have been more or less facing each other and the receivers would not have seen a significant increase in noise floor from the transmissions of each others STLs. However, with the new studio location of the other station, the two paths were actually crossing at almost ninety degrees, with theirs going west to east, WYCA's going north and south, such that they literally collided about three miles east of the other station's transmitter site – a sort of 'shot across the bow' scenario, if you will.

This mis-arrangement went on for about two years of total ignorance and bliss, nobody really interfering with anyone, until one day I got a call from the GM at the other station. I'm not a regular employee of theirs. I just help out maybe once every year or so as needed. The GM was in full panic mode because, in carefully scrutinizing all of his licenses, he came to the realization that the STL license was totally incorrect because it pre-dated the move. A call to his communications attorney had confirmed it. This was also the first I'd learned that this station was using the same channel for STL as was WYCA.

Seeing a potential conflict of interest, I immediately called Cris about it. He had a cow, and rightfully so. Remember, the WYCA STL frequency had been coordinated on the basis of the old studio site location for the other station. In effect, the other station's STL was no longer coordinated, and thus was operating illegally. Though they'd been on the frequency for far longer than had the WYCA STL, *they* were the ones who had to go through the expense of finding a new frequency, getting a new coordination, getting licensed and then moving over to that frequency. That also meant new crystals for the transmitter and receiver. Yes, the STL rig was that old. Have you priced those crystals lately? Bottom line: It pays to make *sure* that your STL coordination is exactly as it should be.

It is said that situations like these come in threes. Well, here's another one for you. I had reason to deal with another broadcaster recently, one who also had an old STL coordination. We're talking decades here. Recently the station's ownership got a knock when a consulting engineer called and mentioned that the station's STL transmitting tower was not located where the coordinates had said it would be. It was five seconds off. A check with a

GPS unit (a check which this STL tower had never had, since it was installed long before GPS was generally available) confirmed the consultant's assertion. The tower is now home to more than one STL, and all of them are going to have to be re-coordinated and re-licensed. The tower is actually a block north of where the licensed coordinates say it is.

Finally, and we're getting back to WYCA again, we are learning that coordination is getting to be more and more important as STL technology evolves. Since time immoral (pun intended), STLs have basically operated with FM technology, be it stand-alone mono, discreet dual-carrier stereo, baseband stereo, or even the digital DSP stuff such as the Moseley DSP6000. All of it is transmitted, at base, using FM.

That's not so true anymore. With the advent of newer, AM-based QPSK digital STL equipment, the name of the game is now *noise floor*. That's not an issue with any FM mode, be it digital or analog, since all you have to do is send just enough signal to fully saturate the limiter, and you're home free. On the other hand, AM-based digital is a *linear* medium all the way, there is no saturation possible, and therefore the noise floor has a terrific impact on the ability STL to work well, or even at all. No matter how far away the interfering signal is, or which way it's pointed, and that could be tens or hundreds of miles away, or whether the signals are cross polarized or of the same polarity, it makes no difference if or whether the interfering signal is even close to being demodulatable (if I can invent such a word). All a "foreign" signal has to do is to increase the noise floor at the receiver enough to decrease the signal-to-noise ratio and cause an upswing in the bit-error rate and you have an interference problem. It's thus no wonder that coordination specifications have become so tight in recent years.

An example of that came to light recently when a new STL coordination was being processed at a station well south of Chicago, or even Hammond. If you look on the Illinois map, find US Highway 24 and follow it west from the Indiana line to the town of Watseka, then continue west, you'll find another little town called Crescent City. There is a new FM station there, and it's trying to get an over-the-air STL coordination. Currently they're doing an off-air hop from their primary station. The powers that be have chosen the next channel down from the WYCA STL frequency, which is not co-channel, and it's both cross-polarized to the WYCA path, and pointed almost directly away from WYCA transmitter site (that is, our STL receive site). However, we recently filed an objection to that coordination application as planned, because we felt that their signal, using AM oriented digital modulation, and fully 500 kHz wide, at the power level they were proposing, would raise the noise floor on our STL channel, and cause degradation to our future plans to install one of those AM-oriented digital STLs at our site (we're currently using a digital, FM-oriented STL on that path). We eventually dropped our objection to their coordination, but co-incidentally, we did so after they came to the realization that the twenty-four mile path with their own AM-oriented digital STL was not going to work, even with a ten-watt amplifier. Yes, they tried it. It worked only marginally. They're going to a different method.

