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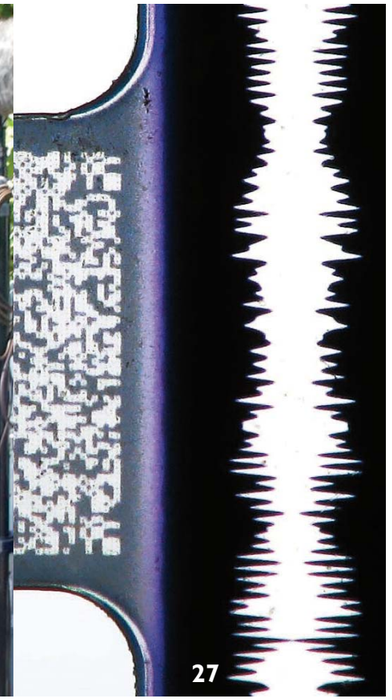
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Features

Cover: Steve Nelson, CAS on the S.S. Hopewell, on the pilot of *The River*, Puerto Rico, March 2011. (Photo: Knox White)

Departments

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From the Editors

Goals, objectives and desired results form every aspect of our lives. It might be a goal to spend more time with the family, improve your sound package, achieve better sounding tracks, a better workout or just your quality of life.

We regularly set goals for ourselves and work to bring them to fruition.

The goal of the *695 Quarterly* is to bring you a great read, full of information in every discipline Local 695's membership provides to the entertainment industry.

This issue begins a three-part series by James Tanenbaum, "The Cable Connection," that explains everything you need to know about interconnecting cables on your sound cart. Steve Nelson explores the travails of mixing the challenging episodic series *The River,* in Puerto Rico and Hawaii, and Scott Smith returns with "When Sound Was Reel-9."

Our goal is to give you new insight into the incredibly complex work our membership does each and every day.

Enjoy.

Fraternally,
Richard Lightstone, Eric Pierce and
David Waelder

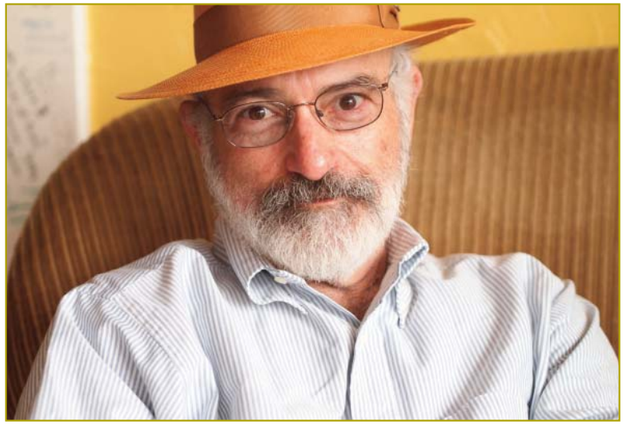
From the President

On My Journey With Obesity

I thought I'd touch on my own journey with obesity.

In our kind of work it is very common for us to become so absorbed in our work that we disconnect from our physical selves.

Years can pass without us being aware of the progression and changes to our bodies as we move along in our lives and careers.



I look back on decades as an obese person and realize that I had literally built a "fortress" around myself. This was a fortress of pushing constantly, not stopping and noticing the present, obsessively multi-tasking and just trying to be ahead of the curve, missing the forest right in front of me, the trees perfectly blocking the view.

I'd always begin some program, some diet, some magic-bullet solution, ultimately falling apart as schedules shifted wildly and life's apparent pressures inevitably gave me a "reason" why I couldn't keep it together.

Eventually, I grew to become a 285-lb man on a 5' 7" frame. Everything was affected by this slow motion, inadvertent suicide.

I'd always positioned it as a logistical or technical issue, something on the "to do" list, to be scheduled, to be gotten to when I could pay full attention. Years passed as I failed to confront the essential nature of taking care of myself.

Then, I had the very good fortune of a couple of "2 x 4"s hitting me upside my head. We had a major health scare with my wife and simultaneously my annual physical revealed that my liver was in severe decline, infested with fat from years of abuse. Although never a drinker or smoker, it was as if I had been a severe alcoholic and had foolishly treated my body like an endlessly renewable resource.

The fecal matter was hitting the ventilation system in spades. I looked up and saw my kids, my wife and said to myself this is it. Everything else is off the table. I withdrew from the project I had committed to so I could remain home during the journey of my wife's surgery, and took stock of what I was doing and what I wanted the future to look like. More importantly, I recognized that it was time to start living in the present.

So I stopped beating myself up and threw the switch, the emotional switch that made it possible to change my behavior. Eating less, moving more...

No angel, I. It has been a process of two steps forward, one back, but I changed this. It took more than four years but I am currently 172 pounds, I run three miles 4 to 5 times a week. I started training for mini-triathalon and learning how to use Russian Kettle Bell for core strength.

"Failure cannot cope with persistence."

This is a day-by-day thing. I try to not let how I feel about any given day affect my behavior regarding the program. Some days I feel terrific and some not so much, but when I miss a run or eat inappropriately, I feel it almost immediately and realize I can't go back...

Only forward.

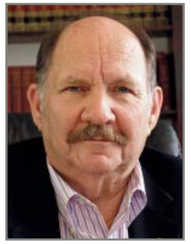
We were very lucky. My wife is well. My blood chemistry is the best it's been in 30 years. People can improve, make it better, get past their own crap. Failure cannot cope with persistence.

No one is perfect, certainly not me. But stopping and noticing, living in the present, facing into the things most challenging in our lives, has the greatest value. You gotta have a system.

Warm regards,
Mark Ulano
President, IATSE Local 695

From the Business Representative

In Perspective



At contract negotiations conducted March 14, 2012, at the offices of the AMPTP, the Local 695 Bargaining Committee presented the following as further substantiation of our members' technical expertise and historically established contribution to the ongoing evolution of the audio and video electronic recording chain.

EVS systems incorporate file-based production tools for script-based production, live studio production, content control and delay, fast turnaround production, soap operas, talk shows, news production, sports production and more.

The EVS hardware and software controllers improve production speed and efficiency and reduce production cost. The primary functionality for multi-camera recording of scripted production is to provide ingest and server-based recording operation and immediate transfer to post-production facilities, both on-site and off-site. In live and live-to-tape production, EVS systems are used to give producers instant access to the timeline for editorial decision and multi-channel playback.

The EVS system's tapeless production technology incorporates an integrated suite of video management tools for a wide variety of production applications. Replacing four or more HD-SDI tape machines, the eight-channel SD/HD and six-channel 3D/1080p intelligent production servers are used to manage multiple audio and video sources for immediate assemble preview and playback or for delivery to post-production or media archives over high-speed server networks. It allows ingest control, metadata management, on-the-fly editing and playout scheduling managed from a single interface.

The responsibilities of the EVS operator include:

>>> Set up and monitor all local and remote server operations.
>>> Assign routing and maintain video and audio feeds in and out of the server.
>>> Enable continuous loop recording, which captures audio and video from all sources virtually all the time without interruption.
>>> Assign and configure video codecs and compression schemes for distribution to required output destinations.
>>> Monitor and control record and playback functions on the server.
>>> Replay, clip management, playlist management, locating, previewing, assembling and playback video/audio files from the server and routing to the appropriate destination.
>>> Control and monitor security features using RAID technology, redundant power supplies, and internal hot-swapped disk drives.

