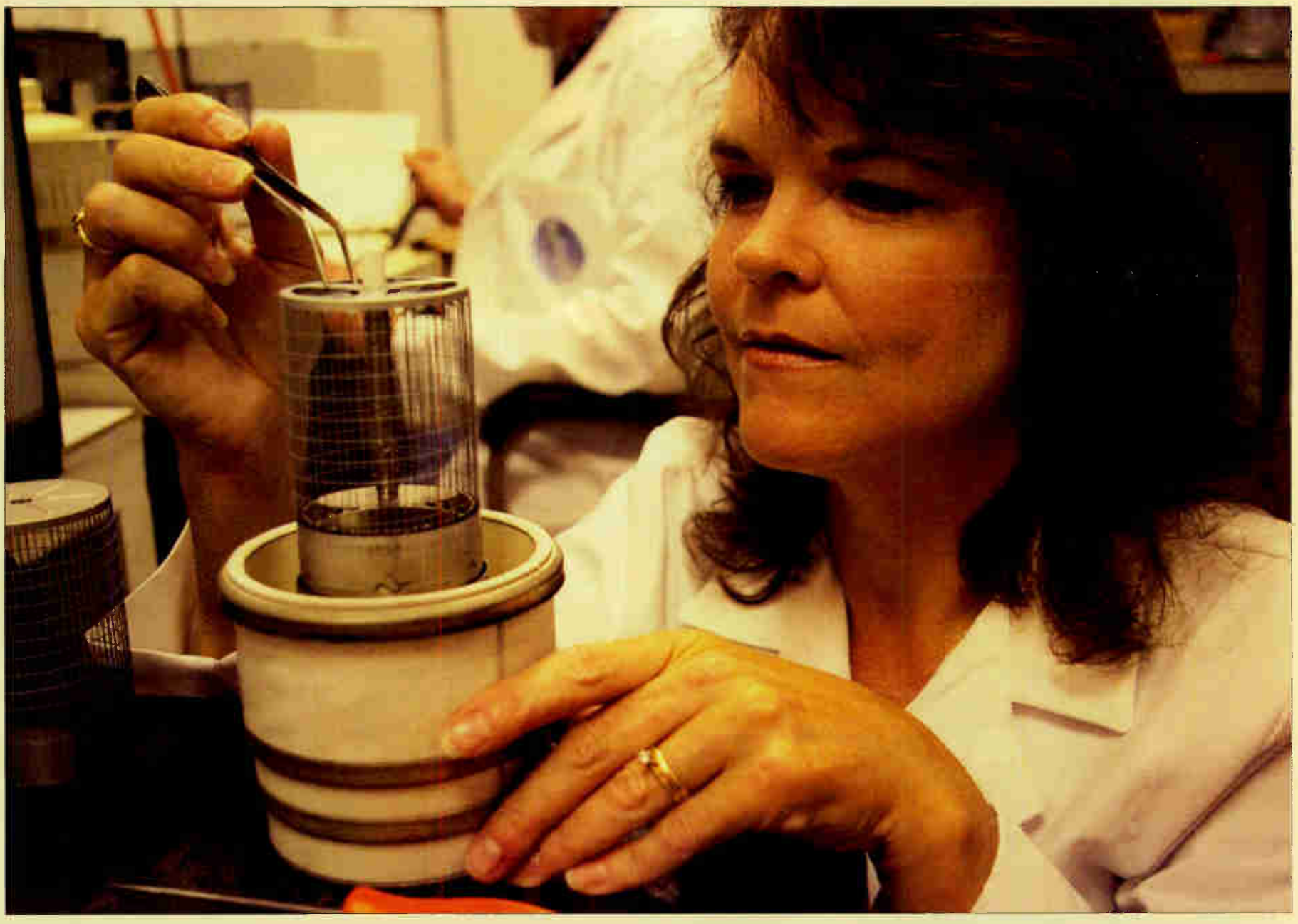
Radio Guide

Radio Technology for Engineers and Managers

December 2007

Vacuum Tube Care Keeps FM at High Power



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Getting the Best From Vacuum Tubes

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Cover Photo

A Freeland Products technician prepares a tube for rebuilding.

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Radio Waves

by Barry Mishkind – Editor

As the year 2007 comes to a close, it is a traditional time to look back and review the good and the bad that happened during the year. For ***Radio Guide***, it has been a very good year.

In fact, it now totals more than five good years for me as Editor. And for that, we have you, our kind readers, and all our advertisers to thank.

This year, I had the opportunity to be on both coasts and from Canada to Florida, including a trip up the Shubenacadie River (now *there* is a story!). While wandering from place to place, I got to meet and chat with a great many of you folks, enjoying your company, and seeing some grand old sites. (OK, there were a couple of less grand sites, too.)

At each stop, I learned something about you, about your station or manufacturing plant, about radio history, and most importantly, about how we can better serve your needs. I truly appreciate the hospitality shown by so many of you. There truly is not enough room to print all your names – but you know who you are.

We also heard a lot of positive comments from you about the magazine. And those of you who have attended one of our ***Radio Guide AM Transmission Seminars*** tell me you came away with both a good educational experience and an understanding of our commitment to help at a time when it is hard for engineers to find the time, energy, and money for education.

As we look ahead to 2008, ***Radio Guide*** fully intends to continue delivering the information you have asked for, building upon what we have been doing. We are also planning some new features and programs to help you do your job better. As 2008 begins, we know you will continue to look to ***Radio Guide*** as a valued resource.

All I can say is: "Thanks a Megawatt!" – *Radio Guide* –

Getting the Best from Vacuum Tubes

– by Randy Davis –

Along with turntables, cartridge machines and reel-to-reel tape machines, many engineers consider vacuum tubes as obsolete. Yet tubes continue to serve many stations well, especially in high power applications. Randy Davis offers some observations and tips to help users get the best service possible from their power tubes.

The best choice for high power RF amplification – especially for use in the VHF and UHF spectrum – continues to be vacuum tubes.

However, the propaganda surrounding these electronic valves suggests that their extinction is imminent.

NOT QUITE CUTTING EDGE

The reasoning for such a prediction is simple. Would you like to have a laptop with a CRT display? How about having vacuum tube switches or gates in that same laptop? Yes, such a thought is absurd, as vacuum tubes are obviously no longer practical for many applications.

Because of this fact, vacuum tubes are labeled by many as "obsolete." This label has prompted educational institutions to move away from in-depth studies of these devices in favor of more modern technology. While I am not critical of this migration, the result is that fewer and fewer engineers and technicians are being taught the basics involving equipment utilizing vacuum tubes or the theory of vacuum tube operation.

Unfortunately as a result of this, in maby cases, newcomers to broadcast engineering are forced to learn from the school of hard knocks and OJT. The intent of this article is to serve as a refresher for old timers and foster improved vacuum tube maintenance techniques among newcomers trying to learn it on the job.

TUBE'S SPECIAL PLACE

Vacuum tubes do have their niche, and simply are not yet replaceable as single device, high-gain, high-power RF amplifiers.

All in all, tubes outperform their solid state counterparts by providing greater efficiency, with a smaller footprint, at VHF and above.

For example, the specifications on practically any forty-year-old television klystron are amazing. A single five-cavity klystron is capable of providing a stage gain of about 50 dB at an output power of greater than 50 kW. Single-stage RF amplifiers, such as the final stage in FM or television transmitters, continue to be tubes in many cases, and this trend is likely to continue for some time.

SOLID STATE'S ACHILLES HEEL

Solid state devices suffer in this venue simply because the number of devices required to produce high power RF becomes daunting as large numbers of complicated combiners are required for the solid state devices, in order to reach large power levels.

These combiners, because of their loss, reduce the overall efficiency of the devices. Multi-stage linear power amplifiers, such as those operating in a large array of combiners, are more likely to exhibit less attractive distortion products and reduced S/N ratios because of the cumulative effect of multi-stage amplification – especially when compared to a single-stage device operating at high power levels such as the final stage in an IBOC FM transmitter.

In addition, the complexity of the combiners makes construction of the device expensive. The racks of parallel amplifiers and combiners also require significant floor space.

STILL THE ONE

So, compared to solid state devices, tubes still make the best choice for today's equipment as well as future equipment design in high power RF and several other applications. In addition, ongoing vacuum tube development continues to firmly plant vacuum tubes in our future.

Examples of relatively new vacuum tube designs are Inductive Output Tubes (IOT's) and Multiple Stage Depressed Collector (MSDC) IOT's. These devices have become dominant among high power UHF facilities for both analog and digital television transmission service. Their claims to fame are efficiency, simplicity, and using the minimum dolars per Watt.

DEALING WITH TUBE LIFE

Although cost efficient, vacuum tubes do present a concern – they do not last forever. Broadcasters know this all too well.

The trick is in making tubes last longer. Vacuum tube management is essential if you are serious about getting the most life out of your vacuum tube. In fact, *simply operating the tubes as the equipment or tube manual suggests may be detrimental to the overall life of the device!*

On the other hand, with proper vacuum tube management, it is not unusual to extend the life of your tubes by a factor of two – or more. In fact, the operating life of some tubes can be extended for *years* with proper filament management.

Several things are required in order to get the best service from your tubes. You may want to get to know the transmitter a little better, including the normal operating parameters. Establish an environment for your transmitter which will support extended tube life.

KEEPING HEAT UNDER CONTROL

Heat is one of the major causes of vacuum tube failure in a transmitter. Abnormal vacuum tube heat loads can cause seal failure, ceramic failure, or permanent poisoning of the cathode or filament through outgassing of internal tube components.

Improper transmitter output tuning or improper tube element voltages can create such dangerous heating of the output tube. A determination of the amount of heat generated must be calculated to ensure the tube is operating within its normal temperature envelope.

This calculation is simple – *if* you know your transmitters RF power output (TPO). Knowing that TPO does not mean reading your output on the meter at 100% and calling it good. This meter must be calibrated using a dummy load and a *calibrated* line section connected to a Watt meter. Using a calorimeter (assuming you are using a water load) for this purpose is even better.

Efficiency can be calculated once you are sure of your output power. Simply multiply your plate Volts by your plate current in Amperes to get your total plate input power in Watts. Subtract your output power from your total plate input power to get the amount of power you are dissipating in heat. For example:

Calculating Transmitter Efficiency

- 9,000 Volts X 2.8 Amps = 25,200 Watts plate input power
- 20,000 Watts measured output power as read on a thru-line Watt meter or calculated from a calorimeter
- (5,200 Watts of plate power is dissipated as heat from the tube's anode)
- 20,000 / 25,200 = .793 or 79.3% plate efficiency

Once you get your efficiency number, compare this with the transmitter's efficiency rating as measured by the manufacturer prior to delivery. Make sure the efficiency is close to the original number. Otherwise transmitter tuning or re-biasing may be required.

MORE THAN ANODE AND CATHODE

Even if your efficiency number is close to nominal, all tube elements must be within the manufacturer's ratings for current and voltage for safe operation. For example, beware of high screen grid (G2) current. While tube screen currents may vary from tube to tube, abnormally high screen current may indicate a potentially destructive tuning condition caused by improper output loading.

If this is the case, output power and plate current will *increase* as the loading is increased and screen current will simultaneously *decrease*. A relatively good efficiency may be obtained even though the amplifier may be operating dangerously unloaded. Seriously un-loaded transmitters can result in arcing and/or catastrophic component failure involving the tube as well as other parts in the RF output circuit due to extremely high RF potentials within the RF deck as well as increased circulating currents in the tube and other components.

Higher than normal RF potentials in the RF deck can also cause arc-overs and these arcs usually occur in a place that winds up shorting out the high voltage plate supply. These momentary shorts are responsible for many blown diodes and fuses in the plate power supplies.

KEEPING THE TUBE BALANCED

Screen grid current is a good indicator for assessing the loading condition of the RF amplifier. This is true only if the output tuning control is adjusted for resonance or maximum output. Historical data and information from the transmitter manufacturer will provide several accounts of G2 (screen grid) normal operating currents.

A good Rule of Thumb is to check output loading if the screen current is abnormal. Severely un-loaded amplifiers can also result in output tube failure due to screen grid over-dissipation. This condition can easily be averted by monitoring the screen grid current as the amplifier is tuned. For this reason it is a good idea to know the dissipation rating of your amplifier tube's screen grid.

Calculating screen grid dissipation is simple – multiply the tube's indicated screen current in Amperes by the screen voltage. For instance if your amplifiers screen grid current is 0.1 Amperes and the screen voltage is 800 Volts, the screen grid dissipation is approximately 80 Watts.

Similarly, relatively *low* screen grid current may indicate that the loading is too tight. An amplifier loaded too tightly will indicate high plate current for a given output power. An amplifier tuned in this condition will produce excessive heat and exhibit low efficiency and low output power.

PROPER TUNING PRACTICE

It is important to remember that tubes and other transmitter components can be damaged while in the process of tuning. All tuning adjustments should be made quickly while observing the plate current, screen current, and power output simultaneously.

Tuning which results in over-dissipation of the grids will require the immediate removal of grid power or internal tube damage could result. Plate and screen grid voltage should be removed from the tubes if the tube is operated outside its plate dissipation envelope for more than a few seconds, allowing the tube time – and air flow – to properly cool.

Tubes, however, are forgiving of momentary plate overloads. Grid overloads are somewhat less forgiving because the grids have much less mass than the anode and can be elevated to destructive high temperatures very rapidly. Always remember that a tetrode or pentode tube must *never* be allowed to operate without plate voltage when screen voltage is applied or screen grid over dissipation will result regardless of whether or not drive power is applied.

(Continued on Page 6)

Impossible Remote?
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Getting the Best from Vacuum Tubes

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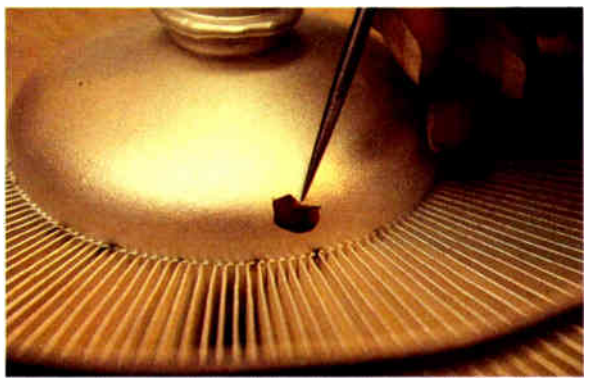
OBSERVING THE TUBE ITSELF

Tubes rebuilt by Freeland Products, Inc. (www.freelandproducts.com) are supplied with temperature indicating paint on their anodes. Two different paint spots appear on the tops of our tubes – one indicates operation above 250 degrees Centigrade, and the other indicates operation above 300 degrees C.

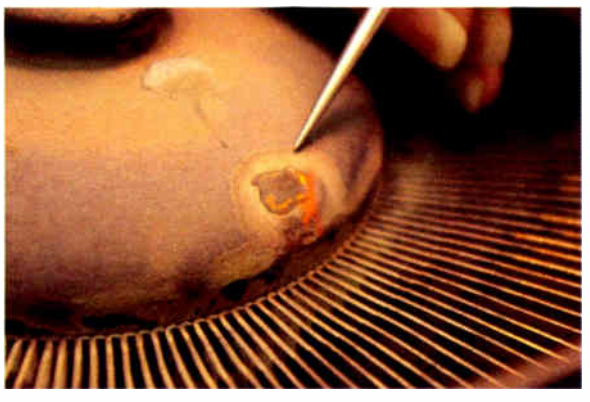
A savvy engineer will use this paint as a quick assessment of his transmitter's cooling capability.



Temperature sensitive paint on the tube anode shows whether operation is within the tube's heat limits.

The maximum temperature most ceramic/metal tubes should be run is 250 degrees C. The tube seals are compromised above this temperature. If either of the paint spots changes color from their original off-white and light brown, then tube over-temperature operation has occurred.

Operating a vacuum tube too hot can also cause filament poisoning. Gas may be released internally which has detrimental effects on the carburized filament. Rapid decarburization resulting from the gas contamination will destroy a tube subjected to continued over-temperature operation.



This tube has been operated in excess of its design limits and the paint has changed color.

DESTRUCTIVE HOT SPOTS

Destructive hot spots can be created inadvertently within a tube. Many tubes have failed as a result of hot spots developing on the filament inside the tube.