Their experience has given us pause. Currently, we have two such AM-oriented digital STLs in service. It took us three years of work to get them to run right, in four-channel mode with the CD, 44.1 kbps audio rate we wanted. Both are working now, and both on the same frequency, both transmitting from the same tower. The path length on both is on the order of three to three and a half miles. They are cross-polarized and their azimuths are a hundred and ten degrees apart. Given all that, the more I've dealt with digital, AM-oriented STL technology, the more I think we have a miracle on our hands here. With that miracle in mind, we had been working toward the goal of putting WYCA onto the same kind of STL system as the other stations. However, given our recent experience, our twenty-mile path length, and the experience of those we trust who have tried doing what we've been wanting to do, and even with using a ten-watt amplifier tacked on, a path of more than about fifteen miles is a gamble, and not a very safe one at that. Cris concurs, and we're shelving the project on that STL path. It's a lot of money to waste on something which may not work. Instead, since we have STL equipment to retire, we're re-deploying that new STL package as a backup to replace an existing Moseley DSP6000 series system.

We're kind of wishing that Moseley hadn't discontinued the DSP-6000 STL system. But, for those really in the know, there are other technologies and frequency bands out there to consider. More about them in a future issue.

Robert A. Jones

In other issues of the *LO,* some of the other engineer-writers have mentioned their mentors and what and how much they meant to their early (or later) careers. I've not mentioned mine because I've had so many of them. They are almost too numerous to list, and a few of them, such as Cris Alexander,

Warren Shulz and Gordon Carter, are still mentoring me today. I don't know about you, but I define a mentor as someone from whom you learn things which are important to your functioning in the career you have chosen. There is a corollary to this, a saying which I dropped on Cris a long time ago, and which he then set forth in the pages of the *LO*: "The secret to being a wizard is in knowing where all the other wizards are."

Where my knowledge of AM directional arrays is concerned, I can count four such wizards: Cris, Carl Smith, yes the inventor of the DA as we know it, John Furr and Robert A. Jones. Bob and Carl were my first teachers of any importance. All I had learned of AM-DAs before them came from my own observations. I took one of Carl's courses back in the early 80s. He was awesome, if not flamboyant. Carl is no longer with us, of course, but his work is being carried on, still in Cleveland, by Al Wormus and his associates. And now I've learned that, early in May, my other early mentor in AM-DAs, Bob Jones, passed away.

Bob Jones was more than the typical Engineering consultant. He had a flamboyant streak, he took risks, pushed the envelope hard if you will, and sometimes it got him into trouble. But that was in great measure a part of his "can-do" attitude, and it was the reason I was attracted to him as an engineer.

Some of his feats with directional arrays were legendary. He once put two stations on the air on the same frequency in two cities 21 miles apart in Ohio, and got both stations licensed. How he was able to do the directional proofs for either station in the direction of the other, I'll never know. Obviously, both stations are day-timers, and not only that, they are sharing the channel with a 50 kW clear operation less than 200 miles away. Both stations are still there, by the way, and probably hating each other, but Bob proved that such a thing could be done, in case anyone would ever want to try such a thing again. I'm sure that someone has at least tried, somewhere.

In Chicago, he took a station which had been confined to 1 kW daytime-only status, even though it was the first station on the air in town, and got night power for it, with five times the power with which it was operating daytime. The secret? The hottest, most efficient in-line six-tower DA I have ever seen or worked. Bob put that array on for John Johnson's WJPC, just to see how efficient he could make an in-line array become, while still properly protecting other, more primary stations on the channel. I was in awe of that feat, but then again some of the most esoteric things do that to me.