James A. Osburn, CAS
Business Representative
Executive Director

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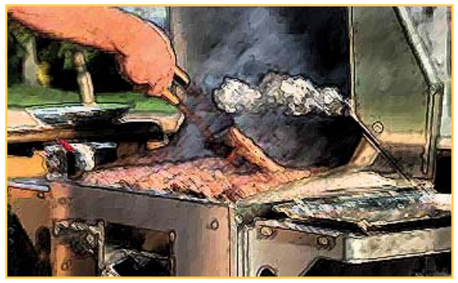
NEWS & ANNOUNCEMENTS

Membership Directory Offers New Features

The Membership Directory Committee continues to add improvements to the membership directory system:

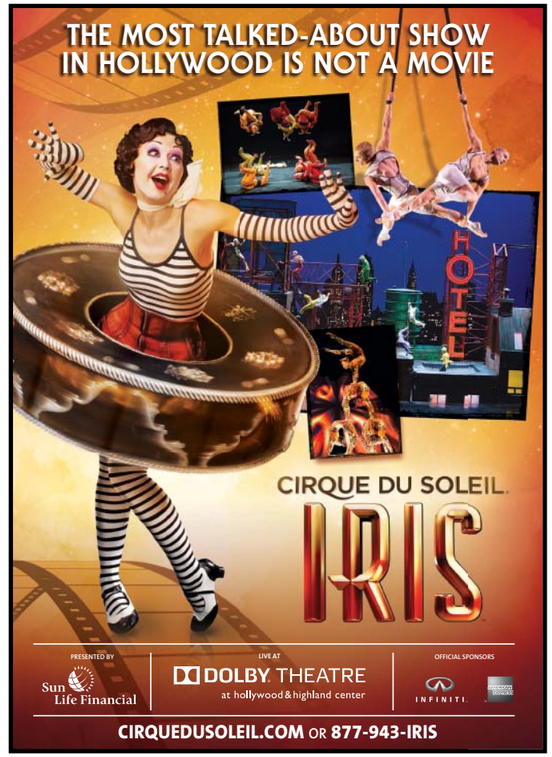
- Members can now customize the order that their "Job Skills" and "Areas of Skills" appear in. From the drop-down menu, select all that apply, then simply drag them into the order you want them to be in.
- Field added for members who have an FCC Low Power Auxiliary Broadcast (part 74) License.
- The directory database will now retain all submitted information if a member has a break-in-service. It won't be part of the active list during the time someone is removed from membership, but once reinstated; all information will be restored to the active database. Previously, all information had to be resubmitted once a member was reinstated.

Remember, you can update your directory information 24/7, 365 days a year by logging in to **www.695.com**



Seth & Kriky's Sound BBQ

Seth Gilbert and Michael "Kriky" Krikorian's Sixth Annual Sound Department BBQ is being planned for June. Great food, BYOB, and a great networking opportunity with fellow soundies! To get on their mailing list, send an email to **soundbbq@kriky.com** or visit Kriky & Seth's Sound Department BBQ on Facebook.



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Tax Credit Program Advances with AB 2026

A bill to extend California's Film and Television Tax Credit Program by five years cleared a hurdle when AB 2026 passed out of the California State Legislature's Arts & Entertainment Committee. The bill is co-authored by Assemblyman Felipe Fuentes, who also led the passage of the program's one-year extension back in October. It's a tough sell as Sacramento grapples with continued budget shortfalls but a Los Angeles Economic Development Corporation study reported that the program generated $3.8 billion of economic activity in its first two years.

In Memoriam

RENE M. SIMONEAU
Chief Projectionist
July 8, 1937 – April 10, 2012

Picket Lines

In the fourth season of *1000 Ways to Die*, a show produced for Spike TV, crewmembers voted unanimously for union representation. The company responded by immediately firing all the workers. On February 27, the IATSE and Teamsters Local 399, supported by the Writers Guild, SAG, AFTRA and the Los Angeles County Federation of Labor, organized a picket line at the offices of *1000 Ways*.

On February 29, picketing expanded to include the Burbank offices of Original Productions, the parent company of the *1000 Ways* production company. Original Productions also makes *Deadliest Catch*, *Storage Wars* and *Ice Road Truckers*.

Local 695 members provided active support at both locations. Soon thereafter, Spike TV declared that it would purchase no episodes made with scab labor and production was halted.

The process has now entered a new phase and the International has "bannered" several companies affiliated with Original Productions. This is a lower profile demonstration to inform related companies that Original Productions continues to be subject to organizing efforts. It also serves notice to Original Productions that they remain a target.

Top: Picketing the *1000 Ways to Die* offices: (Back row) Gary Raymond, Glenn Berkovitz, Shawn Holden, Dean Striepeke, Jesse Kaplan, Doug Brandon, Scott Bernard, Julian Howarth, Laurence Abrams, Clark King. (Front row) David McGraw, David Bernard, Mary Jo Devenney, David Waelder, Jonathan "Pockets" Norton, Steve Blazewick

Middle: Picketing Original Productions: Doug Brandon, Laurence Abrams, Andy Clark, David Waelder, Dean Striepeke, Steve Blazewick, Mark Pat Clark

Bottom: Picketing in the rain.

by LAURENCE B. ABRAMS

Workplace Safety

Stunts, cranes, booms, pyrotechnics, noise, long hours, smoke, water, high-voltage equipment, speeding vehicles and a desire to push the limits. These things sometimes come together to make great movies but they don't come without certain risks. However, by developing a greater awareness for the potential safety hazards that surround us at work, film and television sets have actually become much safer work environments than they ever were before. Here are four very important programs that make it safer for us to report to work each day.

Safety Pass

The Safety Pass Program administered by Contract Services Administration Trust Fund (CSATF) offers classes tailored to the needs of each Local and each job classification. Please remember that the newest course in the training program, the A-2 Environmental Safety class, is mandatory for ALL classifications and that **failure to complete this class can prevent you from being hired for work.** You can verify whether or not you've already completed the A2 class if you go to **www.csatf.org** and on the left, click "Online Roster/General Access" and then enter your name and Local number. If you still need to take it, this three-hour class is offered daily, Monday through Saturday. For details and quick online registration, see **www.csatf.org/safety.shtml**. If you have questions about the Safety Pass Program, you can call Contract Services directly at 818.565.0550, ext. 1100.

Safety Bulletins

The Industry-Wide Labor-Management Safety Committee, a consortium of representatives from the IATSE, the guilds and the producers, has issued a series of documents intended as guidelines for promoting safe practices on the set. State, federal and local regulations take precedence, of course, but these guidelines are specifically developed to address issues that are directly related to our industry and to the kind of work that we do.

Topics covered by the Industry-Wide Labor-Management Safety Committee are wide ranging, offering advice on situations such as working near camera cars, boats and water hazards, firearms, smoke and fog effects, working with animals or around helicopters or near high voltages, in extreme hot or cold weather or high-wind conditions and much more.

The newest document released by the Safety Committee is called *Safety & Health Awareness Sheet – Extended or Successive Takes* and is critically important to our sound crews now working with HD cameras capable of shooting nonstop for extremely long periods of time. Please be sure to read about this particular document here **www.695.com/html/long-takes.php**. To become familiar with all of the other safety bulletins, each printable in PDF format, please visit **www.csatf.org/bulletintro.shtml**

Studio Safety Hotlines

Every employee has the right to report unsafe conditions or unsafe practices to their employer without fear of reprisal. To assist in reporting such problems, a list of all the Studio Safety Hotline phone numbers and contact information for safety representatives at the major studios is available on the Contract Services website at **www.csatf.org/studio_safety_hotlines.pdf**. Most of the studios state that they are available 24 hours a day to accept anonymous safety-related phone calls. The studios have made it clear that they are totally committed to maintaining a safe workplace and that they very much want to hear about any safety problems that you may be aware of.

OSHA and Your Right to Have a Safe Workplace

The Occupational Safety and Health Act (OSHA) of 1970 was created to assure safe and healthful working conditions for all working men and women. At its core, this health law declares that it is the duty of employers to provide workplaces that are free of known dangers that could harm their employees and that the employer must follow all OSHA safety and health standards. It goes on to specify a list of workers' rights and employers' responsibilities and it provides a path for you to report anonymously any unsafe conditions to your employer and to be protected from any discipline or reprisals that might arise as a consequence of you drawing attention to the problem. For more information, links and phone numbers for reporting violations, see **www.695.com/html/health-osha.html**

And the Winners Are...

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Todd Wawrychuk/©A.M.P.A.S.

It was a hat trick for the sound team of the Martin Scorsese film *Hugo,* taking the Oscar for Sound Mixing, BAFTA Film Award for Sound, and the Cinema Audio Society Award for Outstanding Achievement in Sound Mixing for a Motion Picture.