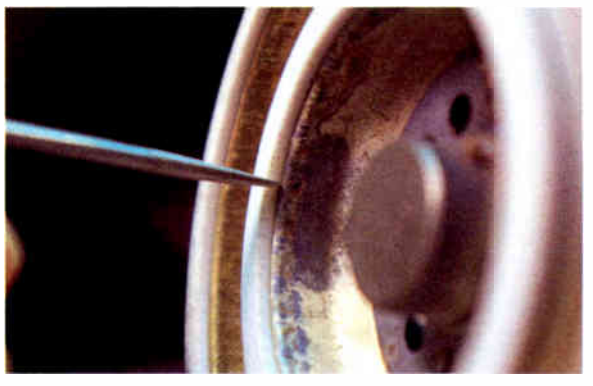
These "hot spots" are created by minor differences in the filament wire's diameter and these diameter inconsistency issues may be exaggerated by allowing high filament start-up currents to occur. Tube filaments can easily be burned open by the application of too much filament start power.

Some transmitters employ a filament step-start circuit to pre-heat the filament at a much lower voltage and current for several seconds. This pre-heat raises the filament resistance to a point where safe application of normal filament voltage can be applied. Other manufacturers simply limit the impedance of the filament supply to a resistance high enough that current limits cannot be exceeded on the tube's filament at turn-on.

For obvious reasons, it is imperative that transmitters incorporating filament step-start circuitry undergo periodic tests of this circuitry to insure proper operation. Some transmitter manufacturers utilize pneumatic as well as electronic time delay devices for this purpose. Any of these time delay mechanisms can fail leaving the transmitter's tube unprotected at turn-on.

HEATED CONNECTIONS

Other forms of heating will destroy vacuum tubes just as easily. One major culprit is bad or loose connections. Poor socket contact can cause sudden tube failure. These bad connections usually occur due to worn out socket fingers.



Excessive heating caused by poor socket contacts can lead to premature tube failure.

Worn out sockets will cause pitting of the contact area on the tube's base. Such pitting and a discoloration of the tube's filament and grid contacts are an indicator of poor socket contact. Should pitting or discoloration of the tubes contact surfaces be found, it is imperative that the associated socket contact be replaced immediately.

(Continued on Page 8)

Wireless Broadband Internet Remotes

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Getting the Best from Vacuum Tubes

Continued from Page 6

The most common socket component to fail is the inside filament contact fingers.

A new or freshly rebuilt tube should *never* be plugged into a socket with worn-out contact fingers. Some tubes are more vulnerable than others in this way. Hot spots produced by poor connections can crack ceramics and/or punch holes through the metal and compromise the vacuum integrity of the tube.

Unfortunately, socketing issues are usually discovered *following tube failure*. This is why it is always a good idea to *thoroughly* inspect a tube once it is removed from the socket. You certainly would not want to plug in another expensive tube just to have it fail because of poor socket contact.

Worn socket fingers should be replaced as quickly as possible, to reduce potential damage to the tube.

A maintenance note: Socket contacts cannot be bent back into position or stiffened up to provide adequate contact – they must be replaced. The intense heat that caused the pitting also further weakens the once-tempered contact material. Most sockets can be repaired by purchasing individual components within the socket that have failed.

MEASURING HEAT REMOVAL

Now that you have considered your transmitter's efficiency and the level of heat generated by the tube during operation, it is time to make another assessment: How effective is your transmitter itself at removing the heat? The fins on the anode are not enough – air flow is needed.

Your tube can still fail from over-temperature, even after you have checked all the components and tuned the transmitter carefully. Assuming you have done your due diligence regarding filter and tube cleaning (yes, you can wash a cold vacuum tube with soap and water), and the tube continues to overheat, it is time to check the transmitter exhaust system.

If your transmitter is exhausted to outside air it may be difficult to determine the overall effectiveness of this sort of cooling because of the changing outside environment. The air inlet to the room as well as the exhaust from the room can be severely affected by outside wind speed, direction and temperature. A brief interruption or reduction in air flow due to this environmental effect could prove catastrophic.

While most transmitters will shut off when the air flow is removed – will yours shut off when the air flow is *reduced*? Is it safe to operate the transmitter at this reduced air flow rate? There is no way to know this unless the airflow is artificially reduced to the point of causing the flow switch to drop out and then measure the air flow at this point to see if it is sufficient to continue operation. If not, the air flow switch should be adjusted accordingly.

THE MANOMETER

Another way to measure this is the air pressure drop across the tube's socket. Do you know the air pressure drop required to safely dissipate the tube's heat at your transmitter's altitude? Assuming the manufacturer got it right (which they usually do) in sizing the blower for your transmission site, how do you know that some component of the cooling system has not been changed with a wrong part – or perhaps the impellor on the blower is sufficiently dirty to cause reduced air flow or socket pressure?

You probably will not know unless you have some way to measure the pressure drop at the socket. The best way to do this is to purchase or construct a manometer. Simply connect the manometer to the pressure side of the chassis and the other side of the manometer to the exhaust and measure the pressure, adjusted for the altitude of operation. This number will represent the pressure drop at the socket.

Once the pressure drop at the socket has been determined with the manometer, this number can be compared with the "pressure drop" figures given in the tube operation data from the tube manufacturer. (An informative article by Clay Freinwald, detailing how to build a manometer into the Rockwell-Collins and Continental FM transmitters, was published in ***Radio Guide***, in the March 2005 issue on Page 28.)

There is another, and in some ways, more important factor in enhancing tube life – proper management of the filament voltage. We will discuss that next time.

Randy Davis is the Plant Manager for Freeland Products, Inc. in Covington, LA. You can contact Randy at 800-624-7626 or by email at randy@freelandproducts.com

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Audio Guide

by Dana Puopolo

Barix Units – Audio's "Swiss Army Knife!"

Any time you can find a product that will solve multiple problems you have found a very useful tool indeed. Dana Puopolo found one and wants to show how it will help you.

Two years ago, I spent several weeks in Pittsburgh, PA doing field strength measurements on a client's AM station to help him get a power increase.

The studios were located in a data center downtown, the transmitter some distance away. But I was astonished at how good the station sounded: far better than one would expect from analog program lines going through many offices.

DISCOVERY

I asked the engineer there (who also ran the data center) how the audio got from the studio to transmitter. He smiled and showed me this gold box that looked like a heatsink. This was my introduction to Barix products.

He was using the units with a 512 kbps fractional point-to-point T1 line that also gave him Internet, telephone, remote control, and even the ability to monitor the transmitters and tower lights (it was a shared site with another station) wirelessly on his Palm Pilot. Two stations on one $250-a-month fractional T1 – what a deal.

The thought of sending audio reliably over IP in general, and the Internet in particular, was something that I never believed was possible. We all know that the Internet is unreliable; packets get lost, audio connections stop and need to be restarted, poor sound quality, the need to use a computer, etc.

Yet, here was a small box that had few things on it: just a couple of RCA jacks, a headphone jack, a digital input and an RJ-45. No computer was needed. It plugged directly into an Internet connection. The received audio from it sounded *great* (the Pittsburgh stations were using 128K mono MP3 streams) with wide frequency response, great transients, and no noise or audible distortion – even when listening to it over headphones at the transmitter.

I had to find out more about these miracle boxes!

ANOTHER USE, MORE SAVINGS

A bit later on, it turned out that that same client wanted me to look into controlling his long distance costs. He runs a national radio network, and long distance costs for the IFB and sales were running over $700 a month.

After doing research, we decided to connect VOIP to his PBX for all outgoing calls. To do this, we installed a 3000/768 DSL circuit from Verizon. Since he also wanted webcams in the studios of one of the stations there, we put in a second DSL at the same time – this one with static IP addresses (you can look at the webcams at www.wsro.com). Both DSLs were installed and both projects completed successfully.

Since I now had a DSL with static IP addresses to use, I decided to buy a couple of the Barix units. (The send unit is called an Instreamer; the receiver an Exstreamer. They list for about $400 and $200 respectively.)

When they arrived, I found that they had improved the firmware quite a bit since the Pittsburgh units were installed. Specifically, they now had MPEG-2 available as a protocol (do not confuse this with MPEG-1, layer 2, also known as MP2) for streaming. This is the same codec used by DVD's, digital cable boxes, and satellite TV providers. They also had a new streaming protocol known as BRTP, and new firmware that could be downloaded and installed in the receivers (Exstreamers) to run it properly.

I set the units up with the Instreamer (transmitter) connected to an FM stereo tuner at the client's studio in surburban Boston and the Exstreamer at my house in Providence, Rhode Island. It was fun to listen to Boston radio stations in full fidelity stereo at my house in RI. Even cooler, I did not need a static IP address on the receive end to use the new protocol – they are only needed on the send end. Then Barix told me that this one Instreamer could use BRTP to stream to multiple Exstreamers – a great way to build a small network.

AN UNUSUAL SITE

While all this was happening, my client again came to me with a problem looking for a solution.

He had just been granted a Construction Permit for a new AM station in the Philadelphia market. The transmitter site was located in an old pumping station in the middle of a golf course. There was AC power available, but no way to get audio or telephone lines to the site for remote control.

The Barix Exstreamer

A 950 MHz STL was considered, but the chance of getting a clear frequency in the area was small. And the equipment cost would be high. Then it occurred to me that Barix might be the solution. But how would we get the Internet out to the pump house?

AN UNUSUAL STL PLAN

I decided to Google "wireless Internet connections" and up came the solution to our problem: the Q-Bridge. Here was a one-box solution that provided the radio equivalent of a wire between two locations. Even better was its cost – $399 shipped. More Q-Bridge info is at: http://www.connexwireless.com/Q-Bridge/

The plan was to get Verizon DSL Internet installed to the Pro Shop in the Administration Building, and then use the Q-Bridge to send it wirelessly to the transmitter building. We would install a Barix Instreamer at the studio with another DSL and stream the audio all the way to the transmitter. VOIP would be used to control the Sine Systems remote control.

The DSL modem at the Pro Shop has a built-in router, so all we did was connect its output to the Q-Bridge with a crossover cable. We also have a UPS located there to keep the circuit running if power fails. At the transmitter the output of the Q-Bridge connects to a LAN switch which also connects the Barix Exstreamer and Vonage VOIP unit. This way, the router built into the DSL modem back at the Pro Shop provides the IP addresses that are used at the transmitter. The wireless bridge acts just like a piece of wire running between the two buildings. We can even hook up our laptops in the transmitter building and browse the Internet.

When most of us implement a plan involving something new, we always tend to find that nothing works out as planned. I am happy to report that that did *not* happen here – everything went together smoothly and the system worked perfectly the first time. It even gave us the ability to test the station a few days early, by running it from Boston, before the local studio was finished.

AN UNUSUAL STUDIO

In fact, this worked so well that we decided to go one step further – running the station completely from Boston. We installed a high-speed cable Internet connection at the studio with five static IP addresses, over which we send the Philadelphia LP1 and LP2 stations, National Weather service, locally produced programming, and an off-air monitor back to Boston. The station's control point is located there, as is its EAS unit.

This studio location setup was declared legal by an opinion the FCC Media Bureau in Washington gave the National Supervisory Network (NSN) back in the 1990's.

All the audio is switched from Boston with a CartReady automation system. Even the local programs are switched by the automation (and also recorded for later broadcast). It allows the client to both control costs and increase quality and reliability because he is fully staffed there 24/7, including engineers. In Philadelphia there is a full time GM, two secretaries, and a contract engineer. That is the whole staff.

FULLY OPERATIONAL

The completed station went on air in July of last year, running a 60 kbps mono MPEG-2 stream. When we signed on, we received a number of compliments on how good the station sounded.

The system has performed almost flawlessly since then. I say "almost" because we have had two minor problems. The first was that six months after sign on, the DSL at the transmitter location stopped working one morning. It turned out that the DSL modem in the Pro Shop had locked up. Now we reboot it once a month and have had no more problems.

The second problem happened during an ice storm. To keep the Q-Bridge antenna at the transmitter end safe, we decided to mount it inside the building in the eave. That way it would not get hit by small white projectiles (also known as golf balls).

As the RF link's distance is less that 1/2 mile, it worked just fine – until one winter day when a major ice storm covered the entire transmitter building with over an inch of rime ice. The link continued to work, but the audio had a funny quality to it, almost like it was running slow. Knocking the ice off the building restored normal operation.

Other than these minor inconveniences, the link has been rock solid and is used on-air every day. The EAS unit always receives the tests and alerts, and passed FCC muster during an Inspection – though the Philadelphia FCC people had their counterparts in Boston come to the studio to see a test received and send one themselves.

IDEAS FOR NEXT TIME

The only thing I would have done differently is to use a direct digital-digital connection to the Optimod 9200. The current analog out to analog in means there are unnecessary D/A and A/D conversions. I also would have installed a static IP DSL at the transmitter instead of the dynamic one, simply because we could re-configure the Barix unit at the transmitter remotely if the IP was static.

Since then, I have installed dozens of these units at various radio stations and broadcast networks with the same result every time – extreme reliability. Along the way I have learned a few tricks on configuring the units, what type of Internet connections work best, etc. – and Barix has contracted with me to do customer support. This has given me opportunities to dig deeper into this "Swiss Army Knife." I will share some of the things I have learned in my next article.

Barix has come out with products that finally can uncouple the radio station from obsolete analog program circuits and expensive, balky analog STLs. This really is the future for radio STLs.

Dana Puopolo is an experienced broadcast engineer in audio, radio and TV. He is also the North American Customer Support person for Barix. Contact Dana at: dpuopolo@usa.net

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Survival Guide

by Rolin Lintag

Remember What Your Momma Taught You!

Do you remember the lessons that you grew up with? *"Choose your friends wisely." "Do your chores before you play." "Measure twice, cut once." "Break the bad news gently." "Make your problems work for you."*

Most of them are just variations of what your Momma told you; if you were listening to her, they became part of your psyche. From time to time, it is a good idea to revisit these lessons – and apply them to your role as an engineer.

CHOOSE YOUR FRIENDS WISELY

New technology and untried products can be your best friends or your worst enemies. To a great extent, this depends upon making intelligent choices, based on your knowledge and experience.

If you are like me, you do not enjoy being caught off guard on a technical question that you do not know anything about. Therefore, it pays to know at least a little bit about every technology coming down the pipeline – and even some of what is still out on the horizon.

In fact, as an engineer, you are expected to keep abreast of new products and act as the technical resource person in the station. This may be one area where you can be perceived as more than just on the debit side of the financial statement – the station's management and marketing people need your expertise to come up with successful business models.

This is your chance to make money for the station. In layman's terms, describe the new technology you have learned about and throw in your opinion on how it will work for your station. Being able to offer the right technical solutions is a key to personal success.

FINDING GOOD FRIENDS

Product evaluations often are good clipping materials. You can call the users and ask a few more questions yourself.

I personally prefer a filing system by subject matter so it is easy to pull out the relevant folder from the drawer. I then can call or send an e-mail to the users of the equipment just to gather a few words of wisdom from them. Almost all of them are willing to correspond in spite of their typical broadcast engineer schedules.

To start your own file system, subscribe to the magazines, e-zines, and Internet support groups that relate to your field. (If you are reading someone else's ***Radio Guide***, go to www.radio-guide.com and get a personal subscription for yourself. A treasure trove of experiences, opinions and technical assistance is also available at www.radiolists.net)

DO NOT FORGET YOUR OLD FRIENDS

Peer pressure among competitor stations sometimes forces us to procure new equipment just to keep up with what we perceive will put us on a level playing field with others. We may think – or be pushed by the Program Director to think – that we need to have the same (or newer) equipment for our signal to be competitive.

Although this may be true for some situations, it also is possible that you just need to maximize the capability of your present gear. New equipment and new technology do not necessarily mean better in terms of quality and reliability. This is especially true when replacing only part of a system. The new gear may not mate well with the rest of the program or RF chain.

Therefore, procurement of new equipment should be rationalized carefully with regard to its function and improvement of the broadcast system. If you need to join the bandwagon, make sure it will take you to where you want to go.

DO YOUR CHORES BEFORE YOU PLAY

As a group, engineers often tend to procrastinate on housekeeping chores. Of course, there may be plenty of valid excuses for this behavior.

There is always one more piece of equipment that needs to be worked on before squaring away the shop table. The transmitter floor has to wait for another day until you have the spare time to mop it. Cleaning the battery terminals on the generator is put off until later on, since the generator is still working anyway. The engineering log has to wait until you find time to put your notes and thoughts in order.

Of course, there are a number of additional "unimportant and/or small tasks" that are on your backburner or – worse – on your tasks-to-forget list. Regardless of however small these tasks may be, they can overwhelm you when they pile up.