I met Bob when he was doing work for me at the Crystal Lake, Illinois station where I was CE back in the early 80s. After working with him awhile, I really desired to tap his brain, so I made an appointment to do just that. He was thrilled, especially since he needed some time off his feet due to a bad back. So I spent the better part of a whole afternoon with him, learning almost literally at his feet, as he lay on the couch in his office, about negative towers and how to treat them, parallelograms vs. in-line arrays, the importance of a good, full ground system underneath, and a lot of other stuff. I was at that time installing one of his antenna designs in another Chicago suburb, a four-tower almost-parallelogram to replace an older six-tower parallelogram that he had also designed, and he asked me about it. I told him that the station owners had moved the site across the road to save money, since the owners of the land on which the station's earlier six-tower parallelogram had stood had wanted too much money for it. The new site, however, would allow a ground system which was only about 45% of the full size, and he told me, "You've got to stop them. That array was designed to work with a full ground system only." It was too late, unfortunately, and the station went on the air with all kinds of DA problems, augmentation needs, and the like. It's still not quite right to this day, as the record of FCC fines against the facility will attest. If they built the array with the proper ground system, I'm certain that it would have worked from day one.

Bob liked his DA proofs done quickly, and his favorite method was to get out the field intensity meter, calibrate it once, then get into a fast car with someone who knew the territory, usually the GM and his Porsche, and drive like a bat out of Sunday School, doing a 25-point radial in an hour or so. When you're in flat country like western Minnesota, where the roads are checkerboard and the detours are few, you can do something like that. The problem is, no one at the Commission would believe that he could do it at all. They accused him of making up all the data, and he got into a lot of arguments and credibility problems with them over it. But the proof of the efficacy of his work is that the stations he proposed, and got built, and those for which he got a frequency change, almost all of them are on the air and doing fine now. He had to have been doing something right. But I'm afraid that such things may have cost him some of his reputation.

Bob was maybe not the most popular personality in the world of Broadcast Engineering, and he did have his flaws, but I for one really liked and admired the guy, because he could take on just about any challenge and make it work. He was one of the

early challengers to the veracity of the FCC's M3 ground conductivity map, and in case after case, he was able to prove that the actual ground conductivity was a lot less than what the map said. Now, everyone is doing that. But apparently not nearly so much back in that day.

He also believed in giving back. He had a hobby. No, not ham radio, but rather helping build and maintain radio stations in far-away places for the spread of the Gospel. All this was on his own nickel. He's one of only three folks I've known who were into that, though certainly there have to be others. It was one of the other two "donors," Gordon Carter, who broke the news to me some days ago of Bob's passing. Gordon and Bob both attended the same church, or I may not have heard the sad news as soon as I did.

I hadn't seen Bob since his retirement well over a decade ago. He and his wife Pat chose not to move to Florida, like other retirees, but to instead stay here in Chicago. I have to admire that. But that's really the least of my admirations. I just like the way Bob did what he did, with flair and dare and the knowledge, at bottom, that he was right. There's not enough of that going on, and I miss that. Rest in peace, Bob. And thanks for everything.

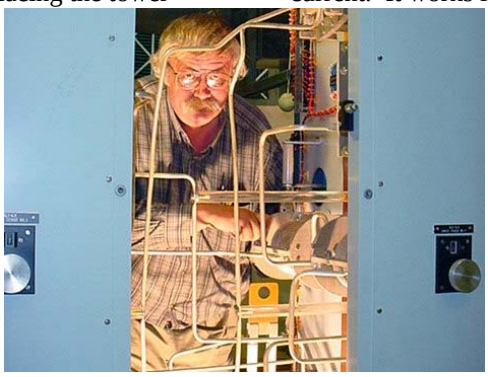
Until next month.

The Portland Report

By
John White, CBRE
Chief Engineer, CBC–Portland

Tower Lights

At the close of April, I had just finished the long weather-delayed project of replacing the tower side lights with new LED fixtures. We finally got a weather break at the end of the month. Working through a weekend, the last boot hit the ground well after dark. The new lights were installed, which left the tower light monitoring system to be addressed the first part of May.



At Mt Scott I have installed a monitoring system that monitors five different conditions:

1. The tower lights are on
2. The beacon is on and flashing (stuck on)
3. The beacon is on and flashing with a single lamp
4. The beacon is not on
5. The side lights are on.