John Midgley, Production Mixer
Tom Fleischman CAS, Re-recording Mixer
Simon Rhodes, Scoring Mixer
Philip Stockton, Eugene Gearty, Sound Editors
Mike Reardon, Charlotte Gray,
Dash Mason-Malik, Peter Clarke, Martin Seeley,
Clive Osborne, Andrew Sissons, Simon Brown,
Production Sound Team

BAFTA Film Award

©BAFTA Film Awards

CAS Award

Ana Gibert

The 48th Annual CAS Awards were held Saturday, February 18, at the Millennium Biltmore Hotel in Downtown Los Angeles.

Ana Gibert

Outstanding Achievement in Sound Mixing for a Television Movie and Mini-Series

Too Big to Fail

James J. Sabat CAS, Production Mixer
Chris Jenkins, Bob Beemer CAS, Re-recording Mixers
Chris Fogel, Scoring Mixer
Michael Schmidt, James J. Sabat Jr.,
Production Sound Team

Ana Gibert

Outstanding Achievement in Sound Mixing for a Television Series

Boardwalk Empire

"To the Lost"

Franklin D. Stettner CAS, Production Mixer
Tom Fleischman CAS, Re-recording Mixer
Sam Perry, Peter Fonda, Toussaint Kotright,
Egor Panchenko, Production Sound Team

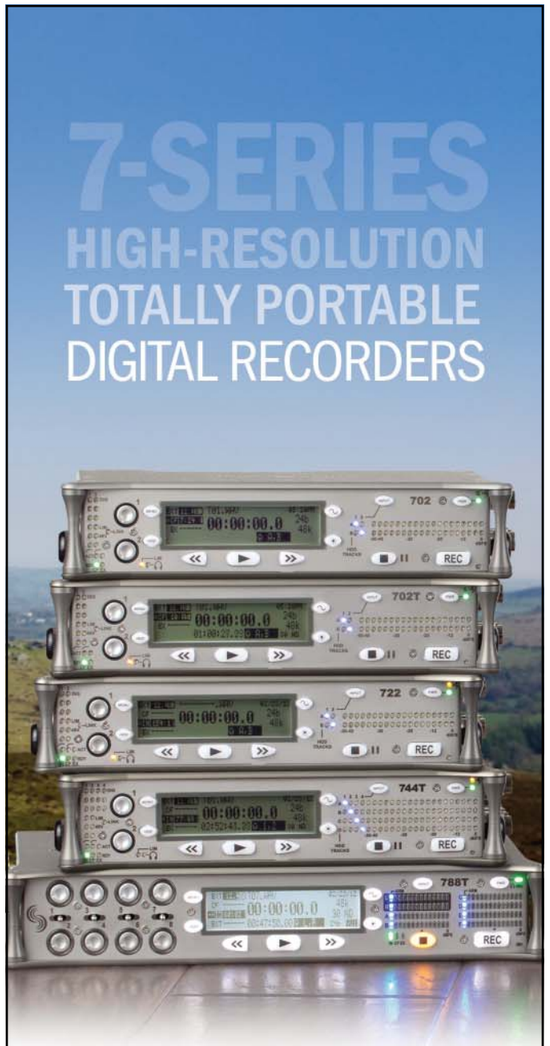
Ana Gibert

Outstanding Achievement in Sound Mixing for Television Non-Fiction, Variety or Music – Series or Specials

Deadliest Catch

"New Blood"

Bob Bronow CAS, Re-recording Mixer



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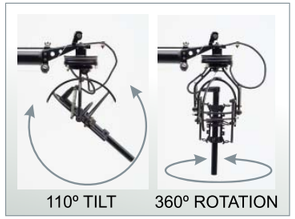

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by Steve Nelson, CAS

Up The River

Director Jaume Collet-Serra operating, actors Thomas Kretschmann, pilot, with Joe Anderson and Paul Blackthorne.

I had some idea what to expect when I heard that the pilot we shot last spring for DreamWorks Television had been picked up by ABC. The one-hour pilot episode of *The River* was shot in Puerto Rico (PR) and, while it was no surprise that the new episodes would shoot in Hawaii, it was a little disturbing that we were nowhere to be found in the fall schedule. Eventually, the other shoe dropped and it was revealed that we would be a midseason replacement with a seven-episode order.

THE STORY

Dr. Emmet Cole (Bruce Greenwood), famous television explorer and family man watched and loved by millions—think Steve Irwin crossed with Jacques Cousteau, dosed on acid, "There's magic out there!" his tag line—has gone missing along with his crew, presumed dead somewhere up a mysterious and increasingly bizarre Amazon tributary. When his locator beacon is suddenly detected, a search is mounted, spearheaded by his wife and son (Leslie Hope and Joe Anderson) and their producer (Paul Blackthorne) with the twist that it is to be filmed for broadcast. The show was co-created by Oren Peli of *Paranormal Activity* fame and master of the "found footage" concept. His concept was to make a show that, while strongly written and acted, would have the look and feel of a documentary, but in the supernatural thriller genre. Scary stories of ghosts and magic shot like unscripted reality TV. On a river, in a boat, in the jungle.

Our push/follow/overflow boat on the Río Espíritu Santos, Puerto Rico.

Following the Zodiacs through the mangroves.
Beautiful but barely navigable.

Boom operator Knox White and our first view of the abandoned Magus.

Actors Eloise Mumford and Shaun Parkes relaxing on the Magus.
By the end of the show, Shaun was a pretty good operator.

THE CHALLENGE

What does this mean for the Sound Department? The first thing we learned before we even left for Puerto Rico was that it meant shooting with many cameras. Up to 14, in fact, and almost every type of HD camera: a couple of Alexas, the hero cameras, Sony EX-3s for the on-camera/actor cameramen, a consumer handicam and Canon 5D and 7D for mounting and random hand-held, and GoPros anywhere you could hide them. (That's right: We're shooting broadcast-quality video for a prime-time network show with the same $200 camera you buy to strap onto your board, your bike helmet, your skateboard, your dog. Welcome to our brave new world!) Not to mention the camera mounted on the miniature radio-controlled helicopter, the so-called Laser Beak. Besides the actual camera operators, whether cast and/or crew, Dr. Cole's boat, the Magus, is wired for video, with a switching/edit room amidships. There are cameras and apparently microphones everywhere imaginable, including a few places not so imaginable. With so many cameras running, we captured so much, let's call it visual data, that the problems I had sneaking in a plant mike surely paled in comparison with the work the editors had to do just to get through dailies. The visual equivalent of recording all eight tracks all the time. Oh wait; I did that!

With shooting underway in San Juan, I learned from Oren Peli, our co-creator and executive producer, that, in his world of "found footage" movies (*The Blair Witch Project, Cloverfield, Paranormal Activity*), the only microphone needed was right there on the camera, so why was I even there? We had several half-joking conversations about this, and I think I was able to persuade him that despite our flagrant deviation from his strict philosophy and aesthetic of this relatively new genre, I was bringing something better than that camera mike and that the studio and the network would be much happier this way. The company had already spent quite a lot getting both me and Knox White, my excellent and endlessly entertaining boom operator, plus several pallets of sound equipment, to this island location. I reckoned we weren't in imminent danger of replacement by that camera mike.

SO MANY CAMERAS SO LITTLE TIME

Next we learned that with up to 14 cameras working, there really isn't any place for a boom operator, much less an actual overhead microphone. Most often all we could get with the boom were the slates. Fourteen cameras means 14 IDs and markers. (Including the GoPros, which, at 25 fps only, were not technically sync cameras since everything else was at 23.978 fps.) Sometimes the best entertainment was watching the slating unfold. When I told the camera assistant that he had to voice ID each camera, his job got a lot harder, remembering each camera in its sometimes obscure location and rattling off each ID in a charming Puerto Rican accent. By the end of the season in Hawaii, the guys were so fast that I even had to slow them down a bit so the poor dailies folks could sort it out. If the cameras were too spread out over the boat for Knox, I might have to sacrifice a radio channel or two just for slates.

In this new hybrid world of fake-umentary (scripted posing as reality, the better to scare you), we would have actors who would play the camera operators and be prominently featured. In subsequent passes, we would float in one actual camera operator and then the other to get the shots we actually wanted. If one of the actual operators got into another's shot, it was accepted that he would be cut out. As it was acceptable to reveal the cinematic process by showing the cameras, the question of sound naturally arose. There was no sound person in the script I read, but for about a minute we entertained the idea that it would be OK to see the lavalier mikes as part of the documentary process. This concept didn't make it to Puerto Rico before the myth of the on-camera microphone prevailed. Business as usual: hide the lavs, forget about how quality sound is actually recorded, even in our make-believe world. Cameras and cameramen are apparently sexy enough for network television, not so much sound guys and their gear. (Personally, I think it all changed when we put away our quarter-inch machines; Nagras were hot! John Travolta didn't have a digital recorder in *Blow Out*; there's just something about those spinning reels.)