ORGANIZE FOR EFFICIENCY

E-mails, for example, need to be answered within the 24 hours after you first saw them. Clean up your inbox regularly to lessen the clutter. Come up with ways to help you focus on the important correspondence and not to waste time on the 80% non-essential messages in your Inbox.

Take note that if you keep the building floor clean, there is less need to replace or clean the transmitter door filters. It is possible that transmitter failures will also be fewer. There are other simple tasks like this that can have a profound effect on the efficiency of your facility. It is good to spend some time to make a facility audit and revisit your maintenance program to make it work more effectively for you.

And do not forget to document everything you do. Some day you will need that information and the grey matter just will not be able to pull it all back without a paper trail.

MEASURE TWICE, CUT ONCE

We are busy working with our hands all the time; generally we enjoy providing solutions to problems that we encounter at the station. Our sleeves are folded up on our arms and, with a few tools in our back pockets, we are ready to go at a moment's notice.

However, many times when it comes to planning projects, we resist taking the time to sit down, get others in the think-tank, and work through everything that we might need to finish a project. We tend to do the paperwork job in a hurry, all too often missing some important details. This scenario almost always ends up with open-ended projects that our accounting people feel should have been closed a long time ago.

We could get away with such habits if money is not a problem. The problem in the real world is that money is a very limited resource and needs to be managed in the form of a budget. Projects need to have a start and a finish date in order to satisfy management functions. The difference between a capital expense and an operational expense should be clear to an engineer. It is just the normal way of conducting business.

The bottom line is to plan your projects as best as you can, trying to anticipate all the details that may be left out on the wayside. Devise checklists, talk to manufacturers, and engage all possible users in the planning of the facility. Call your friends at other stations who can give you a few tips and learn from their experience. By being resourceful and creative, you can come up with a plan that includes every item you need to handle.

BREAK IT TO ME GENTLY!

Are you afraid to bring up bad news? You should be if that bad news will mean being off the air and the emergency expense will be at least $10,000. No GM will enjoy that kind of surprise.

On the other hand, the response from management will definitely be different if you share the bad news as a forecast of an impending failure weeks – or even months – before it becomes an emergency. People appreciate being forewarned and will perceive that you have the situation under control. You do not need to look like a prophet of doom – just be a reasonable forecaster of possible and probable events.

However, make sure that you do keep track of the situation and create reminders (for example, using the task feature of Microsoft Outlook) for when to give updates as to when the situation is mitigated or needs to be addressed on a scheduled maintenance night. This is one area of our job where our communications skills are especially important for our own sake.

GENTLE WORKS DOWN THE CHAIN TOO

Staff evaluations should be given at regular periods and shorter intervals of time. It does not have to be as formal as the annual one, but the main ingredient should be there: feedback.

The One Minute Manager tells us that feedback is the breakfast of champions – and so it is when working with people. Do not pile up all the negative things you see in a folder for the annual evaluation. Remember that bad news cannot wait. It should be communicated as soon as it shows its ugly face.

Evaluations are given to improve the behavior of an employee at work. Thus, you should give feedback on the performance of an employee as soon as they are observed. And do not forget: positive feedback can be just as important. Good employees need to hear "Well done!" or "Ataboy!" from time to time so they do not get discouraged.

MAKE YOUR PROBLEMS WORK FOR YOU

The only difference between a stumbling block and a stepping stone is how you look at it. Problems and challenges in the station are not necessarily bad. They can be an opportunity for you to prove your worth to the organization. The key is to make the best use of what is made available to you.

I remember the time I was working for a particular international shortwave broadcaster. I had many reasons to complain: the transmitters were obsolete, barely making 95% modulation with the refurbished modulation transformers being used and the "homemade" wire antennas. To say that the station was put up from someone's backyard scraps would not even pass as a joke.

But this situation did not deter the engineers from being creative; the daily failures of the transmitters sharpened our skills to make improvements. The obsolete transmitters I wanted to curse had become my best training ground.

In the end, I was elated to hear from our monitors in Mainland China that our signal sounded good compared to another station using brand new ABB HF transmitters. Our listeners only have our signal with which to judge us. They simply do not care what kind of equipment we use to put that signal on the air.

All of this really proves one thing: it is harder to learn anything when everything is working well. Be thankful for the opportunities that may be disguised as problems. Then, *make them work for you.*

Romualdo "Rolin" Lintag, CSTE is Chief RF Engineer for the Victory TV Network in Little Rock, Arkansas. Contact Rolin at rolin_lintag@yahoo.com

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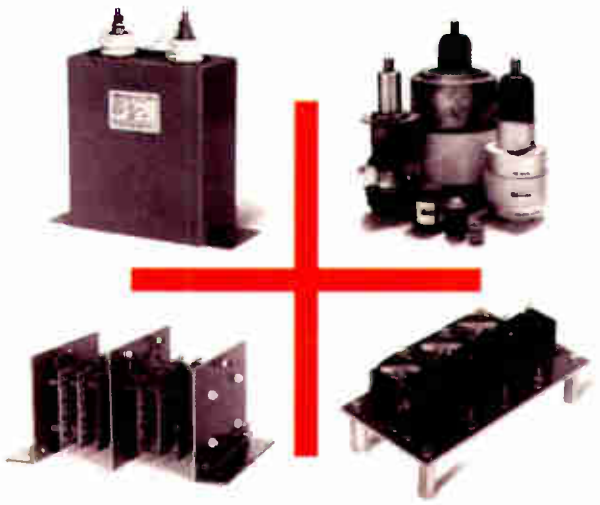

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IT Guide

by Tren Barnett

The Ultimate IT Challenge

Handling Email Communications

Email messages are the backbone of corporate communication today. Messages freely flow in email that often say and speak ideas that are never intended to be seen or viewed by anyone outside of the list of recipients.

Yet it seems that increasingly such innocent messages are playing a major role in lawsuits. It is not uncommon, early on in lawsuits, for a judge to rule that some or all email messages used in corporate communications are "evidence." These rulings may require that archived communications be located and turned over to the court.

Do not feel that it is unlikely that such could happen to your business. Recent estimates indicate that the average company may face as many as 200 lawsuits per year.

Messages may be gleaned over the simplest of matters. All that is required is that someone presents the belief that your email may have content needed to prove a case. Whether you are a big corporation or a small business the likelihood that your data be ordered by the court as pertinent to a case is increasing.

WHAT CAN HAPPEN

Are you ready? Depending on the lawsuit and what the judge may deem to be vital to the case, a hold may be placed on messages during a specific time period from specific individuals. The actual number of individuals and the time period may often exceed what would be expected by the company and/or its IT department.

When such a ruling is handed down, your messages now become evidence, and your business must obey – all involved messages must be archived and stored. A decision must be made as to what will be archived and protected. Additionally, they must be tamper resistant – protected against manipulation and destruction.

Just as our users receive thousands of unwanted messages, so too may the court. Thus it is not usual for the ruling to limit the types of communication from specific individuals. Thus you may need to separate out communications to specific individuals about specific matters. This needs to be done both so as to meet the court order and protect your company.

MIS/IT may not want to filter all of those messages out, but it is necessary. Do not include any messages outside of the scope of the judge's ruling. It is most likely that if a message does not meet the imposed criteria it is not prudent to pass it along. The number of unscrupulous lawyers far exceeds the number of scrupulous lawyers and the likelihood of the communications haunting you vastly increases with each message read.

COMPANY POLICIES

It is vital then that each company has a retention policy put in place prior to such a ruling *and* that the policy is strictly adhered to. That may present a bigger problem than it at first seems. Consider why.

While the company may have a methodical organized policy in place, it does not mean that the end users will adhere to it. Punctilious users are a rare commodity. What if users retain messages on their local computer system stored as files? What if the client email software stores messages outside of the server such as in a PST file? The problem has now become daunting, because either way the court expects these messages to be archived.

How do you archive these messages if ordered to do so? A definite policy is the only way. The policy should encompass how data is to be stored, where it is to be stored and for how long. Perhaps a policy stating all data must be stored on the mail server is the solution. Why?

If users have messages stored on their computer that are inside the scope of the ruling, then these messages must now be extracted, stored, and archived. When a judge orders email messages stored, that means that the company email administrator becomes legally responsible to extract all messages, whether on the server or the local computer.

It also means that if a user inadvertently or unknowingly deletes a message within the scope of the ruling, they can cause irreparable damage to the company. In some cases they too may now become a named part of the lawsuit because of their actions. At minimum they can expect to be accused of tampering with evidence and possibly face the judge's wrath.

EMAIL RETENTION POLICY CHALLENGES

The email policy that is determined to be appropriate for each company must become an intricate part of the company's policies and procedures manual and duly enforced. Yet the real challenge is in getting each user to be aware of the *importance* of the policy and following it. This is not an easy task since users can generally be stereotyped into four categories:

• The user who believes that their actions are above the company policy, so the user stores every message in a PST file, or prints and stores it.

(Continued on Page 16)

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IT Guide

by Tren Barnett

Continued from Page 14

• The user who believes that their messages are personal information and what they do with them is none of the company's business.

• The user who is not judicious or prudent enough to keep their comments on a professional level and thus uses email to convey thoughts and ideas in an unprofessional manner.

• The user who forwards everything to themselves at home or stealthily forwards everything to an outsider.

The company's policies and procedures for email needs to consider the above described users. It also needs to take into consideration the capabilities of the email system that is in use. This in itself can be a challenge. Additionally, the quality of staff used in monitoring compliance plays a major role.

POLICY FRUSTRATORS

The best policies are only as good as the employees in charge of monitoring compliance and the authority entrusted to them. Those who are expected to oversee compliance with company policy are going to face challenges.

Consider the above mentioned stereotypes. Each one may now fall into different categories that present and even bigger challenge. Consider again four stereotypes:

• Those who will not delete anything out of an inordinate fear that they will need that item again later.

• Users who will not delete anything because they feel that proof is needed of all correspondence so that they cannot be held accountable for any failure.

• Users who are not savvy enough to delete items entirely.

• Users who delete everything because they feel that big brother is watching.

Any of these four types present a challenge and thus threatens the policy. While the user who deletes everything presents a problem, this problem is more easily overcome. The true threat comes for user who insist on keeping everything – even the "if you will forward this to 10 people, god will bless you" messages.

IMPLEMENTING POLICIES THAT WORK

Users present a challenge as described above, but what to do about it is yet more difficult. IT needs to be able to meet the requirements of the policy. In meeting these challenges, software and hardware changes may be needed.

The corporate lawyers may insist that the policy allow minimal retention of messages unless ordered otherwise by a judge. If the period that messages are kept is very long, then the cost of archiving data grows. If the period is too short, the challenge becomes enforcing the policy as users will become more likely to print and store message in other formats so that the content is not lost.

The final kink in implementing a policy is that many messages contain previous message content and so when a message is forwarded on, the previous message *still lives on* in the new message. Information cannot be merely destroyed upon date, but users need to understand the consequence of keeping a message alive through replies and forwards.

A CAREFUL APPROACH

Such problems can be addressed in the policies and procedures manual, but again it falls back to the policy and those enforcing it. If we go overboard then every message will be read and scrutinized. Certainly no business can afford this.

A happy medium needs to be found. Rules make for a tenser work place, so any policy can only go so far. Software and hardware alone can control much, but too much and the technology becomes useless.

The ultimate answer lies in training, communication, and team work. This is not the IT Department's problem, nor does the burden fall on the HR Department to impose policies. Everyone must be on board with the policy, and the software and hardware can assist.

THE FINAL FRONTIER

Do not be surprised if someday soon legislation starts mandating periods of retention for electronic data. With each new lawsuit the freedoms and joys of the Internet and computers disappear. Until those freedoms are challenged the solution is up to each company. Do not underestimate the value of a policy for electronic data now, before you are sued. Then, once the policy is in place, stand by it with no exceptions.

Whatever policy or decision that your company makes, it is critical that it is enforced consistently. Any variance to the policy leaves an open door for legal problems.

Finally, be reasonable and prudent, for extremes are also likely to cause problems. If you delete messages daily you will be more likely to be viewed suspiciously. If you are too lax, you are more likely to have your data used against you.

Tren Barnett is an experienced Systems Administrator and programmer in Tucson, Arizona. He can be reached at tpb@ironmind.net

RF Guide

by Phil Alexander

Is Antenna Modeling in Your Future?

Once upon a time we built arrays with nothing more than educated guesses about the tower base impedances.

Later, during the 1960's, operating impedance bridges came into general use. That was a major advance because, for the first time, we could actually measure the operating base impedance of each tower in an array after construction and preliminary tuning. That was better, and more accurate, but still time consuming because it is impossible to accurately measure the impedances until the array is aligned and impossible to align the array until the impedances are known.

The alternative was doing a rough alignment, a set of measurements, another alignment, more measurements etc., until finally we had achieved correct array performance as indicated by the antenna monitor. Then, after two, three or four weeks of field measurements we compiled enough data to prove construction permit compliance to the FCC.

A MORE EFFICIENT METHOD

Some months back, a consortium of consultants and group owners petitioned the FCC for revival of Docket 93-177. This followed a resurgence of the idea that computer modeling has evolved to the extent that it can be an invaluable aid for proving AM transmission system performance in today's environment,

It was hoped that the revival of the dormant Rulemaking at the FCC might allow modeling as an alternative to expensive and sometimes questionable directional pattern proofs of performance. If you are interested in the proposed changes in the Rules, they can be found in the AFCCE comments to the RM on the FCC website at: http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519559919 (Also see Clarence Beverage's article in the June issue of ***Radio Guide***.)

The gathering interest led to the first NAB AM Antenna Modeling Seminar during November in Washington, DC.

BRINGING THE EXPERTS TOGETHER

Conducted by Ron Rackley, Ben Dawson and Jerry Westberg, the seminar attracted a large cross section of the AFCCE, many group DOE's, and others from across the country.

Rackley and Dawson's contributions to the education of this generation of RF engineers through their NAB AM directional antenna seminars is well known by nearly all of the AM community as defining the present state of the art of AM DA systems.

Some may remember Jerry Westberg as Harris' last phasor guru before they quit the business. During that tour, Jerry developed software tools for phasor design and analysis and applied the NEC (Numerical Electromagnetic Code) programming to practical purposes for AM transmission system design. That work grew into a second enterprise where Jerry has conceived two of the most popular and useful AM transmission system modeling tools in use today – PhasorPro and DiplexerPro – while continuing work at his "day job" as a senior engineer with Broadcast Electronics.

MODELING THE FUTURE

The most recent "word" filtering out from FCC is that the Media Bureau staff favors the idea of a modeling alternative – it reduces their work – and that sections of the Rules may soon be rewritten to include that option.

That potential Rules change may have been the attraction for many attending the seminar, but the seminar program really focused on why computer modeling is an important tool, how it can aid the transmission system designer, and its role in improving the bandwidth of systems to meet the demands of IBOC transmission. Equally, the course showed what modeling could not do – and the tools that would help fill some of these gaps.

One point is very clear. Software and new techniques are not a substitute for knowledge and experience when it comes to transmission system design. No amount of investment in software will turn a neophyte engineer into a seasoned transmission system professional. All the programs combined cannot do some of the things good designers have learned through years of experience.

In short, if you want to design directional arrays, modeling programs are a great time saver and valuable analysis tool. But they are not a substitute for fundamental understanding of AM transmission systems or years of practical experience.

MODELING'S PITFALLS

Understanding the pitfalls of modeling is important because it can make system design look deceptively easy. Rackley pointed out several times that modeling math can suggest arrays and systems that appear to work but will not meet FCC criteria nor have a reasonable chance of operating as expected in the real world. Thus, modeling is very much like the Sorcerer's Broom in the hands of his apprentice. This is an important idea to remember.

Another surprising point is that the latest and most accurate software (NEC-4), which unlike the earlier version (NEC-2) can model a real ground system – but is too accurate! After all, the AM Rules began before broadcast engineers understood the knowledge gained over the past 50 years, and those assumptions remain part of our heritage today.

Over the years the FCC has included and embedded several propagation assumptions in the design formulas and approved procedures – thus we are constrained to the world of antennas operating over a perfectly conducting ground and with assumed standard losses, rather than the real thing. This is one of the reasons beginning pattern design with Carl Smith's catalog of directional patterns is probably a better departure point than seeing what can be created in one of the modeling programs.

