AIRCHECK

Welcome to Aircheck #15. If you look closely at the headline below, you'll notice something new. After 26 years, we've changed our name. The real question isn't so much why, but what took so long.

In the early days, much of PR&E's business was supplying Ampex, Scully and MCI recording equipment, along with professional audio services to recording studios. The name Pacific Recorders & Engineering reflected that activity. But since the early 70's, we've focused almost exclusively on developing and manufacturing high-technology products for the broadcast industry.

Unfortunately, to new clients and vendors, the word "Recorders" still implied "recording services." Technical job applicants were confused, too. Invariably, they'd ask, "Do you make recorders or do recording?" Pacific Research & Engineering more accurately defines what we do. In 20/20 hindsight, we should have changed the name two decades ago. But, better late than never.

The timing of our name change also coincides with a key milestone. On May 29th, PR&E became a public company with stock trading on the American Stock Exchange. Our symbol is PXE.

What began as a part-time system design firm "headquartered" in a spare bedroom is now in a stronger position than ever. We'll be able to move forward on ambitious product design and development ideas that retained earnings alone could never have funded. The future will be even more exciting—while, of course, continuing to be fun.

Jack K. Williams

Jack Williams, C.E.O.
Pacific Research & Engineering

BACKSTAGE TOUR
"The Design and Manufacture of Plug & Play Systems"

As a vertically-integrated company, our primary production resources are in-house. Our experienced craftsmen build cabinetry in the same shop we've used since 1973.

AIRCHECK #15

A Broadcast Newsletter From

Pacific Research & Engineering

We're often asked how long it takes to install and test the broadcast systems and facilities seen in Aircheck. A typical control room usually takes one day, and even a complicated design never takes more than two. Likewise, a talk studio table, with host and co-host control turrets and facilities for five guest positions, will also take one to two days depending upon complexity.

A typical PR&E four-room radio studio complex is usually installed in five working days by staging the elements and sequencing the labor, room to room, for cabinet assembly,

A comprehensive package of "as built" drawings, schematics and wiring diagrams is provided and a copy retained in our files.

wiring harness installation, component installation and system testing. Terminal rooms, or "Master Control" as they are sometimes called, can vary from one to three work-weeks depending on the number of stations being served and the extent of the routing, switching, monitoring, logging and other support systems employed.

Pre-fabricating and testing the rack, back-board, cross-connect and inter-room wiring in advance is a key to minimizing on-site time. For example, the WKHX-AM & FM/WYAY-FM installation, featured in Aircheck #14, consisting of 10 studios plus a terminal room, took just 15 working days for a system staff of seven to complete, including pulling and terminating the inter-room wiring. Two station engineers provided coordination of contractor personnel, electricians and the digital audio storage installations. But just as important, they were readily available to make any last minute installation detail decisions. A smaller installation, such as the "showcase" facility at Universal Studios Florida, which consisted of two studios and a transmission room, took four people only five days to complete.

"PLUG & PLAY" DESIGN

Pre-fabricated or "plug & play" design applies the efficiencies of factory production and material resources to the unique task of creating a one-of-a-kind radio studio complex. After all, system design, manufacturing and testing is more efficiently accomplished in a factory environment, not under foot in an office building—often while double rent is being paid. Installation is then simply a matter of reassembling systems which have already been pre-tested.

SPACE PLAN

So, how do we approach the design of a system? First, there is no standard "catalog" or design which can meet both the programming requirements of the station and the architectural limitations of the building. Sure, it may be possible to "shoehorn" a cookie-cutter system into a converted broom closet, but it will never provide the creativity and productivity (read: return on investment) of a system designed specifically to fit that space.

There are three basic types of space allocated for studios—too small, oddly shaped and properly conceived. Renovating existing small and odd-shaped studio space is usually an exercise in choosing the lesser of various evils. New construction lets you develop a plan which satisfies the client's operating goals and provides flexibility for the future. We are often involved in defining new space plans. We don't replace the architect and acoustical consultant, but we do add "real world" studio space planning expertise.

DESIGN

We start by getting a thorough scope of the goals of the new facility to insure that functionality drives the design. We then present the relative merits of alternative solutions for discussion. Once the functional description and design are established and approved, the supporting components are selected. The station's existing technical assets are inventoried and evaluated for use in the new facility. Then we look at our own range of unique products designed to solve specific systems-related problems in audio distribution and logic control. So our designers can not only utilize their experience in defining a smooth working studio, they have many specialty tools at their disposal as well.