Our fate was becoming clear: *The River* would be a wireless show pretty much all the way. Wire everybody always unless they were going in the water. Forget about sneaking in the boom for the close-ups or even hiding a mike; it just didn't work like that. This wasn't "tight and wide;" this was tight and tight and wide and wider and tight and one up on the rigging and so on until we ran out of cameras. At this point, all I could do was embrace it. Forget about mixing for perspective; that is so last century! If their lips are moving, put them on an iso track, make sure the fader is open, record the words on the pages and be ready for more. Even if you could see all the monitors, who has time to watch? Just mix, baby!

ONE IF BY LAND, TWO IF BY SEA

My work would be divided into two categories: Land-based, which meant I could work from the comfort of my cart with all 14 channels of wireless and the big Yamaha board, and water-based, which called for a much more portable setup. Land-based mode would work if we were on the boats, dockside. Our first two days of shooting were interiors on docked tugboats, which, being built entirely of steel, require special consideration for radio work. We also built sets for some of the boat interiors. The scenes in Zodiac boats zipping through the mangroves or on our practical boats underway or traipsing through some inaccessible jungle, obviously called for a portable, studio-in-a-bag modality.

THERE WILL BE TRAVEL

The story unfolds in two parts: the pilot in Puerto Rico and the seven episodes shot on Oahu. Pilots are always a bit special and often quite memorable. This one was. Although PR has been a location in many movies and television, this was the first time for many of us. We were gifted with the participation of Luis "Peco" Landrau, our utility person. Peco ("Freckles," he's a rare Puerto Rican redhead) is an experienced mixer and boom operator who mostly does utility and second units for visiting productions. His uncle is a highly respected mixer there and taught him well; he is extremely professional, prepared for anything, speaks English and gets along with everybody. We were fortunate to be working with DP John Leonetti, who I've known for many years, very talented and a real gentleman. John brought enough of his people to feel comfortable and the locals who rounded out our company were very experienced and competent. Of course, when it's not too busy in a place like this, the top crew is available and we had them. Our production staff was strong, led by line producer Bob Simon, local unit manager Ellen Gordon, and first AD Dan Shaw.

Our director, Jaume Collet-Serra, a Catalan of no fixed address, known for films like *Orphan* and *Unknown*, was embarking on his first adventure in directing for television. The pilot sets the look and the tone of the series and Jaume really went for it, creating a multi-faceted, jittery, sweeping pace that never let up in its intensity. He loves to grab a camera and operate and was fearless, while still showing concern for the quality of our sound and the intelligibility of the dialog. The profusion of accents among our cast was of some concern. We had U.S., Canadian, three different flavors of British (including one doing American), German, Mexican (her character doesn't actually speak English), and an American doing an unspecified South American accent. We discovered in post that there is no sound problem that can't be fixed with subtitles. With *The River*'s "documentary" feel and its use of chyrons for dates and locations and characters, this technique worked very well both for translation and getting us through a few rough spots. I want subtitles on all my shows!

A word here about our lovely cast. This was a truly international ensemble and a more generous, spirited, cooperative, talented, friendly and respectful group could not be found. They all seemed to understand that if this endeavor were to be successful, all the parts would have to work, including sound. Under the circumstances, with so much wiring going on and so much action, this was key. No complaints, endless patience and a costume designer who really got it; the wardrobe was very forgiving and easy to work with.

Amidships on the Magus, studio-in-a-bag mode, taking up as little room as possible.

Yet another camera operator, Laser Beak. They could really thread a needle with this.

That's how we roll on *The River*; fresh air, sunshine and a room with a view.

TOOLS OF THE TRADE

It had been a long time since I'd had to do extensive over-the-shoulder work. Back in the (very) old days at *Entertainment Tonight* with a BVU 110 over the shoulder, a couple of lavs and a short stick, tethered to a running cameraman chasing stars down the red carpet. Or doing docs with a Nagra, hoping that the take-up reel hadn't jammed leaving me with a massive pile of spaghetti under the lid. Since the breakout of reality TV and the digitization and further miniaturization of our gear, bag work has made major strides. How then to gear up for maximum flexibility, ease of use under challenging conditions, best use of equipment I already own, and cost efficiency? The goal was to have two separate recording packages so that I could quickly transition from one to the other. Since I have 14 channels of Lectrosonics UHF wireless spread across four frequency blocks, it was an easy choice to stay with Lectro, enabling me to use a subset of my transmitters in all situations. But what about receivers? The Octo-Pak is very desirable but perhaps a bit over budget for a pilot; for this gig it would be the Venue Field, giving me six tunable receivers in a single box. Of course, if there were more than six speaking parts in a scene, choices would be made; no matter how many wireless you have, sooner or later that will happen. A little research told me which blocks would give us the least interference (almost anything is good where we were going). I would install the appropriate modules and be ready to make a seamless transition from cart to bag mode. (One note about the Venue Field: about the only thing that can go wrong with this all-but-bulletproof device is that there is a chance of damaging the battery contact, a flimsy metal tab. Not a big deal, but it is a good idea to have a spare in the kit.) An eight-track, fully featured recorder/mixer would be required; for the pilot I tried a Sound Devices 788T with a CL-8 controller. As a longtime Deva user, it took a little getting used to the different interface. It is a brilliant unit and, once I gained confidence that I could work it in a pressure situation, the Deva 5.8 stayed on the cart. Since I was using the Venue, I had not the forest of antennas resulting from a bag full of receivers, but antennas are still required. On the pilot I used two log periodic sharkfins, mounted on plastic rods which got me good range. I also picked up a Comtek M-216 Option 7 transmitter so that all Comteks would work from either setup. Shove it all into a Petrol bag and it is very easy to pick it up and go, potentially without changing actors' wires or Comteks.

RUM DIARIES

Puerto Rico is far. From the West Coast anyway. First you fly somewhere far, say, D.C., then you fly quite a ways further. We were put up in the capital, San Juan, which gave us good access to our dry-land locations and wasn't too far a drive to Rio Grande, near El Yunque rain forest, and our little river. A U.S. Territory, Puerto Rico is a spicy mix of Spanish, Caribbean, and U.S. American. Spanish is prevalent, of course, but English is also spoken and taught. The currency is familiar but distances are measured in kilometers. With its Spanish colonial heritage and architecture and tropical setting, you feel like you're in another country but there are four Costcos on the island and many strip malls with all the familiar chains. It should be noted that the Costcos here carry an excellent selection of local rums, quite reasonably priced. As the city grew, parts of the infrastructure did not keep up; there is little in the way of reliable mass transport, everyone has a car, so traffic can be bad. It is painful to be stuck in the morning rush hour on your way home after working all night, but that is really not so different from anywhere and at least we were in a chauffeured van. There are many great restaurants in San Juan, just none close to our hotel. We were at the Hotel Caribbe, one of the original tourist destinations from the swingin' Rat Pack '50s, refurbished nicely, located a long walk from Old San Juan and a shorter walk from the newer strip where most of the hotels, casinos, and restaurants are and where film crews usually stay.

The small slice of Puerto Rico that we experienced on our days off during our three weeks there was lovely and entertaining. Tropical climate, nice beaches, diving, snorkeling, sightseeing, eating & drinking, music, clubs. Knox and I even managed to work in an excursion to the beautiful island of Vieques to see the amazing bioluminescent bay. (That only involved a drive to the marina on the east end, a boat to the island, a van ride to the nature center and dinner, a bus to the bay, an electric boat on the bay, then finally, a dip in the psychedelic water, and then the whole thing in reverse. But so worth it!)