MODELING'S STRENGTHS

So, if you are not Dawson or Rackley, how does Method of Moments (MOM) modeling help you? Should you take the time to learn the basics? Is there a justification for an investment in software? After spending two days at the Washington seminar I saw so many things modeling can do beyond pattern design that I came away with the opinion that there is very strong justification.

In fact, such modeling may become the most valuable tool in the AM transmission engineer's bag of tricks over the next decade.

The techniques of MOM modeling are embodied in the NEC and programs based on NEC allow very accurate solutions for all currents and voltages in all parts of a directional array from modeling of the dimensions and operating parameters in computer programs. Knowing the tower base impedances of any potential array during the design stage becomes simply a matter of understanding how to feed the physical data of the system into a modeling program.

MOM modeling can determine with exactness things we never knew in the past, until the construction and final tune-up of many of the DA arrays now in service were completed. The correlation between model predictions and the field results in actual systems are uncanny.

Provided a model is correctly constructed, if the measured data does not track closely with model predictions it may be time to begin looking for problems, not in the model, but in the real world. Things that plague DA construction such as incorrectly located towers, mis-aligned radials, pattern distortion from nearby power lines, or cell towers in need of detuning – all of these may cause substantial departures from the pattern expected from an array.

IMPROVED DA MEASUREMENTS

Some of us still think of the days after the introduction of operating impedance bridges as the "good old days." In the "bad old days," when many of our present DA arrays were built, we never knew exactly the base impedances of the individual towers even after construction and alignment.

Remember that tower base impedance measurements vary depending on the operation of the array. Unless the antenna monitor shows phase and current ratio values close to design values, the actual operating base impedances will vary, sometimes substantially, from the ones that will be measured when the pattern is working correctly. This variation places loads on the ATU's different from the loads they were designed to match.

The result is the ATU's do not produce their designed phase shift and impedance match, and errors cascade. It is the age-old problem of the chicken and the egg. You cannot read the operating base impedance until the array is working according to design – and you cannot make it work according to design until you know the operating base impedance of each tower, so the ATU's can be set to match their loads correctly.

MOM TO THE RESCUE

Suppose, on the other hand, you could know – during the design stage – the actual operating base impedances of each tower in an array to a high degree of precision? Knowing that data would make setting each ATU for its companion tower a simple matter of adjusting the ATU coils to calculated reactance values.

In a nutshell, that is how Jerry Westberg's PhasorPro can design a complete phasing system from nothing more than the operating constants of a DA array and the physical dimensions of the towers. This opens up a new world of precision and dramatically cuts the time needed for array adjustment after construction. This applies equally for new array construction and for upgrading or modifying existing arrays for better performance.

To give you a quick visual idea of where this is going, **Figure 1** is an example of the data an NEC/MOM program needs to produce the results shown in **Figure 2**.

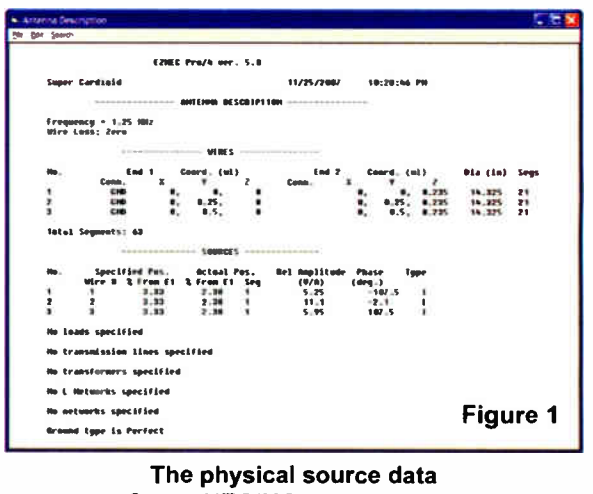


Figure 1

The physical source data for an NEC/MOM calculation.

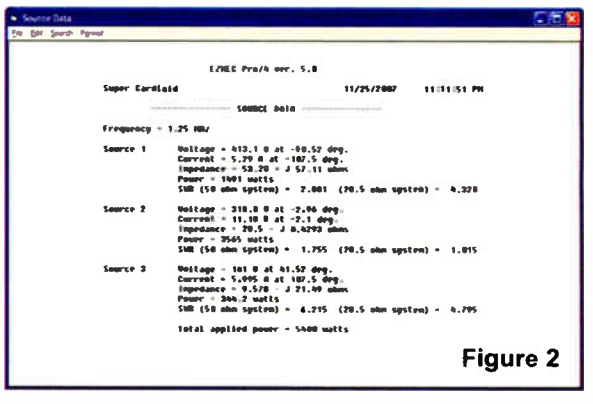


Figure 2

The resulting calculated base drive impedances and currents.

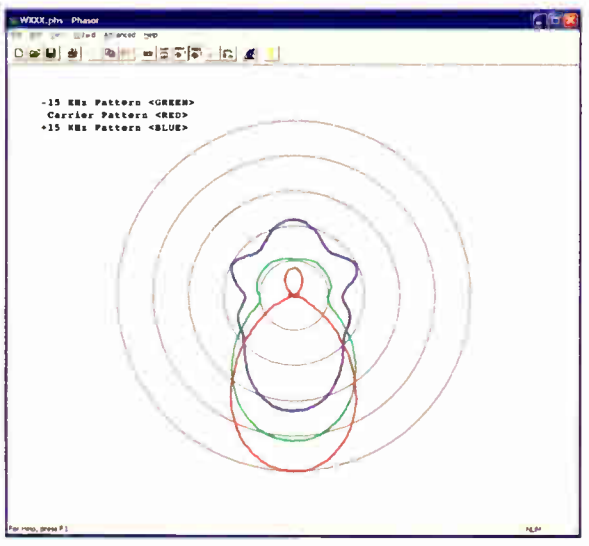
If that is not enough, MOM modeling also can show array pattern performance with a high degree of accuracy at the carrier frequency and at all other operating frequencies, especially in the spectrum occupied by the IBOC digital information. Without a wide impedance bandwidth and broad pattern bandwidth for these "sideband frequencies" interference may be excessive and transmitted digital signals may not successfully decode into listenable programming except very close to the transmitter site – if they decode at all.

(Continued on Page 20)

Continued from Page18

Is Antenna Modeling in Your Future?

As an example, the following figure shows a very bad pattern bandwidth case from the real world, disguised to protect both innocent and guilty.



A Pattern Bandwidth Horror

USE ALL THE TOOLS

One point made during the seminar was that MOM modeling programs alone are not enough for complete transmission system design and optimization.

Starting with the base impedances and tower currents the power and voltage of each transmission system branch can be calculated in a nodal analysis program such as Jerry Westberg's WCAP, the Westberg Circuit Analysis Program. This is a large matrix program that evaluates every node (junction) in a transmission system, permits final changes for optimization and gives precise information about the currents, voltages and power levels at each node, which, in a large system may number several hundred.

PUTTING MOM TO WORK

If you operate or are responsible for a directional array's adjustment and operation, learning MOM modeling is something you need to consider. If you construct or reconstruct directional arrays, MOM modeling can save untold hours during the pattern alignment stage, and may save far more in the proof of performance stage.

If you are doing pattern or transmission system design without the aid of MOM modeling tools you are working in the wrong century.

Finally, if you are trying to make DA arrays work with IBOC without modeling tools in your bag of tricks you have chosen the modern day equivalent of "Mission Impossible."

Having been a NEC-4 licensee for a couple of years and used modeling to explore unfamiliar arrays, I now can say working without modeling is like trying to walk through a dark transmitter room at 3:00 a.m. with the power out. Modeling is the switch that turns on the lights. Knowing what the operating base impedance of a tower should be – *before you connect the OIB* – is a true revelation.

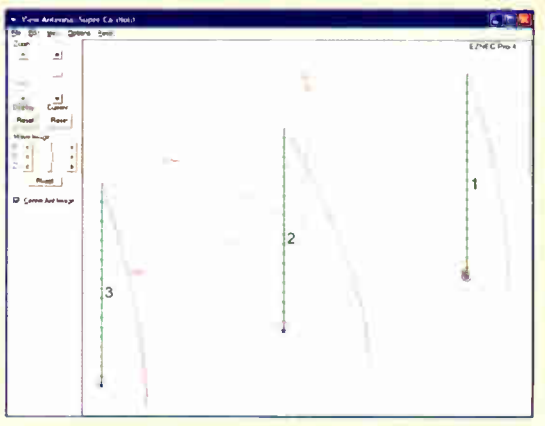
Phil Alexander, CSRE, AMD, is a regular contributor to the ***Radio Guide****. You can contact Phil at dynotherm@earthlink.net*

HOW MOM WORKS

MOM/NEC modeling uses wires; all structures must be converted to single wires or wire frames. Compared with military applications such as the stealth bombers, the broadcast applications of NEC are simple but can be daunting at first glance.

Modeling an entire tower is not necessary. Large cylindrical "wires" substitute for guyed towers without affecting accuracy. The Rule of Thumb is making the outer circumference of the "wire" the same length as the combined faces of the tower. For example, a tower with three two-foot faces is six feet around the outside, thus a "wire" with a six foot circumference makes a good substitute.

The ends of each and every wire in the system are specified in space using X, Y, and Z coordinates, and the wires are broken into segments. For broadcast work the usual number of segments in a tower "wire" is 20 or 21. The following figure shows the modeled structure of the hypothetical three tower super-cardioid array specified in **Figure 1**. The small green dots show the segment boundaries. *(Continued on Page 22)*



An array geometric model over perfect ground.

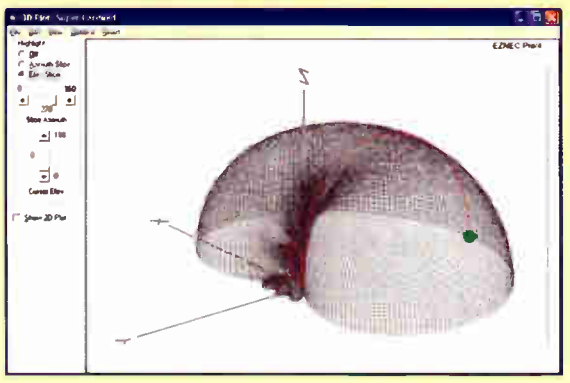
HOW MOM WORKS

Continued From Page 20

Modeling the ground system is unnecessary because the FCC assumes all arrays operate over a perfectly conducting ground. Look at **Figure 1** in the article and you will see this specification. Warning: it should be noted that self-supporting towers with large bases cannot be modeled using large diameter "wires" and must be modeled in some detail as lattice structures.

RUNNING THE NUMBERS

Source currents and phases are assigned and the total array power level specified. The program checks the geometry for errors in wire placement specification and, if the construction is valid, it calculates the currents, voltages and their phases for each segment of each wire. A fast computer with large memory speeds this process.

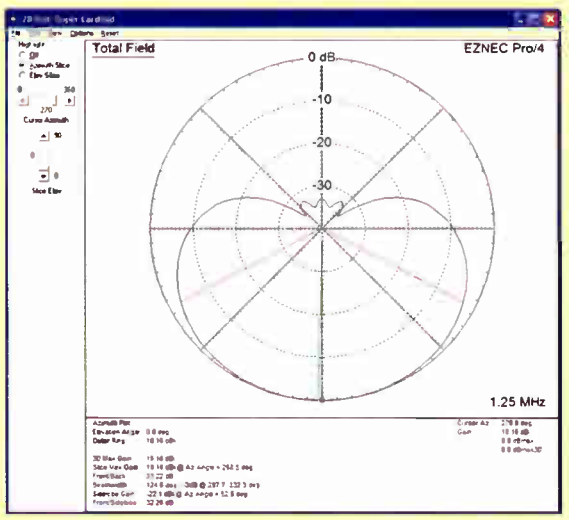


A 3D wire-frame view of array radiation.

The resulting current distribution is shown in the curved magenta lines attached to the top of each tower. With the current, voltage and phase information, the program determines operating tower base impedances, and calculates the far field radiation pattern over a perfectly conducting earth.

These views can be specified in increments of one to ten degrees; the smaller increments increase the computing power requirement. The program will print all of the information in tables showing an individual field strength data point for each degree of azimuth and elevation for the entire hemisphere above ground. (At one-degree increments for both that is 64,800 individual data points – and each is a very complex calculation.)

Conventional two dimensional views of the same pattern show more clearly the expected radiation.



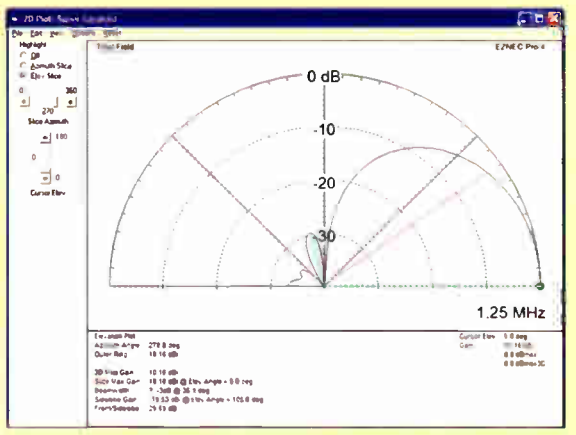
A pattern plot at zero elevation.

"WHAT IF?" ANALYSIS

This type of view is useful for understanding what happens to pattern shape when phases and current ratios are varied.

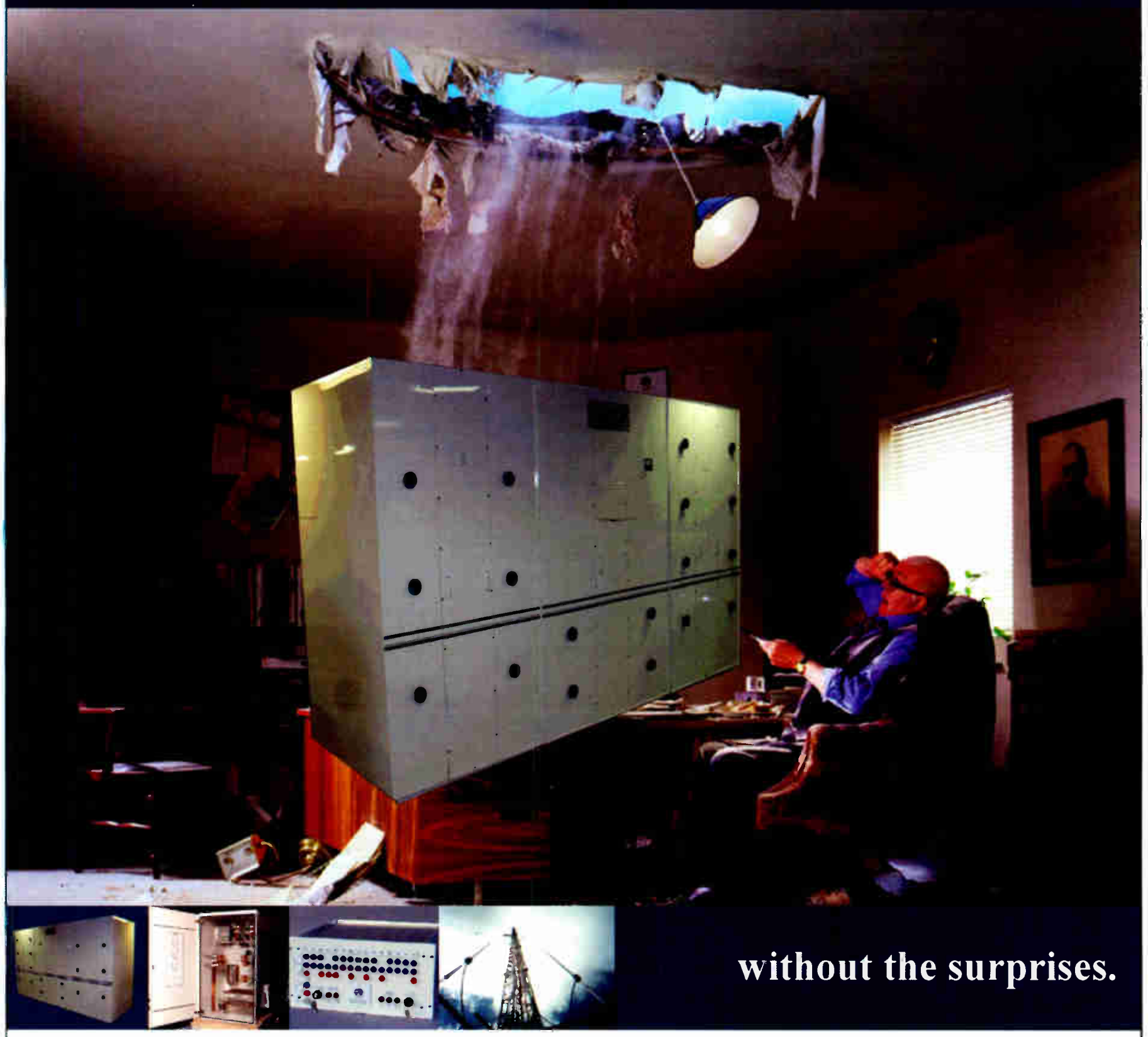
In many patterns finding legal combinations of operating parameters that skew the radiation result beyond acceptable levels is easy. Changing the tower constants in the model will predict where the pattern will wander if the same changes are made in antenna monitor readings.