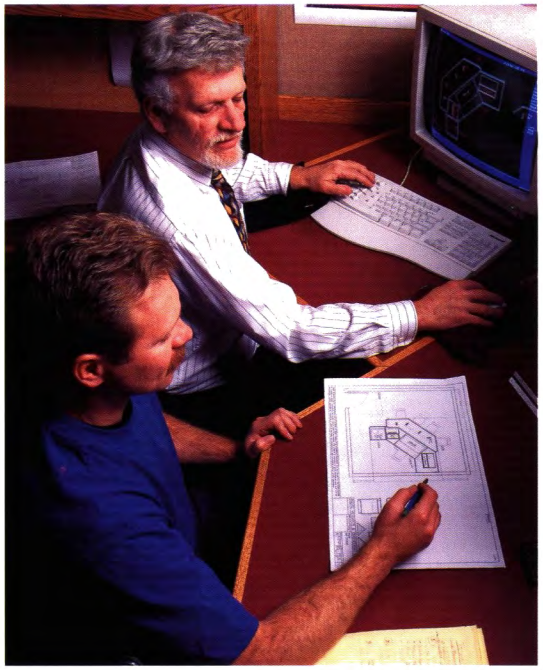
SYSTEMS ENGINEERING

One of our system engineers provides hands-on management of each project—from design and manufacturing, through installation if required. This engineer is the day-to-day contact for the project, ready to listen, advise

listen, advise and answer any questions. Using the design resources of our system engineering department, the system engineer creates all the documentation required for the manufacture of the system. This includes cabinetry, console configuration, equipment placement, audio wiring, logic control systems and wiring, system assembly and test procedures.

DOCUMENTATION

Complete documentation is essential for operating and maintaining a complex system. And it lets the client take full advantage of designed-in flexibility in the future. A comprehensive package of "as-built" drawings, schematics and wiring diagrams is provided in the final project notebook(s). We also retain a copy of the system documentation in our files.



Cabinetry designer and supervisor review construction details in the factory setting, where technical and physical resources are right at hand.

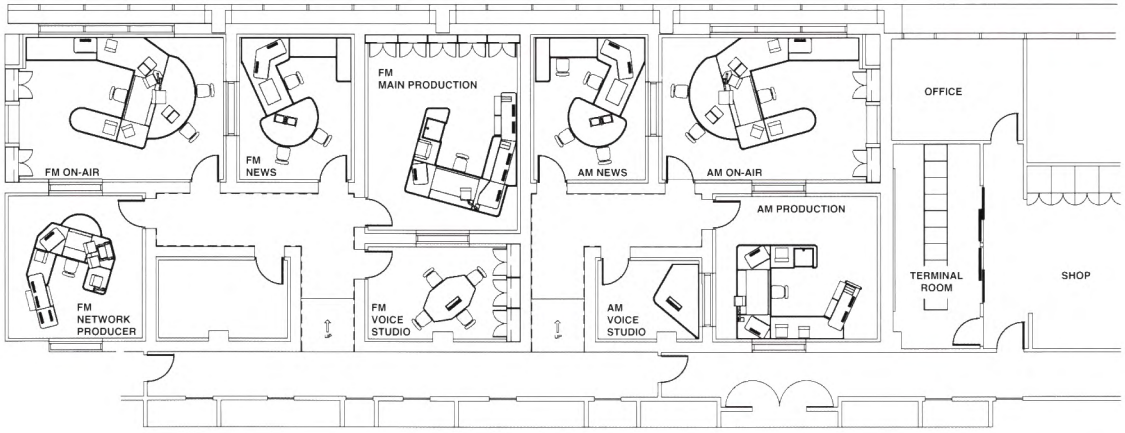
CABINETRY

Cabinetry design establishes the operating environment of the facility for many years to come. The choice of custom-designed or standard modular cabinetry is determined by broadcast mission and/or the space limitations of the site.