At Mt. Scott, the tower lights are powered from a 220 V circuit. One leg provides 110 V for the beacon while the other 110 V leg powers the side lights. Effectively, I have two separate circuits, a situation which allows monitoring beacons and side lights separately.

My system is like most classical tower light monitoring and looks at a long integration of lighting current. It works like this:

1. Looks at the photo cell and reports when it has turned on the tower lights. That's a simple Burk status light.
2. Looks at the integrated current with the circuit adjusted to just below the trip point with the beacon flashing. This will provide an alarm if the beacon is stuck on.
3. Looks at the integrated current with the circuit adjusted just past the trip point. One or both lamps failed will trip this alarm.
4. Looks at the integrated current with the circuit adjusted to below the trip point for one lamp. This alarm will indicate the beacon is not on at all.
5. The integrated current for the side lights just trips the circuit. Alarm when one or more side lights are out.

For annunciation, the Burk status light indicates the tower lights are on. I then use a metering channel to show percentage of a fixed voltage from a

divider circuit.

100% = Normal, no alarms

60% = Advisory, alarm [5] side light problem.

30% = Critical, alarm [3] on and alarm [4] normal. This is the same as one beacon lamp out, or;

30% = Critical, alarm [2] the beacon is stuck on.

0% = Emergency, both alarm [3] and [4] are tripped. No beacon.

After looking at the reduced LED side light current, I suspect that detecting the small change in current of one side light will be difficult for any tower that is wired for a common 110 V circuit providing combined beacon and side light power. For anyone with this wiring arrangement, I would advise rewiring the tower lights to allow separating out the beacon and side lights for individual monitoring.

I had thought that dealing with the reduced side light current would be easy. As it turned out, it wasn't. Initially, I added additional primary turns through the current sample transformer. Murphy's Law came into play as two turns wasn't enough and three was too much. Ultimately, I went with more turns, adding a 10k pot to allow fine adjustment of the input sample.

The main route to Mt. Scott passes the Willamette National Cemetery. This year, on a weather-related trip to Mt. Scott, I was reminded of the meaning of Memorial Day. Passing the cemetery, waiting as the Boy Scouts directed traffic, looking at the sea of American Flags reminded me of those we need to thank for our freedom. When you have a moment, please stop by http://www.cmohs.org/, the Congressional Medal of Honor web page as I did for a few moments of reflection of the valor of our men and women in uniform.

It's no longer winter… time for good weather, right? Well… no. 2008 looks to be a record cold year and with it have come summer storms. This last week, we had a major storm with record hourly rain numbers, hail and lightning. Lots of lightning. Multiple cloud-to-cloud and cloud-to-ground strikes.

At Mt. Scott, the power drop is underground, which helps with lightning strikes. The 277/480 power drop with step-down transformers to provide 240 to the building is another advantage. Although we seldom get lightning here in the Willamette Valley, I am thankful for the surge protection systems installed at the transmitter.

Some time back, I discussed the floating delta power systems at Mt. Scott. My solution was to use a Y-connected series of 220 V lamps to monitor and maintain balance. I recently lost one of those lamps, which prompts a warning to consider stocking up on replacements.

Last year, Congress passed a mandate to outlaw incandescent lamps. The bill originally was based on a very aggressive lumens-per-watt number and will be taking effect in the next few years. I see that bill already impacting the replacement lamp market. How far it will ultimately go, I don't know. It could conceivably impact pilot lamps and the standard 40 W florescent lamps.

Currently, I am looking to identify lamp usage in the company to identify replacement stock needs to deal with the coming loss of replacement lamp products.

Grrr…

I *love* computers. This last week was "fun with computers" time. I need a small system for a single program application. I have some older computers, some with very reasonable hardware and Win98, which should be just fine for the application. So I pulled out the best one to check it out.

It booted up fine wanting me to log onto Windows. So I asked for the old password. Well who remembers if indeed anyone ever knew it? So I canceled out for the time being.