For nighttime arrays high-angle radiation is always a major consideration, and the same can be said for daytime stations that seek improvement of their nighttime authorizations. The MOM model can accurately predict radiation at any departure angle and any azimuth. As an example, here is the result taking a vertical slice of the pattern along the line of the towers of the array we have been discussing.



An elevation "slice through the main azimuth.

AM Directional Systems...



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Digital Guide

by Kevin Tekel

Best Buy Enters the HD Radio Marketplace

Perhaps the slowest part of the HD rollout is in modestly priced receivers. Best Buy has brought two units into the under-$160 category. Kevin Tekel shares his opinion of their performance.

Consumer electronics retailer Best Buy has introduced two low-priced HD Radio receivers, sold under their house brand Insignia. One may be worth your attention; take a pass on the other.

Best Buy's Insignia NS-C5112

FIRST LOOK

At $119.99, the Insignia NS-C5112 car radio is the least expensive HD receiver on the market today. It identifies itself as built by "Huizhou Freeway Electronics" in China.

The Insignia car radio has a relatively uncluttered removable faceplate with logically arranged controls. Unfortunately, the buttons are small and the excessively bright, blue backlighting cannot be dimmed. A remote control is provided – and needed to access the EQ and Loudness features.

The remote is essential for some features.

FM RECEPTION

The FM tuner has commendable sensitivity and selectivity – especially for the radio's price. The tuner is surprisingly good at receiving even fringe-level signals in stereo with only a slight amount of background hiss and virtually no audible multipath. However, the weakest signals are drowned out by the radio's self-generated interference, so it is not a DXer's dream.

The FM HD tuner needs at least a moderately strong in-market signal to decode the HD audio. In central New Jersey, it was only able to decode one out-of-market signal in HD (from Allentown, PA), while all of the nearer New York City FM HD signals were able to be decoded. The threshold for decoding HD2 and HD3 streams seems to be the same as for HD1. A rough spot: cycling from HD2 back to HD1 via the "HD" button forces the radio to momentarily drop to analog reception and then blend back to HD1 digital.

To my ears, the allegedly "CD-quality" FM HD only sounded better than analog FM when the station devoted its entire digital bandwidth to a single HD stream. Stations with HD2 – and especially those with HD3 streams – usually sounded noticeably worse than analog FM – yet the Insignia offers no way to force analog reception.

The NS-C5112 does show HD PAD text data via the "DISP" button, but does not support RDS.

THE AM SECTION

If you are an AM radio fan, the Insignia HD car radio is not for you. The Insignia requires a strong, relatively noiseless signal to decode HD on AM. While it was able to decode four major NYC stations by day, decoding was intermittent at night.

Even on strong signals, the analog AM audio is very unpleasant; most of the time its brickwall cutoff of about 3 kHz restricts AM to telephone-quality audio. The Insignia does decode analog C-Quam AM Stereo, with nearly 40 dB of stereo separation, but the audio bandwidth does not widen in the presence of a C-Quam signal, leaving the stereo sound too low-fidelity to be enjoyed.

The worst part is that the AM audio mutes unless the PLL is able to lock onto the carrier. This silences the "hash" surrounding local HD signals, but also renders weaker signals too choppy to understand, as the audio keeps cutting out momentarily, especially during nighttime conditions. If your favorite AM stations are all analog, you will be disappointed by its very low-fidelity sound and frustrated by its inability to produce audio from weak signals.

ON THE SHELF

Best Buy's $159.99 Insignia HD shelf system is even more of a mixed bag. It has a visually appealing design and the speakers sound good for their small size, but it lacks headphone jacks or useful line outputs.

Worse, the radio is crippled by an unacceptably slow response time to its controls, most of them accessible only through a remote control burdened by small, poorly labeled buttons. Pushing the button to switch from AM to FM or vice-versa will result in a three-second delay before the tuner responds. And tuning across the band is a frustrating process, with about as much accuracy as trying to operate a cell phone while wearing mittens.

FM reception is decidedly substandard. Even though the shelf system's AM actually performs better than the car radio, if you are not within a station's city-grade contour, there will be little or no HD reception without a good external antenna. The AM audio bandwidth is actually wide enough to deliver pleasant audio (measured to be a constant 4.6 kHz). It does not mute weak signals and, like most HD Radio receivers on the market today, it decodes C-Quam AM Stereo, even on signals far too weak or noisy to decode HD.

THE BOTTOM LINE

So, of Best Buy's two house-brand HD Radio receivers, the surprisingly competent $119.99 Insignia car radio offers a lot of value for its price, including a front panel auxiliary input, customizable EQ settings, and good amplifier power. Although the FM section is decent, the AM will disappoint with low-fidelity on strong signals and no audio from weak ones.

On the other hand, the $159.99 Insignia shelf system is a disappointing dud, with an HD Radio decoder that is rendered ineffective by poor reception and placed inside a unit which will disappoint and frustrate the user as soon as it is turned on.

Kevin Tekel is a radio enthusiast in Somerset County, NJ. His longtime interest in audio, especially AM is displayed in his email address: amstereoexp@yahoo.com

Heavy Metal

by Stan Adams

Westinghouse

Up until the time that RCA bought the Victor Company and began marketing its own transmitters, the closest thing that General Electric could call a true competitor was the Westinghouse Electrical and Manufacturing Company.

Indeed, GE and Westinghouse were the real designers and builders of the much of the heavy metal built in the 1920s and into the early 1930s. Westinghouse never was the size of General Electric nor was it driven in quite the same way as GE, but it was large enough – and driven enough – to enter into our ongoing story.

GEORGE'S CHILD

The Westinghouse Electrical and Manufacturing Company was the "child" of George Westinghouse. Although he would come to own over 60 companies with combined assets of almost $200 million dollars, feeding a payroll of over 50,000 workers, Westinghouse died in 1918, without getting to see his company's work in electronics. In fact, Westinghouse lost control of his companies in 1907 to a financial panic and had severed all ties with his former companies by 1910.

Among his many accomplishments noted are his famous work in alternating current with the construction of the Niagara Falls generating station. He obtained exclusive rights to Nikola Tesla's patents for a polyphase system of alternating current in 1888, persuading the inventor to join the Westinghouse Electric Company.

There was opposition, at the first, from the public to the development of alternating current electricity. Critics, including direct current proponent Thomas Edison, argued that it was dangerous and a hazard to health. This idea was emphasized in the public mind by New York state's adoption of alternating current electrocution for capital crimes. Undeterred, Westinghouse proved the viability of alternating current electricity by having his company design and provide the lighting system for the entire Columbian Exposition in Chicago in 1893.

Westinghouse's company took on another industrial challenge when it was awarded a contract along with the Cataract Construction Company in 1893 to build three huge generators for harnessing the energy of the Niagara Falls water into electrical energy. Installation on this project began in April of 1895; by November of 1895 all three generators were completed. A year later, engineers at Buffalo closed the circuits that finally completed the process to bring power from Niagara.

Along with this work, there was that of the alternating current transformer which allowed the generation of high voltages and currents at the sub-station to be reduced at the customer end for use with smaller pieces of equipment. Electrification of the elevated rail lines and also railroads of the East and the use of railroad block signals are also to his credit.

INTO THE WIRELESS WORLD

Westinghouse Electric owes its introduction into the field of radio to Dr. Frank Conrad. Conrad was Assistant Chief Engineer of the company and located at the factory in East Pittsburg, PA. In the late 1910s and early months of 1920 Conrad was transmitting on a fairly well-established basis and could be considered one of the original pioneers, following in the shoes of Lee de Forest, Charles Herrold, and Reginald Fessenden.

Conrad was an early radio experimenter, much like many of the men and young boys of the day. After World War I, as tube receivers began to replace the crystal detectors of the early days, many people were listening for his amateur call of 8XK. At the same time, 9XM at the University of Wisconsin was a famous collegiate radio station.

When KDKA finally did come on the air in the late fall of 1920 it was with 100 watts of pure RF power from a "radio shack" on the roof of the East Pittsburg Plant, along with a tent for the studio performers and announcers. It worked. And it worked well enough to become a working model for many of the stations to follow. People were listening, from near and far.

PIONEERING WORK

Changes came fast at KDKA. The studio was moved truly indoors, to one of the rooms on the top floor of the building. The transmitter increased its power to 500 Watts, then 5,000 Watts, all in a span of about two years.

A famous KDKA line, used beginning on the night of the Harding-Cox election was: *"Will anyone hearing this broadcast please communicate with us, as we are anxious to know how far the broadcast is reaching and how it is being received."*

And they did. Cards and letters poured into the offices of the Westinghouse Company. Along with this came the rush of the public to purchase radios. All types of stores began to sell radio parts, kits and then the basic Westinghouse radio, a crystal set with a pair of phones. Westinghouse sold thousands of radios before they were approached by Owen Young of the RCA, GE, and AT&T combination (Westinghouse eventually became part of the RCA partners).

(Continued on Page 30)

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BROADCAST WAREHOUSE

Heavy Metal

by Stan Adams

Westinghouse

– Continued from Page 28 –

The Westinghouse Public Relations Department went into overdrive, announcing to any and all who would listen that KDKA was the first station to broadcast and was also first to do everything and anything else. Other pioneer stations from Detroit to San Jose, CA, and from Medford Hills (Boston), MA to Madison, WI were not impressed. But clearly the Westinghouse PR folks had a lot of money and influence. For almost 90 years, KDKA has been linked to the beginning of broadcasting.

WAS KDKA FIRST?

But for the simple sake of argument there are a number of firsts that we can attribute to KDKA and/or Westinghouse. In the opinion of this writer:

(1) While it is debatable about KDKA being the first "broadcast station," they definitely were among the very first stations when it came to management providing a well-defined staff and broadcast plan.

(2) Westinghouse was a competitor rather than a partner in the early RCA-GE Days. This points out the fact that they had research, products, and even some patents of their own to work with even before they became members of the RCA combine

(3) By bringing additional stations on the air so quickly after the birth of KDKA Westinghouse proved that they had a very strong interest in this new "hobby," which of course, was not a hobby at all.

(4) In fact, Westinghouse at this time in their existence was one of the very first concerns to realize that broadcasting would be a business on its own. They fostered that by manufacturing one of their first radios, known as the Aeriola Junior – a simple tuned capacitor and coil with a crystal detector and phones.

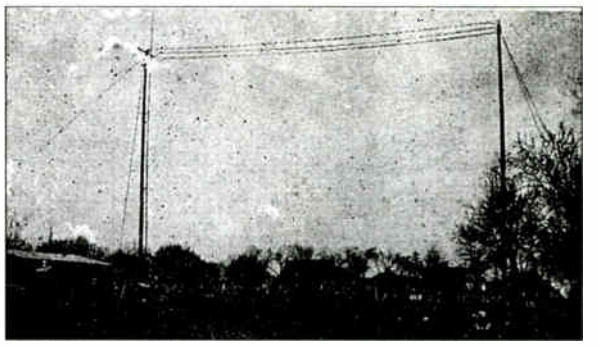
Westinghouse Aeriola Junior

One additional note at this point would be to acknowledge that Westinghouse, of all the radio equipment manufacturers during the First World War, built some of the most stable and efficient transmitters and receivers. This did not go without notice and, following the World War, Westinghouse had large contracts to furnish aviation radio sets for the Government.

BUILDING AN INDUSTRY

Right after KDKA, Westinghouse constructed its cousin stations: WBZ in Springfield/Boston, WJZ in Newark, NJ and KYW in Chicago. Westinghouse built these four medium wave stations before 1921 had ended, linking them up via medium and shortwave radio and dedicated landlines. Then, as a favor to the farming people of the Midwest, they build KFKX in Hastings, Nebraska.

A certain amount of consternation must have been felt by General Electric and its RCA partner, American Telephone, as they wondered just what was happening. Although both of these major corporations were in the game of radio, they must have been startled by the speed with which this unlooked-for "outsider" put up four operating stations and began selling radios by the thousands.



Westinghouse' KFKX brought radio closer to the farming community.

It was not all easy for Westinghouse. According to historian Thomas White, representatives from Westinghouse went to Washington, DC, to the Department of Commerce, to seek approval for their plan to have a frequency set aside for broadcasting from, and between, the various Westinghouse installations. L. R. Krum was to claim credit for proposing and lobbying for 360 meters (833 kHz) as the standard.

Although Westinghouse rapidly received four licenses for 360 meters, in the end the government decision was less satisfying: instead of a national "Westinghouse Frequency," the DOC had determined to put *all* the stations for the new broadcast service on 360 meters. And, of course, the industry grew from there.

WESTINGHOUSE AND RCA

Westinghouse had the Armstrong-Pupin patents, among others, and that was more than sufficient to merit a berth on the RCA train; Westinghouse wound up owning 20.6% of all the stock of the new RCA. Their share of manufacturing in the new venture would be a large amount: 40% of all radio sets.

(Continued on Page 32)

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Heavy Metal

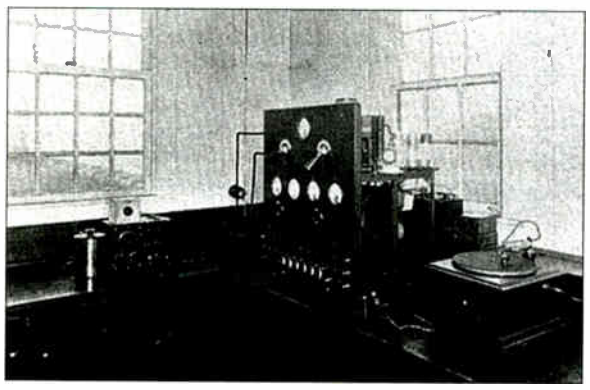
by Stan Adams

Westinghouse

– Continued from Page 30 –

It may also be worth mentioning here that Westinghouse built the first factory-equipped car radio for the Chevrolet car division of General Motors.

Meanwhile, as noted, progress was made on bigger and better transmitters. The original KDKA transmitter, a 100 Watt modulated oscillator, was converted to 500 Watts output in a matter of about three weeks.



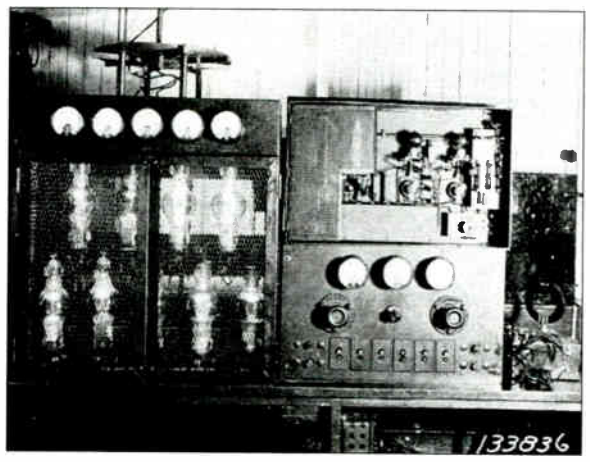
This transmitter served KDKA from 1921 to 1923.

This transmitter stayed in service as a main and auxiliary until October 1923.

TESTING GROUND

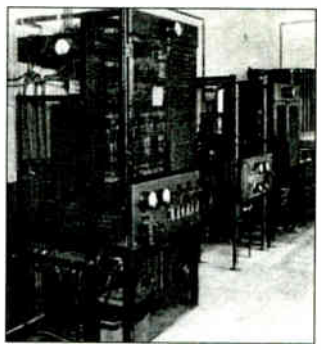
KDKA would not stay at 500 Watts for long. In our Heavy Metal articles about General Electric, we mentioned that WGY was the experimental station for GE. Similarly, KDKA was used the same way by Westinghouse to test the latest designs, incorporating more power output and better reliability.