Working there was great. There is decent infrastructure and good crew used to working with Hollywood productions. We had a cozy but well-outfitted truck to share with video assist and a very attentive owner/driver. We were lucky to have Peco, who had been working with all these people forever; it felt very much like family. Working in a tropical place, it is not a matter of if it's going to rain, but when, and the locals certainly get that. The first thing off the truck is the easy-up, which is automatically sandbagged: rain protection always. If it's not raining, the sun will scorch you, so you're covered both ways. The question is why does it always seem to rain right at wrap? Since we were working near or on the water in a pretty wet area, mosquitoes were plentiful, but nothing that a healthy dose of DEET wouldn't solve. (Sorry, but I've learned that none of those alternative repellants, from Avon Skin So Soft to whatever natural product, are at all effective.) However, even after slathering on the DEET for our frequent night work—scary things do happen at night—I found myself terribly bitten. I thought I had bed bugs, which was ruled out after the hotel tore apart my room in search of them. It turns out they have some particularly nasty no-see-ums, biting midges. The best solution I found was long pants and long sleeves at night.

There is no soundstage in Puerto Rico outside of a television station. Instead we built sets, boat interiors mostly, in a dank and airless warehouse. The best that can be said about this place is that it was right next to one of the aforementioned Costcos and wasn't too far from the hotel.

Our river location was on the east side of the island, below El Junque rainforest, near the town of Río Grande, on the Río Espíritu Santos, about 45 minutes to an hour from our hotel. It's not much of a river; at points you could throw a quarter across it, but it is quite navigable and gave us long runs in either direction with little spurs and mangrove choked banks. It feels isolated even though it is close to the road, a couple of villages, and apparently an airfield. It is lush and green without the constant rain and restrictions of shooting in the actual jungle, but the wide shots would require some digital set extension and augmentation to really sell the Amazon. The boat playing the Magus was a full-sized, 60-foot working vessel not designed for this kind of environment. The art department did a great job of dressing it way down to give it a profoundly abandoned look, but it was very challenging to get it over the sandbar at the river's mouth. We were lucky to be there during a full moon that was actually closer to the Earth than usual, which created a higher than normal high tide and allowed us to make it upriver.

THINGS THAT GO BUMP IN THE NIGHT

Once we got underway, and once we got our heads around the concept of such a multiplicity of image capturing devices and their effect on our work, it was business as usual—almost. All departments share many common problems working on boats: cramped space, not really production-friendly. Kind of like a big insert car on water, it is hard to make changes once you're moving, much less stop or return for something you need. One issue that particularly concerns the sound department: what motivates the boat? Since we were using practical boats, there was the self-powered option. However, the few times that we fired up the twin diesels on the Magus, they were so loud that it was difficult to think, much less record dialog. Fortunately, we had Dan Malone heading our marine department. Dan is a guy who makes you both feel safe in all situations and that he understands your needs. He provided a large skiff which was used as a working platform and to push or pull the Magus and the smaller S.S. Hopewell—the boat that takes our intrepid travelers to find the abandoned Magus. Its engines were powerful enough to do the job, yet quiet enough, and the skiff long enough, to keep them at a respectful distance. The conceit was that the relatively quiet motor noise could be justified and blended with actual motor noise in the final mix. As these were working boats, we could have a pilot in the wheelhouse actually steering; this was not the case in Hawaii as you will see.

If the boats were moving or parked offshore or if we had a rugged and distant jungle location, I needed to grab my studio in a bag, the appropriate transmitters and mikes and go mobile. Knox would join me to manage the wiring and get the slates and maybe even boom a shot. Onboard, it could be challenging just to stay out of shot—did I mention that there were lots of cameras and never a tripod? I could often find a safe perch on the upper deck, which gave me a nice view of the surroundings, if not the action, and lots of fresh air. Sometimes the ferrous construction would limit my radio range; we might remote the antennas or I might have to scamper down from my crow's nest to get closer. We did have a video assist operator who was responsible for wrangling the many monitors attached to the many cameras, but once on board, he had his problems too. If it was feasible to set myself in view of the monitors, I would take advantage, but usually they were crammed in a corner with too many people so it seemed best to find a relatively comfortable spot, keep my eyes on the script, and imagine what it would look like. This worked well; it kind of took me back to the very old, pre-video assist days.

When the boats were tied up to shore, it was possible to work from the cart. I could park in a comfortable spot and push my RF cart close to the water's edge. I keep all the radio equipment, receivers and transmitters (Comtek and IFB) on this cart, which is tethered to my mixer's cart by means of an Aviom digital snake. This allows me 16 channels in both directions via a piece of Cat-5 network cable up to 300 feet long. (I've gone even longer than that with no ill effects.) Of course, this adds another cart to the package, but I find the increase in flexibility more than worth it. Rather than remote all those antennas, we move the whole package—antennas, receivers, transmitters, power—drop anchor, connect the Cat-5 and you're good to go. Aviom makes a good product, born of rock and roll, surprisingly sturdy and very transparent.

We had a few days when we were working with the inflatable Zodiac boats. Four boats, two with actors, an actor cameraman or an actual camera operator on each, simultaneously shooting as we zipped down our little river through the mangroves to where we emerge to find the Magus. We were in a follow boat trying to stay out of shot and yet within range of the video transmitters and my audio transmitters. Those Zodiacs are loud and the very dense mangroves and the water really do soak up the RF. This would have been a good opportunity for the Zaxcom TRX series of recording transmitters. When things get stretched beyond the limits of RF transmission, there is always the option of putting the studio in a bag in the boat with the camera and the talent, pushing "record" and sending them on their way. Sometimes that is the best choice; mostly we were able to keep our link by virtue of good driving. Reminding the actors to speak above the motor noise also helped. The situation is made more complicated when the actors are not only piloting the boats but operating the cameras, but with the coverage shot by the real camera operators and our persistence, we got the scenes.

As night falls on the river, along with the bugs there is a rising chorus, an onslaught of sound, quite formidable and immediately recognizable once you've heard it. It is los coquís (onomatopoeically: accent second syllable, rising pitch), the little frogs, the unofficial mascot of Puerto Rico, out looking for love every night. Barely an inch long, they raise quite a racket and there is no controlling them. I went to some trouble to get some nice clean coquí tracks, heading out on a small boat away from our encampment with a small Olympus pocket recorder. It was surprising how noisy it was out there when all you're recording is frog wallah. It is a distinctive sound, quite lovely and, for Puerto Ricans, very nostalgic, and it is all over the soundtrack of the pilot. I had thought this unique sound would be used throughout the series for continuity's sake, but it was left in the Caribbean. Although coquís had been introduced to Hawaii back in the '80s, they were considered an invasive pest (along with almost every other animal and plant on the islands) and eradication programs were undertaken. I never heard one over there.

The water work fell into the middle of our schedule; once we finished out in the wild, we fell back to our stage work for a few days and then finished with one of our few days shot on location in the city. Then pack it up, ship it home and adíos. A final word of caution regarding departure from Puerto Rico: My equipment had been air freighted out of Los Angeles by a reputable firm and had arrived intact at our stages in San Juan. If you find yourself working down there, do not assume that your outgoing shipment will be treated with the same respectful diligence. Absolutely be sure to supervise any packing for the return trip.

WE'LL BE RIGHT BACK AFTER THIS BREAK

To be continued in "Up *The River* in Hawaii." What? There are no actual rivers in Hawaii? Good point but we didn't let that stop us. Learn how in the next issue.

The Cable Connection Part 1

by Jim Tanenbaum, CAS

For many years, my sound cart has been a "cable-free zone." Besides the talent's radio mikes, both my boom operators are wireless, as are any plant mikes. My cart runs on batteries (105 amp-hours worth), including the built-in worklights. I have two UHF video transmitters that I connect to the video assist system so I don't need coax cables from it to my monitors, and I send the audio out by Comtek. Director, script, producers, etc., all get Comteks, and my boom ops have their Comteks on a separate frequency. (I have a third channel available if each of them needs to hear only their own mike.) As a result, buzzes from H.I.D. (High Intensity Discharge) lights, such as H.M.I. or Xenon, 60-Hz hum from power cables, RF (Radio Frequency) pickup from radio/TV stations, audio/timecode crosstalk, and static from moving bad cables are all a thing of the past.