Next step, no Windows Explorer. So off I went to another system to port over the Windows Explorer executable file. I have it on floppy, so how do I run it? A search locates the file and a double click gets it running. Now I can create a shortcut to add to the file start menu to get it running.

The next step is checking the drive. Scan Disk started up fine, but kept restarting. That's an old problem caused by a Microsoft "upgrade." Something was writing an update to disk causing Scan Disk to restart to check the file system. The known solution is to boot in safe mode to run Scan Disk.

So I rebooted using F8 to select safe mode. The boot ROM indicated that the keyboard is bad. So I tried again and waited a bit. This time, F8 was too late. Must be a really small window intercept boot.

So I tried to confuse it by powering down during boot and before windows fully loaded. That should have made the next boot go to safe mode, except it didn't. Long story short, I finally stumbled on putting a floppy in so the boot ROM would stop. Now I had a window for selecting safe mode.

That's good, and Scan Disk found no errors. So I decided do a surface scan and sector write test. The restart problem occurred again as Scan Disk rechecked the file structure and restarted the surface scan where it left off.

Did I say I *love* computers?

Rocky Mountain "Hi"
The Denver Report
by
Ed Dulaney, CSRE, CBNT, AMD
Chief Engineer, CBC - Denver

Something Good is Bound to Happen...

In the late 1980's I was the engineer and afternoon DJ at a Christian station in Lubbock, TX. Looking back, it was one of the best experiences I could have ever... well, experienced! I learned a lot about FM transmitters, particularly a finicky McMartin BF3.5K and a great Continental 816-R2. I also discovered how wonderful it is to have a well designed studio. Unfortunately, I learned that lesson through hours upon hours of trying to figure out why audio wouldn't get from point "A" to point "B" while crawling around behind racks, studio furniture and the occasional wall!

Being a DJ as well, I had a chance to discover all sorts of great Christian music. Back then I was heavily into Petra, White Heart, Rick Cua, David and the Giants, and other good Christian rock bands. And the station manager was happy to let me have an hour a week to produce a show called "The Rock of the Gospel" where I got to play all that great music. But that wasn't the normal format of the station. In fact, I reckon you could say that we didn't really have a "format." Instead, the station aired the typical Christian programming from 6:00 AM until 3:00 PM. Then at 3:00, I had a four-hour block of music. It was called a Contemporary Christian Music format, but we played inspirational, Southern Gospel and hymns along with the usual CCM fare.

That was where I discovered Bruce Carroll. This man had some of the most incredibly deep Christian music I'd ever heard. It was placed in the Southern Gospel category, but he was more along the lines of Christian Country, a genre that didn't exist in the 1980s.

One of the songs he recorded had "crossed over" to the secular country charts. It was called "Something Good is Bound to Happen." To this day that song gets into my head whenever adversity strikes. The gist of the song is that when things are really starting to fall apart... just keep watching and praying! God is still there and will give you an incredible blessing.

...or The Devil Would Not be Working Overtime!

That heading title is the second line in the chorus of the song. And that brings me to the list of things that have happened over the past month that have brought this song back to mind again!

The month started out with us beginning the work on mowing the field at the KLVZ transmitter site. I had spent about two hours on the tractor, which we had just purchased in April, when the power take-off (PTO) stopped working. This is what drives the accessories that you hook to the rear of the tractor. In this case, the brush hog started slowing down to a halt. So we had to take the tractor in for servicing, which was going to be very expensive. When we got it back, I was bringing it back to the KLZ transmitter site when my truck broke down! The radiator sprang a leak, and I had to wait on the side of the road for Amanda to bring some water to the truck.

We finally got it running again and I proceeded to drive to the transmitter site. But about two miles away it died again! This time it wasn't

getting fuel to the carburetor, so we ended up leaving the truck in a parking lot and hooked the tractor up to the trailer. So instead of hauling the tractor on the trailer, we were pulling it along at the blinding speed of 15 M.P.H.! Thankfully there was a good back road to drive on to get to the transmitter, and Amanda followed behind with her flashers on.

But about a mile into the drive, I noticed the steering getting wonky! The repair shop was supposed to have fixed a problem with the power steering cylinder because it had a leak. But it sure didn't seem like it! Fortunately, we still had some power steering fluid back in my truck. So Amanda went back there to get it. We then filled up the reservoir and I tried to start the tractor. Now we had another problem... the battery was dead!