By October of 1921 KDKA was operating with this 1 kW main transmitter. This was called "Number 1 Transmitter," and its power output was from 1/2 kW to 1 kW. Constant current modulation with modulated oscillator. Eventually they would have three transmitters rated from 1 to 10 kW.



KDKA's Number 1 Transmitter

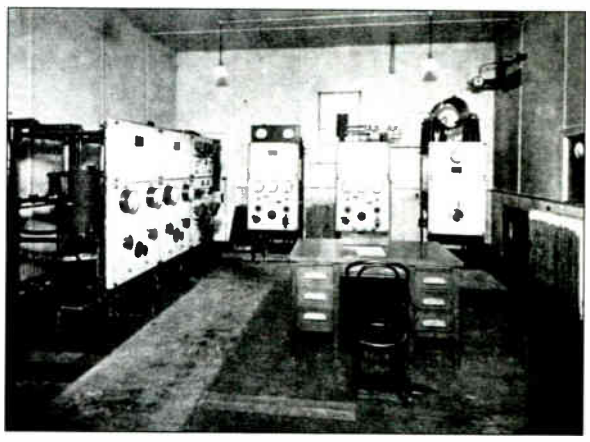
"Number 2" was another unit used on the air for several years. It was rated at 1.5 to 2 kW. As with Number 1, this transmitter was used until October 1923. Especially for the early 1920s, KDKA was equipped very well, and would not lose much air time due to equipment failure.



Number 2

PUTTING ON THE WATTS

Westinghouse engineers kept pushing the transmitter designs, just as the GE engineers did. Soon, KDKA sported a transmitter capable of 5 and 10 kW. Notice the peculiar construction of the gray slate fronts. Obviously this transmitter had all of the latest advances in design.



"Number 3" was capable of 5 and 10 kW output.

The tubes used in Number 3 were all W tubes and thus were all made by Westinghouse. But – believe it or not – by late 1923-early 1924 this transmitter was still using the constant current form of modulation. They apparently did not choose to implement a low level modulated RF stage, and Loy Barton's Class B system was yet to make the rounds of manufacturers.

(Continued on Page 34)

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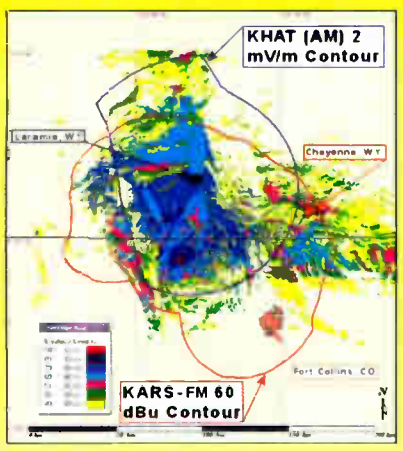

rfInvestigator is a tool for analyzing FCC spacing, FCC contours & much more! Population data, LULC data, terrain data, Longley-Rice models, Topo! maps & drive test data can all be displayed in **rfInvestigator.** It offers a host of advanced features, many of which are not found in similar programs or are offered as expensive additions, like a terrain profile tool and our antenna design tool that can automatically calculate your antenna pattern for you. Add our DB-Builder program and *never* buy another FCC database! Ever!

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Heavy Metal

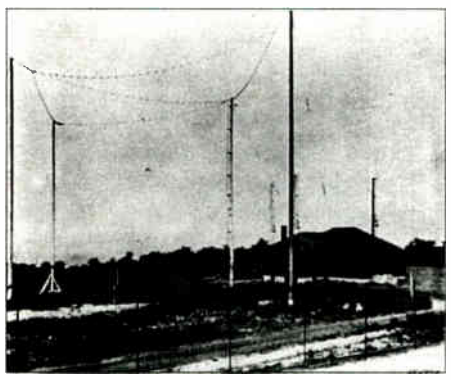
by Stan Adams

Westinghouse

– Continued from Page 32 –

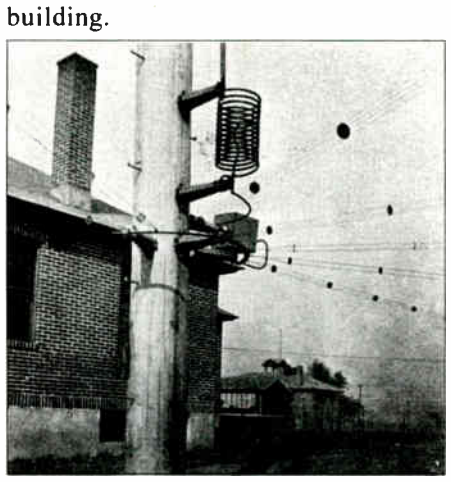
A NEW HOME

The following year, KDKA was ready for its own place, not some penthouse shack on the roof of a factory. Westinghouse bought some property and, by early 1925, KDKA found itself in some new digs:



Westinghouse built a site specifically for broadcast and shortwave services.

Note all of the antenna wires. In this building was housed not only medium wave broadcast equipment but also the shortwave equipment that was used as a way to service all of their affiliate stations. KDKA used more than a few wires to radiate. It might be of interest to see the Antenna Loading Coil and Ammeter, just outside the transmitter building.



The KDKA ATU and Ammeter

Of course, one might well wonder what happened when there was snow or ice build-up?

ON THE WAY TO REALLY HEAVY METAL

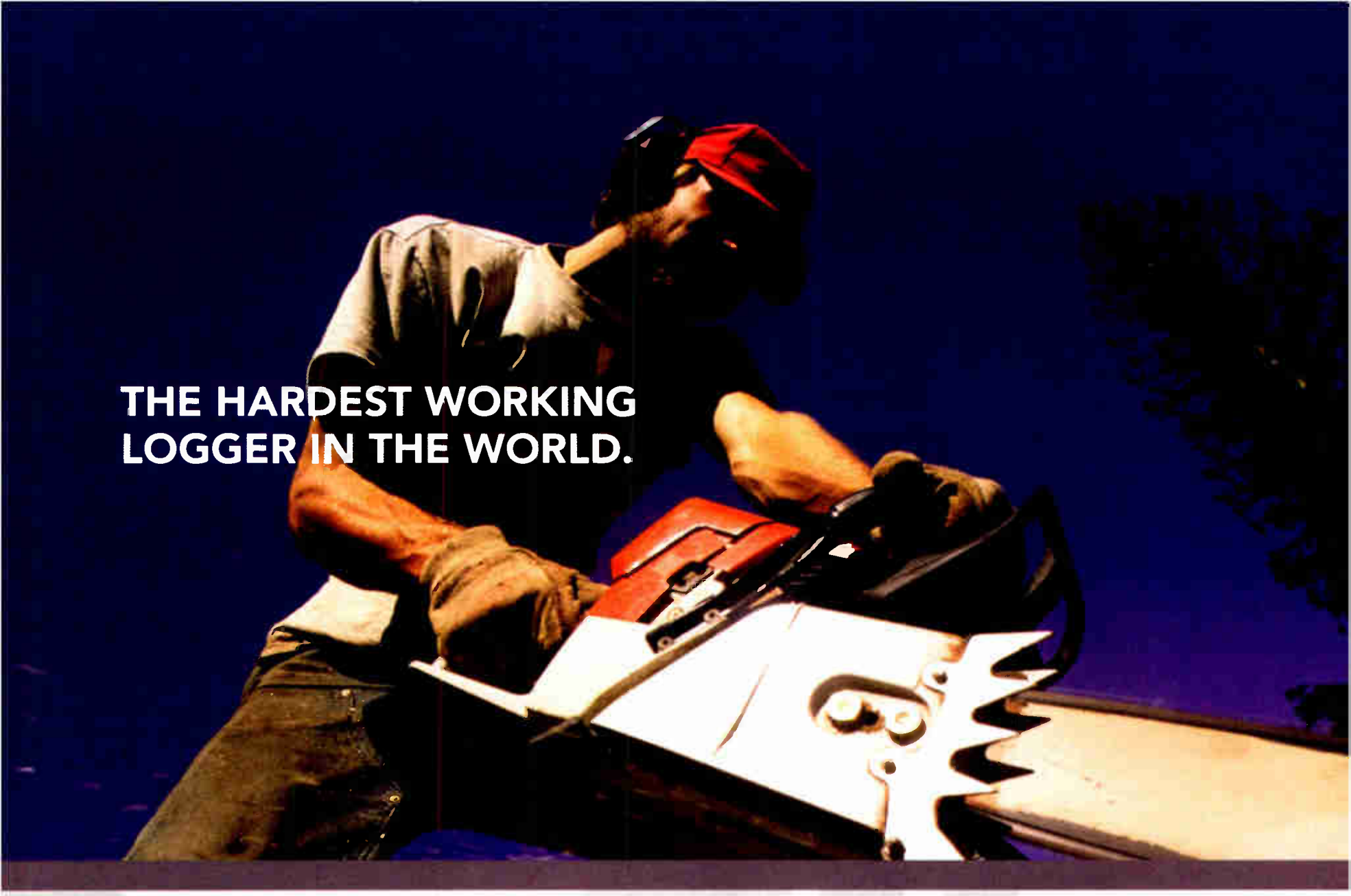
Finally, as laid out the articles about General Electric, we made mention that they made most of the transmission sets for RCA to sell. Well, those that were not GE were Westinghouse – and pictures of them are bit harder to find. But we did find one. It is the Westinghouse version of the RCA 5 kW transmitter installed at station KOL (now KKOL Seattle, WA).

The design and circuitry of KOL's Westinghouse 5 kW Transmitter, is essentially the same as RCA 5B made by GE. Our final picture comes from about the 1932 time frame and it shows perfectly the similar lines of the RCA 5B and the same cabinet layouts.

We still have several other Westinghouse transmitters to show you, both from the combined GE/ Westinghouse manufacturing time (for RCA), as well as some of the war production work and post World War II production of commercial products for some of the nation's greatest stations. Westinghouse will continue to be a leader in producing broadcast gear and, even as the manufacturing side starts to fade out, radio programming. In our next edition, we will watch as Westinghouse morphs into Group W. Please stay tuned – and do not change that radio dial!

Westinghouse made this RCA branded 5 kW transmitter.

Stan Adams' family has been involved in broadcasting since the 1940s. Stan would love to see your comments on the series. You may email Stan at: stanleyadams@yahoo.com



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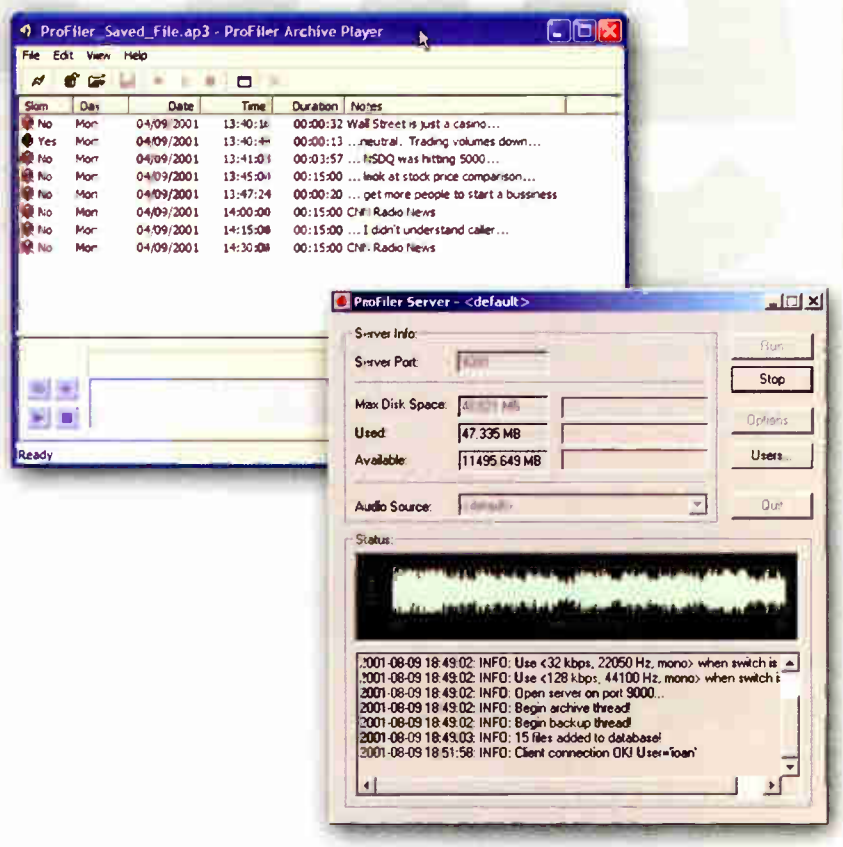

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Tool Guide

By Rick Heil

Test, Tools, Tips and Applications

Parallels Brings MS Windows to the Mac

Even Apple admits it: there are some times where you just need to run software on your Mac that is not available for OS X. Be it automation, logging, programming, you-name-it software – most Mac users will admit that sometimes it can be very difficult to find the software one wants.

There are some virtual machine solutions, but most are slow and cantankerous and almost not worth the license fee. But with Apple using their unique IBM/Motorola PowerPC line of processors, there was no choice for those who had to run Windows applications.

A NEW PLAYING FIELD

Ever since Apple announced they would be switching to Intel processors from their old Motorola PPC line in early 2006, there was speculation in the computer world about the possibility of running Windows on Apple's hardware. And, within a few months of the release, Internet newsgroups were abuzz with talk of the first set of crude hacks that allowed dual-booting with Windows.

Rejoicing abounded! We could finally run our applications in a stable, native environment. The disadvantage was that it was a crude hack and required a reboot. About a month later, Apple announced BootCamp – official software to do what those hacks were doing.

However, there is a notable disadvantage to running Windows under BootCamp – the reboot. One must shut down the computer and restart to switch between operating systems. Another disadvantage, although smaller, is the requirement to partition one's hard drive. For the average user, this is something that is done when BootCamp is installed and not touched, but gets the user into a debate about how much space to allocate to each operating system.

TRAVELING IN A PARALLELS UNIVERSE

Enter a new product specifically for the new Intel-processor-based Apple products – Parallels Desktop. With Parallels, a user can install any operating system they wish into this virtual machine (VM) – and the OS will never know it is virtual.

Parallels changes the fundamental workings of OS X to allow the processor and memory to be allocated differently. The user can either follow the Parallels' recommended amount of memory for that particular operating system or it can be customized at any time before starting the machine. Parallels allows a floppy drive to be connected to an image, DVD/CD drive "pass through" or image mounting, and virtual hard drives.

This virtual hard drive means that, although my Windows installation currently tells me there is 32 GB available, the image file on the real hard drive is only 9.18 GB. Parallels offers tools to compact the images to take up even less space. This allows me to have several different VMs installed without partitioning my hard drive enough to resemble Swiss cheese.

A WINDOWS WINDOW

I would think the most popular choice for a VM is MS Windows. I currently run Windows XP, Service Pack 2. It installed in about half an hour (about how long it takes for a real computer to install). It recognized all the Parallels virtual hardware and interfaces just fine.

You have three options of displaying Windows or Mac applications. Full Screen, Windowed Mode, and, possibly the best part of Parallels, "Coherence Mode." Essentially, Parallels takes the Windows desktop background away, leaving a normally-functioning Start Menu at the bottom of the screen. Windows applications float just like Mac applications do and have their own icon on the application switching shortcut Mac+Tab (similar to Alt+Tab in Windows).

Parallels runs Apple applications and Windows applications at the same time.

I find it much easier to use the integrated Mac and Windows applications in Coherence Mode than to switch back and forth to an almost full screen window when I want to use a Windows application. Copying and pasting between Mac and Windows applications is quick and easy.

Installing "Parallels Tools" gives the user great control over many aspects of how Parallels handles the VM. One that I especially like is being able to open Windows format files through Mac using "Smart Select." For instance, if I open a .css file on my Mac, it automatically starts Dreamweaver 8 (in Windows). It also allows for better sharing of files between operating systems.

Being a keyboard player and studying audio production, I was also curious as to how audio run between the systems sounded. There is virtually no added delay when using live output monitors in recording programs. I use the laptop with a USB keyboard controller for live performances with several bands, and the Native Instruments suite runs flawlessly.

Parallels gives you the best of each operating system.