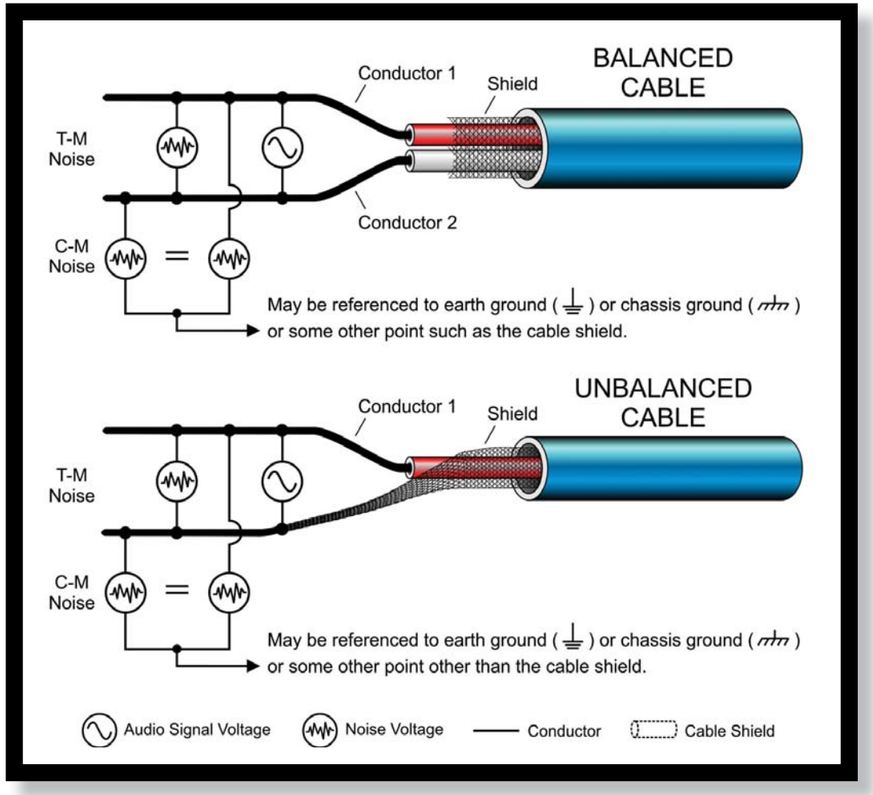


Diagram by Laurence B. Abrams

Or are they? Unfortunately, my cart is not, in fact, "cable free," because all my equipment is interconnected with ... (wait for it) ... CABLES. And some of you still use cabled mikes, connect to video assist with cables, run some or all of your gear on AC, send/receive timecode (TC) by cable, etc. Here's what I've learned in 45 years about dealing with these problems: like radio mikes, cables also work partially by magic. What appear to be similar problems often do not respond to the same solution, and equipment that is trouble-free one day may not be the next, even though everything is still in the same place.

The cables interconnecting various pieces of equipment on your cart are the easiest to deal with because they are under your complete control, do not change position (usually), and do not have to be connected and disconnected as much. Cables from your cart to somewhere else are subject to the "slings and arrows of outrageous fortune" in the outside world.

Most of this article is written at a fairly basic level, not requiring a great deal of electronics knowledge. There are a few advanced discussions here and there that can be safely skipped, or consulted with a more "techie" mixer. If the text becomes incomprehensible—just keep reading and it will soon clear up. (The other end of the cable is that I have overly simplified a few things, so I ask the technically-literate to please bear with me.) Local 695's website has an excellent online "Ground Loop" seminar by Bill Whitlock that is incredibly detailed and technical. It is almost exclusively dedicated to AC power noise problems in fixed installations, but very useful nevertheless and well worth several hours to watch. I have made sure to cover his relevant main points in this article as well.

A final note: cables have a much higher retail markup than recorders or radio mikes. Rental cables, in spite of Herculean efforts by the rental companies, are not 100% reliable. Therefore, if you know which end of a soldering iron to grab; make your own. If not, get your local techno-nerd teenager to teach you or take the Local 695 cable construction class.

Some Basic Information to Start With

1. Mike-level signals are in the 5 to 50 mV (millivolt = 1/1000 volt) range. Line-level signals are in the 0.5 to 5 V (volt) range. AC power is in the 100 to 200 V range. If you are involved with H.I.D. lighting units, the cable connecting the lamp to the ballast (called a "head feeder") carries thousands of volts (KV). The higher the voltage, the easier it is for the current to "leak" into some other circuit, like your mike cables.

2. Civilian AC power frequencies are in the 50 to 60 Hz range. (Hz or hertz, formerly called "cycles-per-second," or "CPS," a much more descriptive term.) Audio frequencies are conventionally said to be in the 20 Hz to 20 KHz (KiloHertz = 1,000 Hz) range, although few people today, especially anyone over 16, can hear anywhere near the top or bottom of that. RF (Radio Frequency, but not limited to "radio" signals) starts around 500 KHz with the AM radio band, and goes upward from there. MHz = 1,000 KHz and GHz = 1,000 MHz. The RF spectrum is further subdivided into HF (High Freq) = 30-100 MHz, VHF (Very High Freq) = 100-300 MHz, and UHF (Ultra High Freq) = 300-1,000 MHz. There is also ULF, VLF, LF, and MF, but they probably won't concern you. Frequencies in the GHz range are often called "microwave" or "MW."

3. All electrical conductors (except for superconductors, which you won't be dealing with) have some amount of resistance, measured in ohms (Ω). When an electrical current flows through a resistor it loses some of its voltage, although the amount of current (measured in amperes) remains the same. The amount of this "voltage drop" is given by Ohm's law: E = IR. (E is voltage; I is current; R is resistor; and IR means I times R.)

   For example, a table lamp with a 100-watt light bulb draws about 0.9 A (ampere or amp) at 110 V. If the 2-wire power cord has a resistance of 1 Ω in each wire, there will be a 0.9 V drop in each wire (0.9 A times 1 Ω), for a total of 1.8 V, so the light bulb will get only 108.2 V across the terminals of its socket. IMPORTANT: This drop is distributed such that the "hot" terminal of the socket will be at 109.1 V with respect to "ground" (the meaning of which we will discuss later), **and the other ("neutral") terminal will be 0.9 V above ground.** This "IR drop" phenomenon is the cause of most of our woes with "ground loop" problems, as we shall eventually see.

4. Whenever two wires run in proximity, energy can transfer between them by two mechanisms. This is true whether they are internal circuitry in equipment or inner conductors in a cable. Shielding may reduce or increase the effect, and the shield can even serve as a conductor itself. Current flowing through a wire produces a magnetic field around it, and if the flow varies, the varying magnetic field can inductively couple to the other wire(s) and induce a current flow. In addition, if a wire has a voltage on it, even if there is no current flow, a voltage can be capacitively coupled to the other wire(s). Sometimes the energy source is the pair of wires of a circuit, with the signal current flowing up one wire and back down the other, or a static condition with the voltage on one wire positive and the other negative. In these cases, the corresponding magnetic or electric fields around each wire are opposite polarity and cancel out, theoretically. In reality, the physical arrangement of the two wires is never exactly identical so the cancellation is never complete. There will still be some residual field left to interact with the remaining conductor(s).

5. Cables have a characteristic *impedance*, also measured in ohms but using the symbol "Z" to represent impedance, instead of "R" (used for resistance). Impedance is a more complex form of resistance, having capacitive and inductive components in addition to resistive. The main thing you need to know is that for analog audio cable, its impedance is relatively unimportant. For digital audio and timecode, it may be necessary to consider impedance, especially for long cable runs (see *baluns* later in the article). For video and RF antenna cables, impedance definitely needs to be taken into account.

6. Input and output circuits also have a characteristic impedance, and some of the same considerations mentioned above apply. Most professional dynamic mikes are Lo-Z, about 150 Ω, but some ribbon mikes are 50 Ω. Semi-Pro Hi-Z mikes are about 1,000 Ω (1 KΩ). Professional line-level circuits are 600 Ω. High-impedance circuits are many thousands of ohms (47 KΩ is common). In general, you can connect the output of a low-impedance device to a high-impedance input without distorting the signal, though the Hi-Z input circuit may not have enough gain. (And certain types of 600 Ω line-level outputs may not deliver the full level of low frequencies to a Hi-Z load. You can usually fix this by connecting a 600 Ω resistor across the input terminals.)