I was on a narrow canal access road and there wasn't any way that Amanda could pull alongside the tractor so that we could jump-start it. So she had to back out of this narrow road, and drive a mile or so around to the other side. When she got there, we managed to run the cables to the battery and get it started; I was rolling again. We got the tractor safely back into the garage at KLZ, and I headed home to rest after this nasty day!

The next day, I had a tow truck get the truck from the parking lot and bring it to the KLZ transmitter. Then I ordered a new radiator and started looking at the problem with the lack of fuel flow. It seemed that the fuel was getting through the line without any problems, but not into the carb. So I took the carb apart and found a lot of gunk around the float valve. When I cleaned that out the fuel seemed to flow perfectly. Then I replaced the radiator and tried it out. There were still some issues when the truck got hot, so I traced the fuel line. It went up through a hole in the firewall and back down to the fuel pump. This was a "hack job" that the previous owner had done, and it certainly would cause problems. The fuel pump on older cars and trucks is at the engine, not at the fuel tank. So basically it had to pump the fuel "uphill" to get it to the carb. That's not a problem when the truck is cold, but when it gets hot it causes vapor lock! So I ran the fuel line along the original path that it should have followed. After all that work, it seemed like I had a working truck again. I drove it around a bit over the weekend while running errands, and all seemed well.

Then near the end of the month, I started doing some work with the tractor. I did a small bit of mowing at the KLZ site, just enough to make sure that we had solved the battery and power steering problem. Apparently we did, as those both worked perfectly.

Then, while backing the tractor into the garage, I suddenly found that all motion had ceased! The tractor wouldn't go forward or backward. I tried all 12 forward speeds and all three reverse speeds and it just sat there. So now I had a dead clutch on the tractor. Arrgh!

I checked with the repair shop and they said that I could bring it up anytime and they'd take a look at it. They also needed to look at a problem with the three-point hitch, as it wasn't working right either. So I had planned on doing that at the next opportunity, however...

Amanda and I were going to take the small John Deere mower out to KLTT to do some weed mowing. But we needed to get gas and some parts at the hardware store. I decided to take the truck so we wouldn't have to get the smell of gas in either of our cars. But on the way there, the truck died again! And this time the starter wouldn't turn over the engine. So we had to walk back to the KLZ transmitter, which was only ¾ mile away, and wait on Cris to arrive. He had a tow strap that we could use to bring the truck back to the KLZ site.

By now I'm thinking that it's getting close to the time that something good is bound to happen! We loaded up the trailer with all the mowers and accessories. That was when we noticed that a part was missing from the lawn tractor! We couldn't mount the mower deck on it because one of the support links wasn't there. We looked everywhere for it, but it was nowhere to be found. So we figured we'd just take out the push mower to do what little we needed to do at KLTT.

On the way to the site yet another problem reared its ugly head! The tie-down strap came loose from the push mower and it slipped off the back of the trailer. Thankfully, the strap stayed connected to the mower and it was pulled along behind the trailer while I hurried off to the side of the road. I was actually looking in my mirror at the moment that the strap came loose, so I got stopped pretty quickly. But it wasn't quickly enough. The mower lost a wheel, both the engine and drive controls from the handle, and had a pretty beat up deck. I later looked at the strap to see what had happened. Amanda was the one that attached it, and I watched as she cranked it down pretty tight. I knew that it wasn't something that she'd done, but I just couldn't figure out why it came loose.

Well, this time it turned out that the ratchet was defective. The clamp spring that held the ratchet into place was loose because the metal was bent. I'm certain this didn't happen because of the mower falling of, and it was likely that way for some time. It

just decided that this was the place that it was going to fail.

We still headed out to KLTT as there was still work that we could accomplish. On the way out there the skies opened up, and we had a major rainstorm. This was the same storm that you may have seen on the news that spawned all the tornadoes in Northern Colorado last month. It was still somewhat dry at KLTT, and we did get a little work done, but not as much as we wanted to.