Video also runs very well; I am able to watch DVD movies without any noticeable skips or lag. Parallels lets the user allocate up to 64 MB of video RAM per VM. The newest build of Parallels also features hardware-accelerated 3D graphics

MORE THAN WINDOWS

Parallels works brilliantly with Windows – I was sure of that. But part of me wanted to try Linux, just for the heck of it. So I downloaded the OpenSuSE 10.2 DVD (thanks to a wide-bandwidth internet connection), and mounted it as an image. Being new to Linux, I am sure I checked way too many boxes of packages to install, so it took about an hour to install and configure – but it runs like a dream.

A Linux box inside Parallels

This allows me to test drive Linux applications like Rivendell, an open-source automation system. It also lets me experiment with Linux – something I have not had much of a chance to do because I did not like the risk of messing up my Windows OS to dual-boot. If I do happen to do something horrible to the Linux machine, I do not have to worry – I can just wipe the hard drive image and start again.

Parallels Desktop is a great piece of software for Macs – it runs virtual machines smoothly and allows for greatly increased productivity and flexibility. Running Windows programs on Mac hardware is no longer just a dream!

More information on Parallels, as well as trial and fully operational software versions, can be found at www.parallels.com

Rick Heil is the Operations Manager and IT guy for WONY at the State University of New York at Oneonta. You can contact Rick at wonynerd@gmail.com

Enjoy the Experience

ADMS 44.22 Analog/AES Digital Matrix Switcher

WVRC-8 Web & Voice Remote Control System

Pro-Mix 12

WVRC-4 Web & Voice Remote Control System

SRC-16 Serial Remote Control

ADMS 44.22
Analog/AES Digital Matrix Switcher

The ADMS 44.22 is a four input stereo AES and four input stereo analog matrix switcher with two independent stereo analog and AES outputs in a 1-RU profile. Each input is equipped with a three band EQ, five types of filters and a leveler function. Any or all of the inputs may be mixed, faded, dimmed to either or both output pairs. Additional features include; selectable stereo VU meters; headphone amplifier; powered monitor output; 16 x 16 GPIO port and RS-232/USB port.

WVRC-8
Web & Voice Remote Control System

The WVRC-8 provides a cost-effective, eight channel solution for web based and/or recordable voice response dial-up transmitter site control. Each analog, status, silence sensor, temperture sensor and power failure input can be configured to email up to four individual email addresses allowing different input alarms to be routed to different email recipients.

WVRC-4
Web & Voice Remote Control System

The WVRC-4 is a four-channel version of the WVRC-8 in a half-rack profile.

SRC-16
Serial Remote Control

The Broadcast Tools® SRC-16 is a computer interface to the real world. Connection through an RS-232, RS-422 or RS-485 serial port with baud rates up to 38400, the SRC-16 can notify your PC software program that any of 16 optically isolated inputs has been opened or closed and allows your software to control sixteen SPDT, 1-amp relays. Two units can be operated in a standalone mode (master/slave mode) to form a "Relay extension cord," with sixteen channels of control in each direction.

Pro-Mix 12

The ProMix 12 is a feature-packed broadcast audio mixing console that is ideal for broadcast and audio production facilities needing an affordable, compact solution. The ProMix 12 comes in a small package, but is loaded with useful features including mix-minus outputs, an announce booth output with full duplex talkback, a monitor output, selectable mono, and mono operation on all line level stereo input channels. Whether you need a compact console for your on air applications, or a mixer for post-production or field work, the ProMix 12 is the right choice. We're confident that the ProMix 12 will provide many years of trouble free operation.

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ACT-2
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ADC-1
Analog to Digital Converter

The ADC-1 provides professional quality 24-bit A/D conversion. The ADC-1 is a perfect companion for converting the analog output of equipment (EAS encoders, etc) to stereo AES. The A/D converter may be configured for sample rates of 44.1 or 48kHz (32kHz may be special ordered) or an external word clock from 32 to 96kHz. The front panel is equipped with left and right analog input trimmers, LED level meters and power LED indicators. Recessed sample rate switch with LED indicators. The ADC-1 is powered by a surge protected internal bi-polar 15-vdc-power supply affording superior headroom and high definition audio. The ADC-1 may be set on a desktop, mounted on a wall or up to four units may be mounted on the optional RA-1, Rack-Able mounting shelf.

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INNOVATIVE PROBLEM SOLVING TOOLS FOR BROADCAST

PathfinderPC Audio Routing Software from Axia

by Igor Zukina

Routing systems are nothing new in the broadcast industry. Source routing systems can be used for virtually all tasks in the radio studio facility, such as reconfiguring a transmission chain, expanding available sources on the mixing console (x-selector), or creating a monitoring selector.

The router often needs to route program source as well as the General Purpose Input (GPI) and General Purpose Output (GPO) signals used for remote control and signaling. Traditionally, router control and user access is done through dedicated hardware panels.

Equipment manufacturers have their own philosophy behind routers and router control. Often the end user is stuck, unable to help themselves without "re-programming" help from the manufacturer. System changes or expansion, if possible, often have a price tag attached.

A LARGE PROJECT

Recently, I was involved in the design and setup of Axia digital studio systems for 21 radio stations. Our company was hired to configure and commission 42 studios and 21 Master Control rooms.

At first, it looked like quite a simple project – just repeat the same configuration 21 times. We discovered, though, that this would be quite a demanding project, as every station had its own "personality" and way of doing day-to-day radio business.

Fortunately, Axia's Ethernet-based Livewire system is a router by nature, so no additional hardware routing equipment is required. Studio system installation and configuration with Axia is extremely quick and simple.

SIMPLE SETUP

The Axia system is based on only a few key components, which are very easy to configure and use. After screwing all equipment into the racks, all you need to do to configure the system is connect your audio devices to the Axia audio nodes, which you can do with pre-made cables. There are no punch blocks, jumper leads, or patch bays, which helped us to keep the hardware portion of 21 station installations pretty much the same!

I like to say that there is a "punch tool" hidden inside each Axia node in the shape of a web-based (HTTP) configuration page, which also provides a precise record of the connections and configuration of the studio equipment. All sources that are connected to Axia are available to be "terminated" on any destination in the system. The Axia Livewire node is actually routing hardware, and you can route to any node output (destination) from any node input (source) in the facility.

With the Axia system audio nodes are spread across the facility as required, there is no centralized main frame, so wiring is extremely simple and localized to individual studios, or even an individual rack. An added benefit is that there is no problem with ground loops.

EASILY EXPANDABLE

The routing system can be configured simply for current needs. If, in the future, you need to connect additional equipment, just add an additional node to the system. Or if the audio equipment is already equipped with a Livewire interface, simply plug it in to the network.

Axia audio nodes are available in different 8x8 configurations. Inputs can be a choice of balanced stereo analog lines, AES/EBU, or mono microphone. All outputs are balanced stereo lines, except in the case of the AES/EBU node where, naturally, all inputs and outputs are AES/EBU.

If you need to connect General Purpose Input/Output (GPIO) there is a node designed specifically for this purpose; eight GPIO ports each with five logic inputs and five logic outputs (on/off logic, opto isolated). GPIO can be routed independently or assigned to an audio source and routed together with the audio.

ROUTING

Routing is truly distributed and, from an expansion point of view, linear. No complicated mainframes or expensive x,y configurations. Redundancy is also native to the system as system sources are spread across individual nodes; a fault on an individual node will not affect the other nodes in any way.

Router control and user interface is provided through a separate cost effective software system called PathfinderPC. PathfinderPC is a suite of client-server applications that talks to the Livewire network's individual Axia nodes and is able to dynamically configure many system parameters, including the source-destination route.

PathfinderPC's Routing table, selector and metering provides access to everything.

The Livewire system is audio – and GPIO – level aware, so PathfinderPC can use this information to make "intelligent" decisions. The configuration of PathfinderPC and its logic is carried out through a series of configuration wizards.

PATHFINDERPC – PROBLEM SOLVER

Every radio station's technician experiences some kind of demand from their program director to provide systems which will give the station some technical edge over the competition, or help them to achieve some tasks more efficiently – and they usually want it yesterday.

As techs, we usually prefer to find an off-the-shelf "black box" solution, but often end up trying to design and make our *own* black box to sort out our problem. Sometimes our automation system or mixing console manufacturer can help us eventually and, given enough financial incentive, make both our PD and our accountant very unhappy.

I have discovered that it is possible to meet 90% of these demands simply by configuring the studio system using PathfinderPC – and with literally no budget expense. How often during an installation have you come up against a brick wall where you needed to create some special logic or special pulse to control some device? The insidious black box used to be the only solution, but not any longer.

PATHFINDER CONTROL

PathfinderPC contains a relatively simple method of creating conditional events which may be scheduled. In this way we can configure and schedule our routing system to carry out complicated tasks.

In fact, PathfinderPC can control most system features. Some of the more important ones include:

- Audio node source and destination routing.
- GPIO port pin-to-pin routing.
- Audio signal level, silence monitoring, and conditional logic.
- Axia Element console Show Profiles and GPIO profiles (direct Element channels x-routing is not supported yet).
- Axia IP-Audio Driver record-source routing and GPIO control.
- Virtual mixer control.

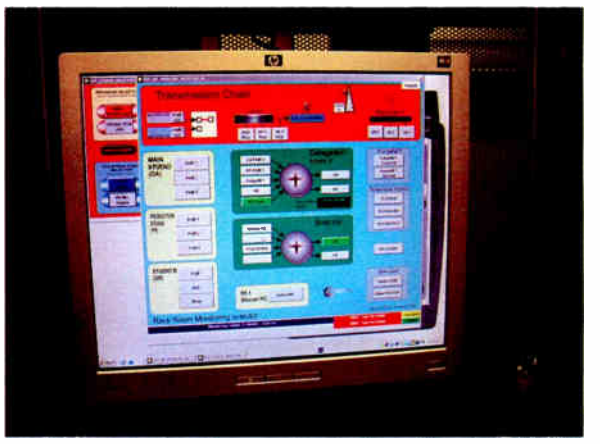
In terms of user interface, there are two client applications available; *Pathfinder* (which is more technical), and *Pathfinder Mini* (which provides access to on-screen "soft panels" that can be used by operators and studio staff).

Pathfinder is a purely software control solution; however, Axia has a number of hardware panel options which are also controlled via Pathfinder. The ones I like best are the LCD "smart" button panels whose properties can be fully controlled by Pathfinder. Combinations of "soft" (on-screen) and "hard" panels can be used.

REAL WORLD APPLICATION

A large routing selector is most commonly found in the Master Control room, where it is used for control and monitoring of the whole station infrastructure. Here we usually need to have instant access to key points in the transmission chain and in the studios. Historically, a custom panel with some kind of screen printed block diagram was made and selector buttons placed on the panel.

For our project we created two panels: one purely a status and monitoring selector panel, the second a program chain selector, which also includes a contribution network send source selector.



A selector panel on an LCD monitor in the equipment rack.

The monitoring panel is displayed on an LCD screen in the rack where the monitoring lives. The actual application that runs the panel is Pathfinder Mini. Two shortcuts on the desktop enable access to both panels. Some stations have touch-screen VGA monitors, others use a standard mouse or touchpad.

EASY LEARNING CURVE

With PathfinderPC, this can be done very elegantly on a standard PC with no additional hardware required. In our case, we created our own Soft Panel. A block diagram graphic was created in CorelDraw and imported into the PathfinderPC panel creator, where buttons and labels were edited and placed over the drawing – and very quickly our panel was done.

I am not a software programmer, but I was able to configure and create these complicated functions with no external help. The guys from Axia created a very good manual, with examples of how and how not to use PathfinderPC; that was sufficient for me to create and test a basic concept in one afternoon.

The Pathfinder Panel Creator is a simple visual editing tool which enables quick configuration of labels and button properties. To bring the panel to life, button logic is created using the "stacked events" in Pathfinder Server. The resulting wizards produce XML-based scripts. However, you do not need to understand XML in order to be able to use and configure events in Pathfinder Server.

(Continued on Page 40)

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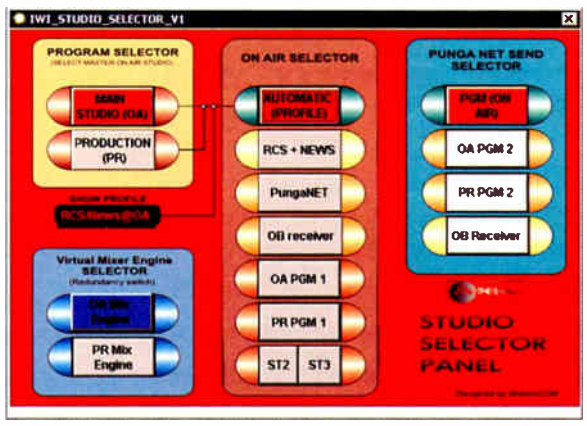


Pathfinder mini-studio On-Air Selector and contribution network send selector.

No matter which method of activation is used, pushing the button on the screen causes Pathfinder to re-route a selected source to the node destination where the monitoring speakers and meters are connected. The panel in our example actually controls two outputs; one is a monitoring output in the rack, and the second is a remote monitoring output via Skype. When monitoring is done remotely, the rack room speakers can be detached from the selector.

VIRTUAL MIXER FOR REMOTES

Another handy application is an Outside Broadcast (Remote) mixer panel. The mixer is created using three blocks of a Virtual Mixer which is part of the Axia studio mix engine. There are five mixer channels available; remote operators can turn a channel on and off, preview a channel and select a source to send to the transmission chain, all from the field.

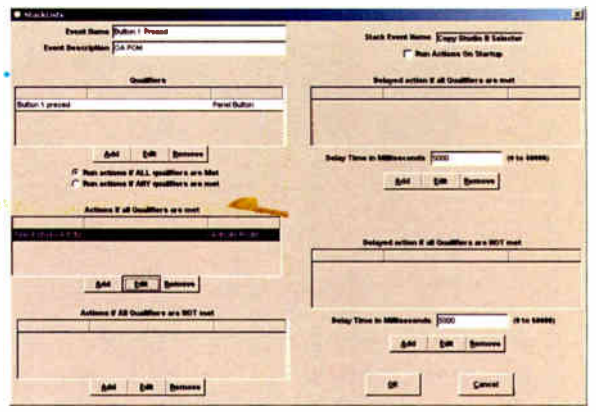
Audio connection is via the public Internet, and a standard audio IP codec is used for the audio link. A channel's fade-in and fade-out time can be configured in the PathfinderPC script. The remote panel is really a thin client, so even an Internet connection over cell phone can be used for activation.

A Pathfinder Mini mixer panel for remotes.

A MUST-HAVE TOOL

How many times have you been called out in the middle of the night because the station was off-air, with the only solution to jump in to the car and drive in to work to fix it?

An Internet connection and PathfinderPC can help do away with that. The Pathfinder Server can be configured to detect silence, fire off a backup source and reroute it to the transmitter chain. The Pathfinder Server can also send an e-mail message when a targeted event happens.



The Pathfinder Server Stack List Controls Editor builds logic events.

After more than one year of using PathfinderPC, I am finding it a valuable part of my tool kit. It is a great tool for quick diagnoses and for remotely returning a station to air. If you need to support multiple sites, PathfinderPC can easily be configured to remotely connect to each individual site.

Using the Pathfinder system, you can have full remote control of all routers (audio and GPIO). The system can also control third party devices such as video routers.

The list price of the PathfinderPC software is $1,095.00. Client applications can be used on as many PCs as you need with no extra cost or licenses involved. Support is excellent, and the application updates are frequent and free of charge. PathfinderPC is a great software companion to an already versatile and flexible Axia digital routing studio system.

Igor Zukina is the Broadcasting IT engineer for StreamCom, New Zealand, a technical management and support company for radio stations. He is directly involved in Axia system design and support for AVC-group customers in New Zealand and Australia. He can be reached at igor@streamcom.com

Audioarts Engineering Air 2+ Console

by Mike Erickson

As a full time engineer and a part time on-air personality, I sometimes end up taking my work home from both sides of the fence. Sometimes I test some audio gear, sometimes I end up recording full-length shows to cover my own absence.

My home studio consisted of a Mackie mixer and a source switcher harvested from an 80s stereo system. The system worked, but was very confusing and complicated for anyone else who wanted to use the studio.

Unlike the rotary consoles I was offered from run-down transmitter sites (and passed up over the years), I yearned (yes, yearned) for something more elegant for home use. The Audioarts Air 2+ fit the bill.

A PERFECT FIT

The console arrived well-packed, direct from Wheatstone. Three other engineers interested in the console gathered with me for the install in my home studio.