7. To summarize the above, you can connect a 50-Ω ribbon mike with a 110-Ω mike cable to the 5 KΩ "bridging" input of an audio amplifier with no problems. If you are sending AES/EBU digital audio to a device with a 75-Ω BNC input, but use a 110-Ω mike cable and a simple mechanical XLR to BNC adapter at the end of the run, you may or may not have a "jitter" problem, depending on various things including the length of the cable. But if you use a 50-foot length of 75-Ω video coaxial cable to connect your 50-Ω wireless mike receiver to a 50-Ω sharkfin antenna, you will definitely notice a loss of range compared to the proper 50-Ω coax.

8. "Crosstalk" is the transfer of a desired signal to another circuit where it is not wanted. Factors that increase crosstalk are: higher voltage, higher frequency, closer proximity, less effective shielding, and ground loops. Note that digital signals (audio and timecode) are a type of "square wave" that have high-frequency components (over 20 KHz) and can more easily crosstalk into other circuits compared to analog audio signals. Crosstalk can occur between external cables, between components of multi-cable snakes, or between the wiring inside equipment. (e.g., if you're recording TC on one audio channel of a video camera, attenuate the TC signal to at least 30 dB below full scale with an external in-line pad to prevent TC crosstalk inside the camera to the audio channel.) Even though some of these signals are above the audible range, they can still cause audible problems, as discussed in the next section for RFI (Radio Frequency Interference, but used for any type of noise signals in the MHz range.)

9. "Noise" refers to any unwanted addition to a signal (whether it is immediately audible or not). Beside audio and TC signal crosstalk, interference from AC power is another major offender.

AC power noise consists of *hum*, a low-frequency (usually the AC power frequency) tone, composed of a single, pure sine wave signal, or buzz, which adds harmonics to the basic hum. Because hum is a pure tone (60 Hz, or 50 Hz in some other countries), it can be more or less easily filtered out in post. A buzz, with its harmonics, can sometimes still be removed with a sequence of filters at 60, 120, 180, 240, 300 Hz… (or 50, 100, 150, 200 Hz…), but if there are nonlinear elements in the source, there will be non-harmonic components that cannot be readily eliminated. WARNING: Many military vehicles and installations use 400 Hz AC power or even higher frequencies. Working in this environment is extremely challenging because any AC pickup is almost impossible to filter out.

When AC power circuits have a bad connection point (loose or corroded; whether visibly/audibly arcing or not), it can create "static," which is heard as a sputtering or ripping sound.

Static (actually a form of radio signal) is created whenever electrical current flows through a mechanically imperfect (e.g., a rubbing or lightly touching) joint, as compared to a solidly clamped or soldered one. Note that static can also be created if one of your own cables has an intermittent connection at a plug, or a broken conductor or shield wire(s).

Finally, "inaudible" RF audio and video signals can produce audible noises, especially from high-powered commercial radio and television stations, even at a considerable distance. (Or a nearby video assist or remote control transmitter.) While their frequency is far above the audio range (MHz vs. KHz), if they infiltrate audio equipment, nonlinear components in the audio circuits can "detect" these signals and produce audible interference based on their AM modulation. RF signals can also interact with wireless mikes by heterodyning, creating sum and difference frequencies that fall in the audible range. And if their level is great enough, RF signals can overload lower frequency circuits, causing distortion or complete muting.

A Balancing Act—It's Easier to Balance on Two Wires Than One

Audio circuits can be either *balanced* or *unbalanced*. Balanced circuits have their signal carried by two conductors, neither of which is connected to "ground" (to be defined later, but we're getting closer). The two wires can be surrounded by a metallic shield, or not. Unbalanced circuits have only one conductor, surrounded by a metallic shield that is used to complete the circuit as well as to keep out interference. Almost always, balanced circuits are less susceptible to noise than unbalanced.

There are two forms of noise: *common-mode* (C-M) and *transverse-mode* (T-M). (Transverse-mode is sometimes called *differential-mode*, or *normal-mode*, from the geometric term "normal," which means "perpendicular to," but I will use "transverse" in this tutorial as it is less confusing.) Transverse-mode noise involves the interfering signal appearing between the single conductor of an unbalanced circuit and ground (or some other point), or between the two conductors of a balanced circuit. Common-mode noise involves the interfering signal having identical voltages (referenced to ground or some other point) on both the single conductor and the shield of an unbalanced circuit, or on both conductors of a balanced circuit. Like phantom mike powering voltage, C-M noise will not affect a balanced signal, but unless blocked, it can travel along with the signal until it reaches a susceptible circuit component and causes trouble there.

Noise can get into audio circuits by various methods: directly, by means of an electrical connection (or leakage through insufficient insulation); or indirectly, by means of an electric field (capacitive coupling) or a magnetic field (inductive coupling), or both. Any metallic substance can shield against electric fields, but only certain magnetically-conductive materials can block magnetic fields. A radio wave consists of crossed electric and magnetic fields, and it is sufficient to block just the electric field to shield against it. (Or just the magnetic field, but that's much harder to do.) An isolated electric field is most often encountered as "static electricity," such as when you pull off a sweater on a cold dry day and your hair stands

on end. Magnetic interference was a common problem in the days of tape recording, when the recorder's heads would pick up hums from nearby AC motors or transformers. Today, the problem usually occurs when dynamic microphones, or certain condenser microphones that use audio transformers, get too close to an overhead fluorescent light fixture with a magnetic ballast.

On the Ground at Last

The term "ground" has many meanings (the U.K. uses "earth" for some of them):

1. The physical substance on the surface of our planet. Most AC electrical power systems have their neutral conductor "grounded" at the service entrance, usually by bonding to the underground metal water-main piping and/or an eight-foot metal stake driven into the earth next to the structure.
2. The metal case and/or chassis of a piece of equipment. Often called *chassis ground*.
3. The zero-potential circuitry of a piece of equipment. Often called *circuit ground*. This may or may not be connected to the unit's case/chassis.
4. The metallic shielding of cables or other components.
5. A separate wire included in a cable or conduit for grounding purposes. This is done in some AC power cables as well as some audio cables. In the United States, power ground wires are colored green; other countries may use other colors. The ground wire may also be bare (un-insulated) or replaced by the metal conduit through which the wires are run.
6. A specific terminal on a device to which "ground wires" are connected.

In theory, a ground has no voltage on it, and can accept unlimited amounts of unwanted signals and dispose of them completely. Unfortunately, things in the real world are not so easy. In AC power outlets, there is a third opening (in the United States, it is round to distinguish it from the power slots) for the safety ground circuit. Any leakage current from connected devices flows through it to the bonding point at the service entrance, where it returns to the neutral wire. But this current flow creates an IR drop of hundreds of millivolts or higher, and this voltage will be different at each outlet. Where the electrical conduit serves this purpose, it often has high resistances at the mechanical joints, which may increase further with age, so the IR drop can be several volts. In addition, normal AC current flowing through the power and neutral wires can inductively couple to the ground wire and raise its voltage even more.

Ground Loops (Not the kind an airplane does when it crashes on takeoff)

Since any current flowing through a conductor (whether AC power, a desired audio signal or unwanted noise) will experience an IR voltage drop, if the audio and noise share a common circuit path at any point, their voltage drops may be added together, with unpleasant results for the audio.

Let's take a simple example. A small nightclub has a singer performing in front of a stand mike. The Hi-Z mike is connected to the house sound system with an unbalanced mike cable. The PA amplifier is connected to an AC outlet with a three-wire power cord, which grounds the amp's chassis to the electrical service entrance ground. The shield of the mike cable is also connected to the amp's chassis. The singer sings and all is well. Then she grabs the mike with one hand to remove it from the plastic clip, while she steadies the metal mike stand with her other hand. A loud hum blasts out into the audience. What happened?

The mike was in a plastic clip that had insulated it from the metal stand. When the singer touched both it and the stand, her body now provided an electrical connection from the mike to the stand, which was resting on the concrete floor (concrete is not a very good insulator). While it is true that the AC-powered amplifier's case and chassis were grounded, the ground connection was implemented through a long length of wire running down conduits in the building, and the AC leakage current flowing through it produced an IR drop of almost one volt, raising the amp's chassis above ground by that much. This "hot chassis" voltage in turn caused current to flow through the alternate path to ground created by the mike cable shield, the metal mike housing, the singer's body, the mike stand, the concrete floor, and the damp soil beneath it. Remember that the mike's unbalanced cable has a center conductor surrounded by a metallic shield. The few millivolts of audio from the mike travel down both of them to the amp. But now a far larger voltage is driving 10 or 100 times more 60 Hz current down the cable shield, and its IR drop adds to the mike's audio signal—indeed it completely overpowers it.