Needless to say I'm ready for that blessing to head my way!

It Went Where?

Along with those issues, I also had a bit of a shipping mix up that caused us some major headaches. As many of you already know, the CBC mail server had scrambled eggs in the hard drive! This was causing loss of mail and very sluggish performance of the unit. I repaired it fairly quickly, but the problem that I'm writing about isn't related to the repair.

You see, I had to send the bad hard drive back to Dell, as the unit was under warranty and they simply sent me a replacement. So I boxed it up in their box, put their DHL label on the box, and called DHL to pick it up.

However, alongside the Dell box in the lobby downstairs was another box that was awaiting pickup by UPS. This was a Sonifex profanity delay that I was reviewing for *Radio World*. It had some issues, so I was sending it back to Sonifex for retrofitting with a new knob (don't ask!). So when UPS came to pick up a box did they take the Sonifex? Of course not! They picked up the Dell box (with a brand new DHL label on it) and put their call tag label on top of it. A couple days later, I get a call from the company that was going to repair the Sonifex asking me why I sent them a Dell hard drive!

It took a couple of hours of phone calls to get that one straightened out. But I just had to shake my head! Here was a box clearly labeled as being shipped to Dell, and UPS puts their label on that one. Meanwhile, another box is sitting a couple of feet away with a sticker on it that shows it's awaiting a UPS call tag, and they don't even give it a second look!

Of course DHL showed up about an hour later wondering where the box was that they were supposed to pick up! I guess that's life in the big city for you.

Until next month... press on!

Digital Diary
by
Larry Foltran
Corporate Website & Information Technology Coordinator

The "Sweat Box" Revisited

A little over a year ago, I wrote about my visit to Delta Air Line's Training Center located in Atlanta, Georgia. I recently had the opportunity to make another trip to Atlanta and once again try my hand at some of their full-otion simulators… this time with somewhat better results I might add. Pilots call these simulators, "sweat boxes." With three sets of eyes floating over your shoulder, watching your every move as you make a nighttime, cross-wind approach into Atlanta airport, I now fully understand the meaning of that moniker.

Our guide was a friend of mine who is one of Delta's simulator techs. He is responsible for getting a broken simulator back up and running as quickly as possible. My dad also made the trip down with me and another friend from the Atlanta area met us there as well. Our first stop was the MD-90 simulator, where we started the "aircraft" from a cold and dark

scenario at the gate, flew the pattern around Atlanta with some various surprises thrown at me, and landed the aircraft safely.

We then moved to one of Delta's MD-11 simulators, which is actually no longer used by Delta, but is often leased to other airlines for pilot training. Although I expected the same general layout as the MD-90 based on the fact that both are McDonnell-Douglas aircraft, I quickly realized that it is not the case. Called to fix an ailing simulator, our guide basically told us we were on our own. Surprisingly, by the time our guide returned, my friend and I were able to get the aircraft's systems up and running and we were in the process of starting the engines. Not bad for a couple of amateurs.

Aside from our "play time" inside the simulators, we were shown some of Delta's newer simulators and really had a chance to see how this area of technology has advanced. The MD-90 and MD-11 simulators we were flying were built in the early to mid 80s, and the computer and hydraulic support system to operate these machines are massive. In front of each of these older simulator bays are two large computer cabinets to provide the visuals, flight aspects, and the motion to the sim. Seemingly ancient IBM computers with monochromatic screens served as the input devices

for the control computers. Below the simulators are large, dedicated hydraulic pumping units to provide motion to the simulator. Large hydraulic hoses stretch from these pumping units up through the ceiling and into the hydraulically-actuated legs of the simulator. Needless to say, it's an elaborate and costly operation.

As we moved further down the line, we saw some of the newer simulators and noticed not only the physical differences, but the fewer pieces of support equipment. Although the computer control systems were a bit smaller, the massive hydraulic systems were still there. We were also able to take a peek inside one of Delta's 767 simulators while the pilots-in-training took a break.