All of the consumer line-level input and outputs were wired in about the time you would need to wire a remote, literally 10 to 15 minutes – redefining plug and play! The PCs used balanced TRS plugs that we matched using Henry Boxes. It was the same for an auxiliary input we wired for a friend who records some production items and uses an Instant Replay.

The Audioarts Air 2+

Each channel could be assigned to either program buss or both program busses at the same time. The built-in cue speaker was a plus; no more pre-monitoring off an auxiliary buss on the Mackie.

All of the other features of a full-fledged console – monitor muting for microphones, talkback, impulse starts, external monitor inputs; mix-minus for phone hybrids – are there, making the Air 2+ a bargain. The clincher? RCA phono jacks on all but the microphone inputs.

MATING THE MICS

The microphone inputs were a little more tricky. I use a Symmetrix 528E for my Shure SM58 and a Hnat Hindes Mic Maze for my SM7.

The Air 2+ has two preamps built into the back of the console on Phoenix jacks. The idea (although it is not documented well) is to bring the microphone audio to the Phoenix jack, then take the RCA phono output labeled "MIC OUT" and insert the microphone audio into whichever of the 12 channels you want to bring the audio up on. We thought we would have enough gain out of the microphone processors to go directly in, but that was not the case.

We ended up using the built-in preamp with the microphone processor. Fortunately, the audio is very clean. In fact, it is as clean – if not cleaner – than the preamps in the previous mixer. Outputs are also on Phoenix connectors. Each program buss feeds an 8X2 DA which, in turn, feeds the equipment requiring audio from that particular buss, eliminating the cheesy (and not as clean) stereo consumer switching device that I had been using to feed recording and streaming devices, including two PCs, a mini-disc, and a cassette deck.

MINOR QUIBBLES

If I had any beefs about the console, the documentation about the implementation of microphone audio would be one. Another would be the rear panel, which should be an easier flip up. Currently it is a multiple screw-on panel that makes it more difficult to reach the connectors.

I would also secure the DC plug to the console in a better way. It is currently a DIN connector that did fall out once while we were installing the console. The power supply is external in the form similar to that of a laptop. The outlet plug is a traditional three-prong, not a wall wart.

A VERY HAPPY USER

All in all, the project took a little more than four hours to complete from the time we set the console until the last recorder was balanced with tone.

The audio sounds great, there is lots of headroom, and the console feels like something that costs a lot more than I paid for it. As a ham operator, I have used my 2-meter rig near the console and have not had any problems with RF issues with the unbalanced consumer inputs.

For educationals, LPFM, home studios, or even your main studio, the Audioarts Air 2+ is a great console that does a good job without doing a job on the bottom line.

Mike Erickson, President of Long Island Broadcasters Wireless Inc., is an experienced New York City radio engineer. Contact Mike at wirelessmedia@gmail.com

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Radio Systems' Millenium Livewire Consoles

by Tim Starliper

WMSS is the student-run radio station of the Middletown Area School district, staffed by students in grades 7 through 12. Recently, a new Middle School was built to replace the one in which we had been located, which meant new studios for us.

As part of the move, we decided we would replace our existing consoles with newer, digital consoles as part of the relocation. Thus, the search was on to find the best console for our station.

SETTLING ON THE MILLENIUM DIGITAL

We had several requirements, including ease of use, reliability, and low cost. We also wanted flexibility and something that was easy to expand. We eventually settled on the Radio Systems Millenium Livewire console.

We did have concerns about going with a new product – we have had several bad experiences in the past with newly introduced hardware and were a bit gun shy. However, prior to purchasing the consoles, a considerable amount of time was spent talking with Dan Braverman from Radio Systems. Dan provided plenty of pre-sales information on the console and Livewire systems and how the two integrated with each other. We also liked the look of the console and, in the end, chose our new main studio furniture based on the colors of the console.

The Millenium Livewire Console

The combination of the Millenium console with the Livewire nodes enabled us to design a flexible studio setup, without breaking the bank. We settled on an 18 channel console for our air studio, and a 12 channel console for the production studio. We also chose an Axia AES node, an Axia analog node and an Axia GPIO node to complete our system.

A QUICK INSTALL

Once the consoles arrived, we were passing audio within about an hour. Installation was a breeze. The RJ-45 connectors for the console inputs and outputs integrated easily with the Studio Hub (also from Radio Systems). We found the Radio Systems consoles easy to configure – despite the many options available.

The modular nature makes them very flexible; we can easily change any channel from analog to digital by swapping out a card. Each Millenium Livewire console also integrates an Axia digital node. This node appears on the last six faders on the console and can give access to any of the sources on the network.

The Livewire configuration sets up the sources you want to appear on the console's six Livewire channels. In this configuration you also define the source names and how they behave, such as generating a mix-minus by using one of the utility outputs.

The one thing not in the console is the main power supply – this is a separate, rack-mounted item that keeps a good deal of heat, and a potential source of interference, out of the console.

LOOK AND FEEL

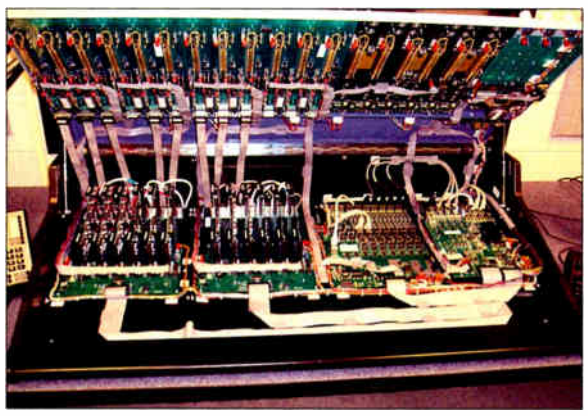
The clean looking consoles are very well constructed – very important for something that will be used largely by teenagers. The faders have a nice feel to them. The buttons have a soft touch to them, and the LED lighting in the indicators is clear and bright.

The selectors and level controls for the monitor, headphones, and cue are on the right side. The cue speaker is above this part of the console. This is one area of the console I would like to have seen done differently – I think the level controls would be better placed right below the cue speaker, instead of along the front edge of the console.

FLEXIBLE OPERATION

The console program and audition outputs are available as both digital and analog outputs, both of which can be active at the same time. The analog program output goes to a DA to feed some of our tape devices, while the digital outputs feed the Livewire node in the console, making them available anywhere on the network.

There are also ten utility outputs, which are paired on their RJ-45 jacks. There are also two monitor outputs, with different muting available on each. One is a full mute, the other is a dimmed monitor, which can be set to full mute by adjusting it to dim the output the whole way down.



The console interior is modular and easy to access.

There are also additional external inputs that can be switched to the headphones or monitor speakers, useful for a feed from an off-air receiver or anything else you may want the on-air staff to be able to monitor.

Each channel of the console (except the Livewire channels) also has remote start/stop (and tally) functions so you can trigger equipment based on channel status. These are accomplished by 15-pin D style connectors, which are extended by the use of ribbon cables that Radio Systems supplied with the consoles, along with mating 15-pin connectors and shells.

THE LIVEWIRE CONNECTION

On the subject of networking – ideally the consoles should be on a subnetwork by themselves – they generate a *lot* of traffic. There is constant communication between the Livewire components, which increases considerably when there is audio being passed over the network link.

This network link is also the means to configure the Livewire node built into each console. Unless you want to put a PC on the same subnetwork as the consoles and other Livewire nodes, you will want to make sure you configure a subnet mask and default gateway into the consoles.

When our consoles arrived from the factory, they had our IP addresses in them (I had provided them to Radio Systems), however they did not have the subnet mask and gateway address configured. Once I added those parameters, I was able to access the configuration from the user subnetwork in the radio station.

The configuration interface is another area I would like to see improved. The network accessible configuration is for the Livewire node only. To configure other console parameters requires a PC with a serial port, an adapter (provided with the console), and an RJ-45 straight through patch cord. If this could somehow be incorporated into the network configuration, that would make changes and adjustments much easier.

SETTING THE SCENE

In addition to configuring the console audio sources, you also can configure one of eight "scene" preset buttons for the six Livewire channels. Each of these can be configured to change one or more of the Livewire channels. Options include the channel source, the buss the channel is placed on, whether or not the channel is in cue, and even whether or not the channel is turned on.

I assigned one scene at WMSS for sports. This brings up our three telephone devices (a Tieline and two Gentner hybrids) plus our RPU into the first four Livewire channels. At the same time, it turns the channels off and places them all in cue.

When configuring a scene, one of the options is whether or not you want to lock the scene's settings. I chose not to do so. If you do have the scene settings locked, as long as the scene is active (the LED on the scene button is on when the scene is active), you cannot change the channel settings. Pressing the scene button again will turn off the scene, leaving the channels unchanged.

PLENTY OF FLEXIBILITY

In addition to the Livewire configuration, there are many console parameters that can be configured via an RS-232 interface using the supplied adapter, an RJ-45 straight through cable, and software supplied with the console.

For example, there are settings to trim or boost the input audio levels or configure the utility busses for mix-minus operation. Each utility buss can have as many channels as you want feeding it, plus you can select pre- or post-fader audio for each channel. Each buss also has an alternate configuration that can be triggered by a specific event.

In our case, we are using six of the utility busses as mono mix-minus feeds for our telephone interfaces. Each buss is tied to a specific channel, and through configuration of the sources, we can have the correct mix-minus fed to the device on the channel. We have the utility busses set to switch to the alternate configuration when the cue button is pressed. This configuration feeds the main microphone audio, pre-fader, to the telephone device, giving us a talk-back function.

ROOM TO GROW

I have only touched the surface of what these consoles are capable of doing and the features they have. Radio Systems has produced an excellent product with the integration of the Axia Livewire node into the Millenium digital consoles.

While, as I mentioned, there are some areas which I feel could be improved, there is nothing that makes me regret our decision to go with these consoles for our new studios. The service we have received, both before and after the sale, has been outstanding. The performance of the consoles has been outstanding as well.

As we bring these studios fully on-line and on the air, I am sure I will be spending time on the phone and exchanging e-mails with Radio Systems as I learn more about the features and ways to fine tune the configurations of the consoles. They have been very responsive to my questions so far, and I have no reason to expect that to change.

Tim Starliper is the Chief Engineer of WMSS in Middletown, PA. Contact Tim at rtstarliper@wmssfm.com

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Administer this • The beauty of the Web is that you can get information anywhere. Same thing with Axia: you can set up and **administer an entire building full of Axia equipment** – audio nodes consoles virtual routers whatever – from your own comfy office chair. All you need is a standard Web browser (PC or Mac we like 'em both). Put an Internet gateway in your Axia network and you can even tweak stuff remotely from home or anywhere there's a Net connection. Hey, isn't it time for a Mochachino?

It's not rude to point • Little kids tell mommy what they want by pointing – a pretty intuitive way of doing things. PathfinderPC software gives talent the same convenience. You can **build custom "button panels"** to execute complex operations with just one click. You can map these panels to controller modules on Element consoles or to turret mounted controls, place mini applications on studio computer screens, even run them on touchscreen monitors.

Automation station • Wouldn't it be cool to have a **self-monitoring air chain with silence-sense** that can fix problems then e-mail a status report? To be able to switch your program feed from Studio A to Studio B with one button? Or build custom switching apps and scheduled scene changes based on Boolean logic and stacking events? PathfinderPC software does all these things and more. But unlike HAL 9000, it doesn't talk back to you.

Nothin' but Net • Did you know you can plug a PC directly into an IP-Audio network to exchange audio? Can't do that with a mainframe router. Well, you *could* add more input cards to the mainframe, buy high-end audio cards and run more wiring... but with Axia, you just install the **IP-Audio Driver** on any Windows PC to send and receive pure digital audio right through the PC's Ethernet port — no sound card required or additional router inputs needed. The single-stream version is great for audio workstations; the multi-stream version lets you send and record **16 stereo channels simultaneously** — perfect for digital automation systems.

Put that in your pipe • How many discrete wires can a CAT-6 cable replace? Well, a T-3 data link has 44.7 Mbps of throughput. But Axia networks' Gigabit Ethernet links give 1000 Mbps of throughput between studios — more than 22 times the capacity of a T-3, enough for 250 stereo channels per link — the equivalent of a **500-pair bundle on one skinny piece of CAT-6**. Use media converters and optical fiber for even higher signal density. Think that might save a little coin in a multi-studio build-out?

Jammin' on the mic • Radio studios and microphones go together like Homer Simpson and donuts. Unfortunately, so do preamps, mic compressors, EQ boxes, de-essers — let's face it: most studios house more flying saucers than Area 51. Axia helps clean up the clutter by including mic preamps with our Microphone Nodes, not bargain-basement units either, but **studio grade preamps** with headroom enough to handle Chaka Kahn. Phantom power, too. And if you choose to use Axia Element consoles in your studios, you'll find world-class mic processing built right in: vocal dynamics (compression and de-essing) from the audio processing gurus at Omnia, plus three-band parametric EQ with SmartQ, available on every mic input. Rap on, Grandmaster.

Very logical, Captain • Routing logic with audio used to be as hard as performing the Vulcan Mind Meld. But Axia makes it simple, converting machine logic to data and pairing it with audio streams. So **logic follows audio throughout the facility** on Axia's switched Ethernet backbone. Eight assignable GPI/GPO logic ports, each with five opto-isolated inputs/outputs, are built into every Element power supply, so you can control on-air lights, monitor mutes, CD players, DAT decks, profanity delays, etc. Got more than eight audio devices? Add a GPIO node like this one wherever you've got gear.

Level headed • These green, bouncing dots built into every Axia Audio Node are confidence meters. One glance and you know whether an audio source is really active — or just playing possum.

AES yes • You like your audio to stay digital as much as possible, right? We get that; our AES/EBU Audio Nodes let you plug AES3 sources right into the network. Studio-grade sample-rate converters are inside; anything from **32 kHz to 96 kHz** will work. Oh, and there are 8 AES ins + 8 AES outs in each node. Digital distribution amp, anyone?

Heavyweight champion • This Axia StudioEngine works with our Element Modular Consoles (the fastest growing console brand in the world, by the way) to direct multiple simultaneous inputs and outputs, mix audio, apply EQ, process voice dynamics, and generate multiple mix-minuses and monitor feeds on the fly. To make sure it delivers the reliability and ultra-low latency broadcast audio demands, we powered the StudioEngine with a fast, robust version of Linux — so fast that **total input to output latency is just a few hundred microseconds.** How can one little box do so much? There's a blazingly fast Intel processor inside, with enough CPU muscle to lift a small building. Strong *and* fast. Ali would approve.

Push to play • Axia Router Selector Nodes are **really advanced selector and monitor panels** that you can put anyplace you need access to audio streams. Like newsrooms, dubbing stations, or even the station's TOC, so you can monitor any of the thousands of audio streams on your network at a moment's notice. The LCD screen scrolls through a list of available streams; the eight Fast Access keys let you store and recall the streams you use most. There's even an input, for convenient connection of an analog or AES device. Sweet.

Brains in the box • The typical radio jock cares for studio equipment about the same as a five year-old cares for a puppy: haphazardly, if at all. That's why we **took the CPU out** of our Element modular console and put it in here, with the power supply and GPIO ports. That means a greatly reduced chance of being taken off the air by a Coke spilled into the board. Because we know that you have better things to do on a Sunday night than trying to dehumidify circuit boards with a hair dryer.

Quick Connect • Axia I/O is presented on RJ-45 and adheres to the StudioHub+ standard. A couple of clicks and you're done.

You got to have friends • Delivery system providers like ENCO, Prophet BSI, BE, iMediaTouch, DAVID Systems and more all have products that **work directly** with Axia networks. So do hardware makers like AudioScience, International Datacasting, 25/Seven, Telos and Omnia. Check out the whole list at AxiaAudio.com/partners.

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www.cesweb.org

National Assoc. of Tower Erectors (NATE)
February 11-14, 2008
Orlando, Florida
www.natehome.com

National Religious Broadcasters Convention (NRB)
March 8-11, 2008
Gaylord Opryland Resort, Nashville, Tennessee
www.nrbconvention.org

Great Lakes Broadcasting Conference & Expo
March 10-11, 2008
Grand Rapids. Michigan
www.michmab.com

NAB 2008 Convention
April 11-17, 2008
Las Vegas, Nevada
www.nabshow.com

NAB 2008 Radio Show
September 17-19, 2008
Austin, Texas
www.nabradioshow.com

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October 2-5, 2008
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