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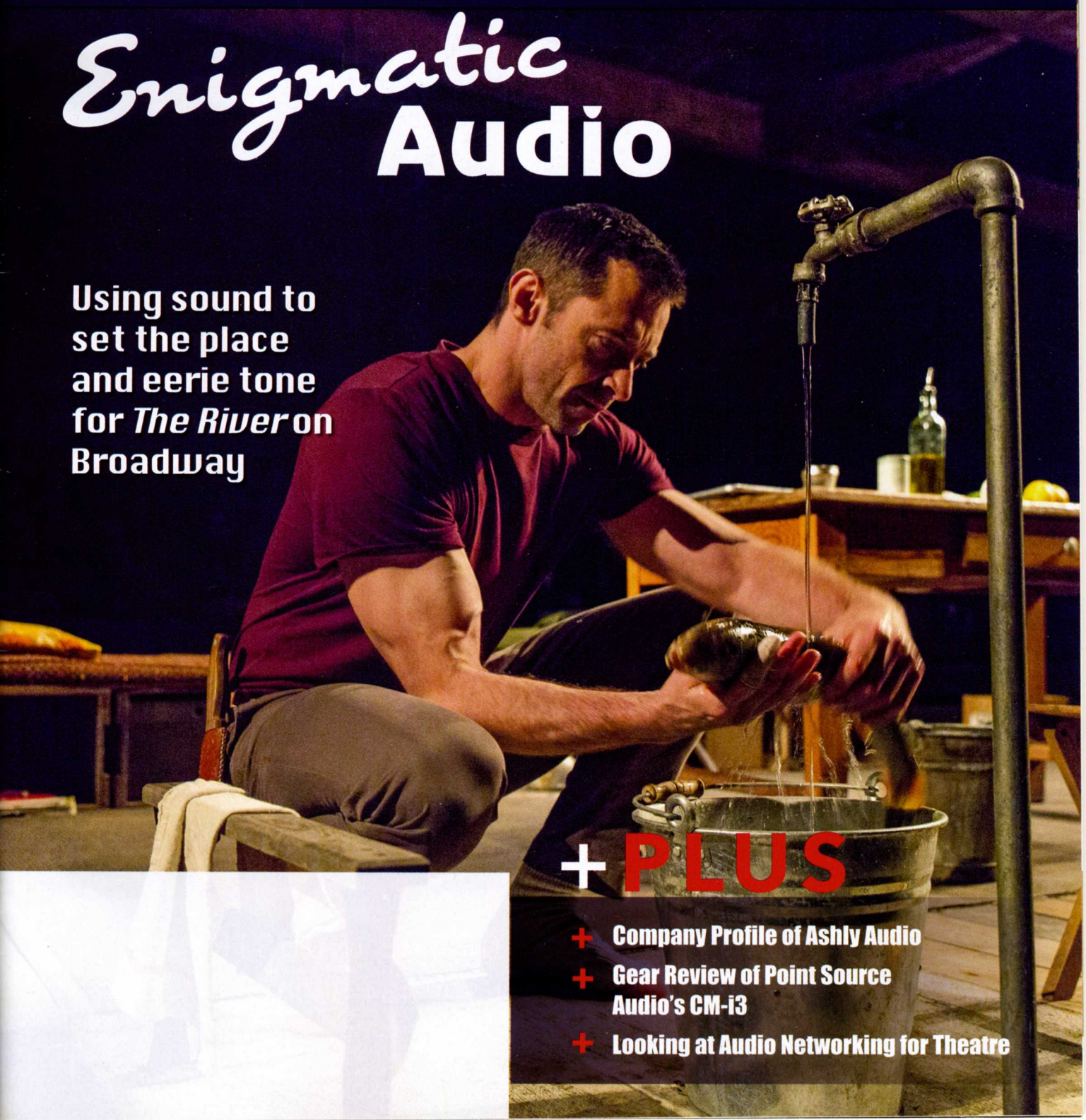

+ PLUS

+ Company Profile of Ashly Audio
+ Gear Review of Point Source Audio's CM-i3
+ Looking at Audio Networking for Theatre


KEVIN BERNE

Masque Sound just recently supplied a custom audio equipment package (including networking) for Disney's *The Hunchback of Notre Dame* at the La Jolla Playhouse. Ciara Renée (center) and the cast are shown here.

Sound in the Age of Networking

Digital audio networking is its own revolution – and isn't just for the elite

Right around the same time Pro Tools rewrote the book on recording, another revolution was getting off to a somewhat quieter start. With the 1996 introduction by Peak Audio of CobraNet, digital audio networking entered the mainstream of audio production. Less than 20 years later, networked audio is everywhere and quickly extending even further. And not a moment too soon for the theatre community, where the size and complexity of audio systems has similarly exploded over the same time period.

In this article, we will take a necessarily brief glance at the current state of audio networking in theatre, but it is a big topic that is far more involved than can be discussed here.

To start, let us clarify a few concepts. When I say "digital audio networking," I refer to technologies that carry multiple channels of audio over a single cable to multiple destinations that may use all, none, or only selected channels. Contrast this with point-to-point interfacing technologies such as AES3 (aka AES/EBU), SPDIF, ADAT lightpipe, or MADI. These technologies simply carry audio in one direction from a single source to a single destination. You may see any of these integrated into an audio network, but they are adjunct technologies being "hung off" the network using converter boxes.

The other worthwhile differentiation is between audio networking and networked control of audio devices. Control networks do not carry audio, they carry signals for manipulating or monitoring settings and performance in audio devices, an application that uses far less bandwidth than audio and is not nearly as time-critical. This category includes loudspeaker management networks such as Meyer Sound's Compass software, which controls multiple units of their Galileo-class loudspeaker management processors. Data is data, so control signals theoretically can be carried on the same network as audio, but, in practice, it is more common to run separate control and audio networks.