We finally made it to the last bay in the newer side of the training center where they were installing a brand new 777-200LR simulator. Manufactured by CAE, this simulator represents the bleeding edge of flight training technology. The

interior had that new simulator smell, and many of the components were still covered in foam. I was told that the flight instruments and control panels in this simulator are actual aircraft parts and can be installed in a 777 if ever necessary. Further, once the installation is complete, FAA certification is required before pilot training can begin.

We descended to floor level where the simulator towered above us. The massive screen that the visuals will some day project on sat to the side of the simulator. One of the most unique aspects of this new simulator is that the motion is provided by electric motors instead of a traditional and costly

hydraulic system. We were told that the simulator will require less ongoing maintenance and will be quieter during operation. A win/win situation.

Once back at the main level, it suddenly hit me that there were no large computer cabinets to control the simulators. Our guide directed us into an adjacent office room where one rack of computer equipment and one Dell PC sat waiting for the show to start. Although our guide hadn't yet been trained in the computer system, it looked as if the "brains" of the system was a blade server system utilizing the nearby Dell PC as the input unit. Blue Ethernet cables snaked out of the rack and into the floor, eventually making their way into the simulator. The large cabinets of years ago had been replaced by a blade server and a single PC.

As impressive as this computer system is compared to its predecessors and how much the visuals have improved along the way, we were told that the graphics are still surpassed by those provided by MS Flight Simulator. To think that my home PC provides me with a richer simulated view of the world than one of these multi-million dollar machines seems a bit odd, but also leaves me somewhat content. Eye candy aside, the feeling you get when you pull back on the yoke of a simulated airliner is unforgettable especially for someone who will most likely never be at the controls of an actual airliner. Now if only I could find a way to mount my home PC system onto hydraulic legs.

…until next month!

KBRT • Avalon - Los Angeles, CA
740 kHz, 10 kW-D, DA
KCBC • Riverbank - San Francisco, CA
770 kHz, 50 kW-D/1 kW-N, DA-1
KJSL • St. Louis, MO
630 kHz, 5 kW-U, DA-2
KKPZ • Portland, OR
1330 kHz, 5 kW-U, DA-1
KLZ • Denver, CO
560 kHz, 5 kW-U, DA-1
KLDC • Brighton - Denver, CO
1220 kHz, 660 W-D/11 W-N, ND
KLTT • Commerce City - Denver, CO
670 kHz, 50 kW-D/1.4 kW-N, DA-2
KLVZ • Denver, CO
810 kHz, 2.2 kW-D/430 W-N, DA-2
KSTL • St. Louis, MO
690 kHz, 1 kW-D/18 W-N, ND
WDCX • Buffalo, NY
99.5 MHz, 110 kW/195m AAT
WDJC-FM • Birmingham, AL
93.7 MHz, 100 kW/307m AAT
WEXL • Royal Oak - Detroit, MI
1340 kHz, 1 kW-U, DA-D
WLGZ-FM • Webster - Rochester, NY
102.7 MHz, 6 kW/100m AAT
WRDT • Monroe - Detroit, MI
560 kHz, 500 W-D/14 W-N, DA-D
WMUZ • Detroit, MI
103.5 MHz, 50 kW/150m AAT
WPWX • Hammond - Chicago, IL
92.3 MHz, 50 kW/150m AAT
WRCI • Rochester, NY
990 kHz, 5 kW-D/2.5 kW-N, DA-2
WSRB • Lansing - Chicago, IL
106.3 MHz, 4.1 kW/120m AAT
WYRB • Genoa - Rockford, IL
106.3 MHz, 6 kW/65m AAT
WYCA • Crete - Chicago, IL
102.3 MHz, 1.05 kW/150m AAT
WYDE • Birmingham, AL
1260 kHz, 5 kW-D/41W-N, ND
WYDE-FM • Cullman - Birmingham, AL
101.1 MHz, 100 kW/410m AAT
WXJC • Birmingham, AL
850 kHz, 50 kW-D/1 kW-N, DA-2
WXJC-FM • Cordova-Birmingham, AL
92.5 MHz, 2.2 kW/167m AAT

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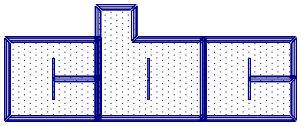

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