Custom designs are usually chosen to accommodate architectural constraints, special feature requirements or interior decorator goals. All of the "showcase" stations and network systems with which we are usually identified are one-of-a-kind designs. Custom cabinetry provides maximum design freedom, yielding best use of space, the most efficient operating environment, and the optimum arrangement of console and peripheral equipment. Custom cabinets also provide an opportunity for management to make a design statement in the facility. Of course, the development, documentation and fabrication cost of a custom design is higher.

Our PrimeLine™ modular cabinets are manufactured using plans derived from years of building custom cabinets. In fact, PrimeLine™ cabinets visually complement many features of our custom designs. Yet, with standardized design and medium-quantity production techniques, we can build high-quality cabinetry for significantly less. Like our custom cabinets, our standard designs are manufactured and finished using the same in-house shop—and many of the experienced craftsmen—that we've been using since 1973.

Sample Floor/Space Plan



Our system engineers use custom software programs to create the manufacturing plans which are then used by wiring harness assemblers to wire the systems.

Experienced system assemblers install the pre-fabricated audio and control wiring.

The console and peripheral equipment are mounted into the cabinet.

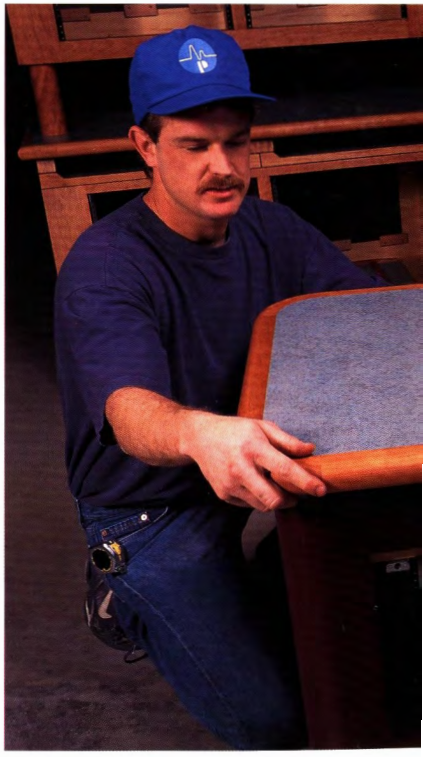
SYSTEM AUDIO WIRING

An audio system's wiring may be as simple as point-to-point (direct wiring), or as extensive as using patch fields and terminal or connector panels for each and every signal in the facility. The most common practice is an efficient and judicious blend of the two, patch bay for processing loops, temporary reconfigurations and test purposes; direct wiring for dedicated signal functions.

While there are many schools of thought on what should be direct wired and what should be routed through patch bays, our design and documentation process can accommodate most reasonable schemes. Our system engineers use custom software programs to create the manufacturing plans our wiring harness and system assemblers use to wire the system. This software also outputs wire numbers, patch bay legends and audio wiring documentation.

SYSTEM LOGIC CONTROL

Today's radio studios require more control infrastructure than ever before. Turntables and cart decks are going or gone, but we still have guest and studio mic positions, CD players and DAT machines, along with new digital recorder/editors, instantaneous sound element players and digital program delivery systems. Add the communication requirements for a demanding talk format, and your control interface systems can exceed the complexity of the analog and digital audio wiring. Once again, this is work best designed, executed, tested and documented in a factory setting, where the technical components and physical resources are right at hand.



After completion of factory tests, each system element is color tagged for studio location and disassembled.

The pre-assembled system is tested in-plant for proper operation and performance.

IN-PLANT SYSTEM ASSEMBLY & TESTING

Our system engineer coordinates all the system elements—including any peripheral equipment from outside vendors—for factory assembly to the pre-shipment level specified in the project proposal. Experienced system assemblers install the pre-fabricated audio and control wiring, the console, and finally, the peripheral equipment. The pre-assembled system is then tested for proper operation and performance. Many clients will visit our plant during this final phase to review their systems and delivery plans. We strongly encourage them—both to see their systems in assembled form and to take photos for the staff back home. This is also the ideal time to determine final placement of microphone arms or cable sleeves for such counter-top equipment as telephones, computer terminals, etc. These items can be difficult to position on a cabinet drawing and much easier to visualize when walking around the real thing.