In a large production, such as Broadway or major touring theatre shows, there might be a front-of-house mixing station; a backstage monitoring station to keep an ear on radio mics; many different zones for loudspeakers, each carrying its own mix; cue software, and more. It would not even be feasible to consider wiring such involved systems with analog audio; even the rats would refuse to nest in such a mess. More importantly, notes sound designer/engineer Charles Coes, the crew appreciates trading in lugging big reels of copper wiring for much less, more lightweight, armored Cat5 cable.

Networking allows each station to access the channels needed by the operator running it. For large surround systems, networking provides a way to get the right audio to each zone.

The sands shift some over time, but today the audio networking schemes you hear about the most often in the theatre world are Audinate Dante, Ethernet AVB, EtherSound, and Optocore. Of these, EtherSound was the first, but it seems fair to say that Dante is currently the most entrenched.

Taking Issue

There are several primary issues to consider in looking at digital audio networking systems for theatre. First and foremost is reliability. The show must go on, and people pay too much for tickets to big productions for clicks and pops to be tolerated, let alone partial or complete system failure. While this has implications for the individual network components, the design and implementation of a network have as much to do with its performance as the components that make it up. Good components in a bad system design will still have problems.

Redundancy is a time-honored method of insuring reliability, and all of the designers with whom I spoke emphasized how intensely this remains true in networking, with the advantage that the entire purpose of networks—to facilitate interaction between compo-

nents—is of benefit when the needs arises to detect and compensate for a failure.

While nearly all current audio networking solutions incorporate redundancy, the Optocore system is especially strong in this regard, using a redundant, bidirectional, optical ring structure. If a cable breaks or becomes disconnected, signals can be rerouted, because a route still exists from any source to any destination. A system relying on a single connection to each component lacks the same robustness. This is particularly true in environments involving long distance cable runs, which optical fiber is capable of traversing. Larger Broadway shows often need this level of performance.

Audio networks need reliable timing, as well. If samples don't get where they are going in a timely fashion, ugly artifacts (clicks, pops, glitches, insults about your mother) will usually be the result. There are two parts to this puzzle. First, there is quality of service (or QoS), which is a guarantee that each data packet of audio samples transmitted will reach its destination on schedule.

The other part to the puzzle is clocking. Even if a sample gets to its destination on time, it can only be played at the proper moment if there is a clock available to act as a timing reference.

Original Ethernet does not respect this on-time delivery imperative, lacking both parts of the puzzle. Instead of guaranteeing delivery on time, Ethernet signals traditionally take turns if two want to go at the same time. It's nice for your kids to do this, but not your digital audio. This is the reason that most of the various networking schemes running over Ethernet do not use plain vanilla Ethernet.

Some systems, like the AES50 standard, use only the physical infrastructure layer of Ethernet. Others, including Dante, avoid collision problems on Ethernet by using audio over IP. Dante also chooses the UDP protocol over TCP because it is leaner and supports streaming. This approach allows the use of cheap, off-the-shelf Ethernet switches.

Ethernet AVB enhances standard Ethernet, rather than replacing it, by reserving bandwidth exclusively for audio signals, adding clocking and scheduling mechanisms to ensure QoS, then scheduling all non-real-time packets around the needs of real-time packets. Other systems, such as Audinate's Dante, opt out of the whole Ethernet issue by relying on the IP protocol, but not on any specific platform, like Ethernet. Optocore employs a proprietary optical fiber system, connecting to Ethernet-based control networking systems when necessary through interface boxes, and ensures proper timing by making the system synchronous (everything is locked to a master clock).

Latency is another major concern. A signal traversing a network can incur delays going through switches and processors. While very small, these delays can become important in timing—critical applications such as monitor systems for live music performances, where small timing differences can make it difficult or impossible for a band to be fully locked into a groove with each other. It is also critical that whatever latency is in the system is consistent between all points to avoid comb filtering and other destructive artifacts.

Distance considerations come into play, as well. Gary Stocker, technical director at Masque Sound, describes a recent production where a Cat5E line tester was brought in to help diagnose clicks and artifacts in the system, but reported that the system met the appropriate standards. Masque solved the problem by replacing the unshielded twisted pair cable they had run with shielded twisted pair. "We've run networks for control for quite some time with no problems, because a packet can be easily resent" explains Stocker, "but audio is harder because it is time-sensitive."

When runs of more than 100 meters or so are in play, Stocker's advice is to switch to running fiber optic cable, which is far less sensitive to the stray electromagnetic and RF fields especially prevalent in older venues. "Noise can occur in very long (copper) lines because they might be run next anything," he points out. "They can pick up interference from motors, fan systems, or other systems that generate magnetic fields." The cost of fiber optics has come way down from the past, as well, Stocker points out.

Choosing a Networking System

There are numerous performance parameters and software capabilities one could analyze to decide on which of the available networking systems to use, but most of the time, none of those is the deciding factor. The choice of networking system is commonly determined by the equipment specified for the system by the sound designer.

The mixing console, being the heart of the sound system, is frequently the component around which the rest of the system is built, so the choice of network simply ends up being whichever kind of networking the console supports. For example, if a sound designer selects a Yamaha console then Dante will be the networking system, while if the choice is a DiGiCo console the network will be Optocore.

Another major consideration in choosing a networking system is that many systems, like Dante and Optocore, are developed by a single manufacturer, while Ethernet AVB and AES67 are standards. (AES67 promotes interoperability between systems using audio over IP, including Dante.) There are two significant implications of this. First that the single-manufacturer-driven systems can develop faster, because companies don't have to agree on new developments, as