DELIVERY

After completion of factory tests (and any last minute additions by the client), each system element is tagged for location, disassembled and blanket wrapped for shipment by Electronic/Trade-Show Van service. This is the industrial service division of those moving companies who specialize in the packing, transport and delivery of fragile, high-value shipments. This service delivers each system element to the studio/room as indicated by its ID tag. If the project is large and the studios are small, the cabinetry may be delivered to each room and the peripheral equipment grouped by tags in a staging room—often the GM's future office or conference room is the only space large enough.

INSTALLATION

Many of our clients reassemble the systems using their own staff. Depending upon the project's size and station activity level, it may be supplemented with a few local contract engineers. Others either retain PR&E or one of the independent installation groups serving the industry. Either way, the installation crew gets a tremendous head-start by reassembling systems which are pre-fabricated and pre-tested.

Each system element is carefully blanket wrapped for shipment.

Systems are shipped via the Electronic/Trade Show Van service, which specializes in handling fragile, high-value shipments.

TECH TIPS

Specsmanship vs. Performance

"Great engineering is choosing the optimum compromise between competing benefits"

How does a design engineer determine the optimum operating reference level within a circuit's total dynamic range?

What should be a purely technical decision, choosing the balance point between the competing benefits of a high signal-to-noise ratio and a wide headroom margin, can become unduly influenced by marketing pressures. This is not to slam marketing. Its job is to "position" a product within the "acceptance window" of the prospective customer. Unfortunately, marketing "specsmanship" can corrupt otherwise good designs.

Here's a typical discussion:

Marketing: *"Everyone reads the signal-to-noise spec. Only the 'Golden Ears' types ask about input and output headroom. The competition doesn't even publish their headroom figures."*

Engineering: *"That may be true, but isn't a prudent headroom margin from clipping distortion more important than adding a few more dB of 'eye wash' to the signal-to-noise ratio?"*

Sales: *"No, it's not more important when the competition is claiming better noise numbers! After all, most customers don't make headroom a buying issue and when they get clipping distortion, they'll just blame the jocks for being sloppy operators."*

Engineering: *"Well, since you're the guys who have to sell the product, we'll give in and bump the operating reference level up 5dB. But don't blame us if anyone complains about clipping."*

What has just happened to the real-world performance of that design? Let's assume that the product is a medium-sized analog on-air mixing console constructed using current technology components. If it's well designed, it should have an input (pre-fader) total dynamic range of around 110dB (assuming a 20kHz noise measurement bandwidth). The post-fader dynamic range should be around 102-104dB as limited by the maximum output capability of the program amplifiers.

Given that the distortion of a mixer at clipping is audibly more painful than the low noise level of modern amplifiers, it is surprising that operating headroom specifications are not examined more closely. The signal-to-noise ratio is a legitimate concern until it reaches about 80dB. This is quieter than available broadcast sources—mic or line, analog or digital. To go further simply takes away one decibel of headroom margin for each decibel increase in the signal-to-noise ratio.

The more important question should be: "Does the design provide sufficient headroom for the real world of broadcast operations?" The input headroom margin decision should be made in consideration of the most extreme input signals level likely to be encountered. Since the gain structure before the fader is preset during installation, the input headroom figure must accommodate whatever signal levels are presented without the protection of readily available operator controls.

Using the 80dB signal to noise benchmark, the input headroom margin is as follows:

Input Headroom Margin

Input Dynamic Range	*110dB*
Signal-to-Noise Ratio	*- 80dB*
Input Headroom Margin	*30dB*

30dB of input headroom will tolerate the maximum level capable of being delivered by all pre-recorded and virtually all live sources. Therefore, this should be considered the optimal allocation of 110dB of input dynamic range.

The output headroom is determined by how much "in-hand" mix fader margin is available to the operator, the station's standard operating reference level (usually +4dBm or +8dBm) and the maximum output capability of the mixer. The operator needs a reasonable amount of in-hand fader control to bring up low level sources such as a weak voiced telephone caller, or to "establish" their own voice coming out of a music element. We provide 12dB in our Mixer Class consoles and 15dB in our X-Class consoles. Therefore, these consoles provide full-up fader margins of 10dB and 9dB above a standard level signal.

Output Headroom Margin

	Mixer Class	X-Class
Output Dynamic Range*	102dB	104dB
Signal-to-Noise Ratio	80dB	80dB
Output Headroom Margin*	22dB	24dB

*assuming a +4 dBm output operating level

Why the difference in output dynamic range between the two consoles?

Modern consoles utilizing active output circuitry (instead of transformer coupled outputs) are constrained both by the sophistication of the output circuitry and the voltage of the power supply rails. Differential output power amplifiers with ±15 and ±18 volt supply rails can deliver up to +26dBm and +28dBm respectively. The X-Class consoles' line amplifiers operate at a higher supply voltage than the Mixer-Class.

Please note the use of dBm. We believe that a line output amplifier should be rated as loaded by a 600Ω termination (dBm) in addition to the open-circuit voltage (dBu) measurement listed in most manufacturer's specifications. For example, the popular NE5532 dual IC, which is found in unbuffered form as a "transformerless" output amplifier in many low-cost designs, will show a significant drop in its maximum sustained output level when terminated. The same IC coupled to a pair of high-current output driver stages, while more expensive to manufacture, is a legitimate line power amplifier.

So, what happens when we raise the internal operating levels of our two console series by 5dB?

Input headroom is reduced to 25dB, which is still adequate for line level sources. But it will encroach on the range desired to accommodate a wide variety of broadcast voice types and microphone techniques. The consoles' output headroom would be reduced to 17dB and 19dB and the full-up fader margin reduced to only 5dB and 4dB. This is little clipping protection given that the typical peaks in a recorded program are 6-12dB above the average level while the peaks of a live, unprocessed voice can easily be 8-16dB above the average level.

As can be seen, the price of noise specsmanship is paid with headroom and, in our judgment, it's not a good bargain when there is so much dynamic range available.

Digital note: *It will be interesting to see what will be the allocation of dynamic range between noise and headroom as digital mixers are introduced.*

The professional digital audio communities have adopted a questionable practice of operating with nominal levels of only 20dB below "Full Scale Digital", which is the point of digital clipping if you prefer. With nominal analog input and output levels of +4dBu, clipping within the digital domain occurs precisely at the analog equivalent of +24dB.

As one examines this 20dB headroom practice, it becomes clear this choice is driven by the technical limitation of the analog to digital (A/D) conversion process. Even the very best-of-breed 18-bit converters offer only 104dB dynamic range. This limitation does not give one the luxury of providing 30dB of input headroom without an attendant reduction of the signal to noise ratio to an unimpressive figure of -74dB. Once again, the price of noise specsmanship is paid with headroom.

Fortunately, digital signal-to-noise performance figures do not often degrade as signals pass through multiple digital devices. The ultimate limitations are in the analog to digital conversion process. When digital vendors proclaim 40 bit DSP performance, this does not imply a dynamic range of 240dB, it is simply an indication of the strongest link in a weaker chain, not real-world input to output performance.

A PREVIEW OF http://www.pre.com

Introducing Pacific Research & Engineering Corporation's world wide website, http://www.pre.com.

The site will be developed in two phases. The initial phase will provide visitors with basic product and company information, along with archive data from past PR&E technical and evaluation articles. For example, we'll provide a complete library of Aircheck Tech Tips and case histories on some of our most enterprising studio installs.

The second phase will add more depth to the technical support area. Plans include adding on-line viewing or instant faxback of system documentation such as wiring diagrams via a point-and-click menu. Customized technical support will also be available. You will be able to receive detailed answers to your specific questions via private customer e-mail boxes accessible through the site. Special security steps will ensure that you're the only one who can access your mail box. We'll also be adding new case histories and technical articles on a regular basis.

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- ☐ **ABX** Multitrack Production Console
- ☐ **STX** Stereo Television Audio Mixer
- ☐ **Newsmixer** Compact Console
- ☐ **Stereomixer** Compact Broadcast Console
- ☐ **ADX** Digital Audio Workstations
- ☐ **LS-5,10&20** Line Switchers
- ☐ **Micromax** Cart Machines
- ☐ **PSS-8** Program Select Switchers
- ☐ **TX-990** Phono Preamplifier
- ☐ **SDA-8A** Stereo Distribution Amplifier
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For over 25 years, Pacific Research & Engineering Corporation has been designing and manufacturing premium quality products for the most prestigious names in major market and network broadcasting.

PR&E continues its commitment to the industry with products that deliver long-term value to clients who appreciate the benefits of uncompromising quality.

Where Great Radio Begins

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