In fact, the singer was lucky that a loud noise was all that resulted from her actions. If the amplifier wasn't properly grounded (e.g., the plug's third prong broken off, a mis-wired outlet, or a 3-to-2 pin adapter used without attaching the grounding wire), she could have received a severe electrical shock instead of just a nervous one from the sudden loud noise.

If you plug several pieces of your equipment (with 3-wire power cords) into different AC outlets, the outlet's "grounds" will be at different voltages, and therefore, so will the equipment chassis. Now, when you interconnected the gear with audio cables, AC current will flow through the cables' shields to equalize the difference. 100 mA (milliamp) flowing through a 1 Ω shield will give an IR drop of 0.1 V. This is about a third of consumer or "semi-pro" line level, and only about -25 dB below professional. If it gets into the audio circuits…

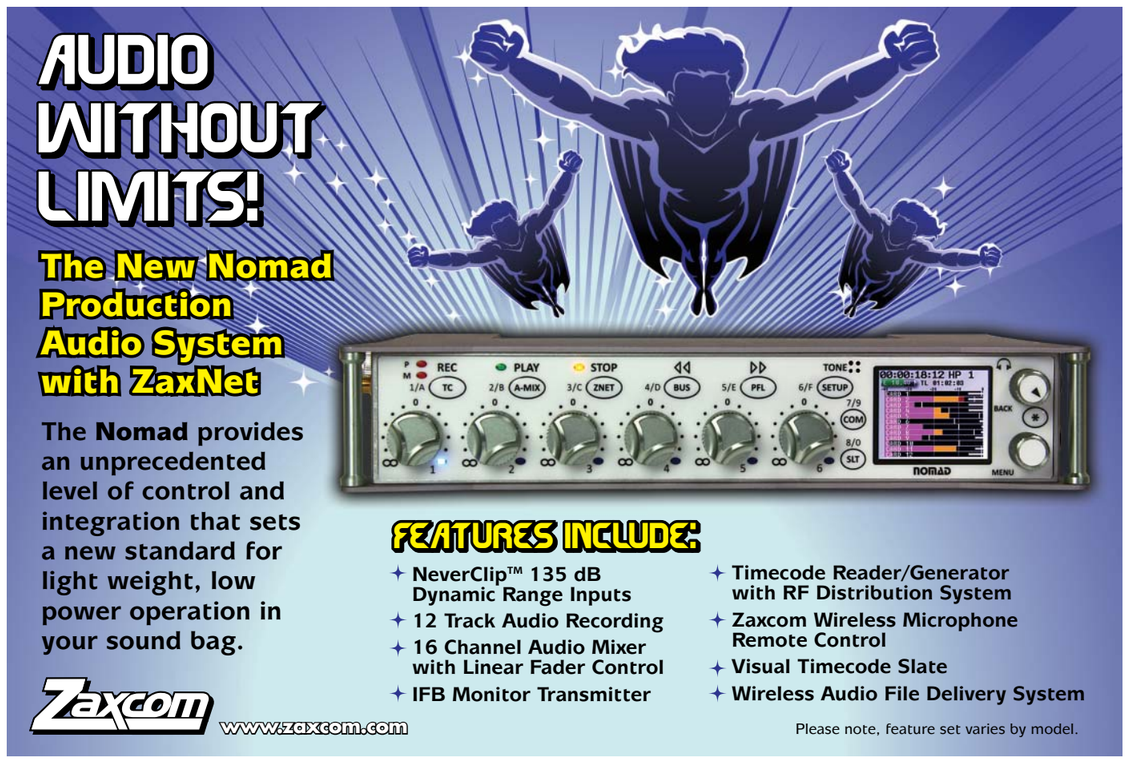
Using equipment with 2-wire cords won't necessarily prevent problems because they still have electrical leakage, and it will flow down the audio cables to any 3-wire units. Using all 2-wire gear can still give trouble because their leakage voltages will be different and will produce equalizing currents. Furthermore, 2-wire equipment is required to have its leakage current limited by higher impedance, to protect you from electrocution hazards. (Unless there's a design defect that got by the UL inspectors. You do trust them absolutely, don't you?) But because of the higher impedances involved, touching a particular unit can increase or decrease the hum or buzz, which terribly complicates troubleshooting.

WARNING: Using 3-to-2 pin adapters without connecting their ground lug/wire to "lift the ground" of all the 3-wire cord units may sometimes actually stop the hum/buzz, or reduce it to usable levels. DO NOT DO THIS! NO SHOW IS WORTH YOUR LIFE OR THAT OF A FELLOW CREWPERSON! Floating safety grounds are a disaster waiting to happen—even if only a "mild" shock results, it can cause someone to fall or jerk back into a serious or fatal accident.

Ground loops can also occur with the low-voltage DC current that powers your equipment, or even audio signals themselves. If you have an audio signal from one device passing through an unbalanced cable to another device powered from the same DC source, and the power cables to these pieces of equipment do not have exactly the same current times resistance, the IR voltage drop in the power cables will be different and the ground voltage at the equipment end will be different. If the equipment's cases are connected to one side of the power (as most are, usually the negative), they will be at different potentials, and DC current will flow through the shields of the audio cables to equalize them. Unbalanced audio circuits can be severely disturbed by this situation, and even balanced audio circuits may be affected.

This DC current flow can upset circuits regardless of whether they have *active* or *transformer* inputs. A *direct-coupled* active input can have a DC offset introduced that is sufficient to swamp it, or at least, add to the audio to the point of overload.

IMPORTANT: If you crimp a ring or hook lug to your wires, be sure that the crimper is properly sized for the gauge of wire, AND the particular type of lug. Lugs for the same gauge wire can have barrels of different wall thickness, and using a thin-wall lug in a crimper designed for thick-wall lugs will result in too little crimping pressure and an unsatisfactory joint. Make a test crimp and try to pull the wire out of the lug. The wire should break instead of pulling out. As an added protection, some mixers will solder the lug after crimping the wire in it.



Jim Tanenbaum at work. Note the empty cable hooks on the rear of the cart.

ing through). The lower the high frequencies you want to block, the larger (physically and electrically) these two elements must be. You may have seen *ferrite traps*, split ferrite cores in a plastic housing designed to snap around the outside of a cable, but they are suitable for stopping only radio frequency interference.

While not a ground loop problem *per se*, if one piece of equipment has inadequate power supply filter capacitors, it may have its current drain modulated by the audio (or some other function) and cause the output voltage of the common battery to fluctuate. This variation may in turn affect other devices connected to the same battery (or power supply if you're running on AC). You can solve this problem with "decoupling caps," large electrolytic capacitors (1,000-5,000 MFD @ 20 VDC) installed across the power circuit, as close to the offending device as possible. WARNING: These capacitors are polarized and must be connected correctly. They may explode, or at least vent hot gasses if hooked up backward.

Be sure to use adequately-large wires to carry DC power to the various gear on your cart. A 1-volt drop is not significant in a 110-volt circuit, but definitely is in a 12-volt one. Also, stranded wire can have several strands broken in the process of stripping off the insulation, further increasing the voltage drop. Be careful to avoid this when making connections. As an example, 10-gauge wire is rated at 30 A for a 100 feet of household electrical wiring, but for 12 VDC it should be limited to no more than 10 A for runs of 10 feet. (Easy to remember: 10-10-10.) 10-gauge copper wire has a resistance of about 1 milliohm (mΩ) per foot, so 10 A and 10 feet gives a voltage drop of one tenth of a volt (0.001 x 10 x 10 = 0.1), or slightly less than 1% of 12 V. But remember that there will be this drop in both power wires, for a total loss of 0.2 V. (Another example: a smaller 20-ga wire is about 10 mΩ/ft, so it is good only for 1 A @ 10 ft, or 2 A @ 5 ft, or 4 A @ 2.5 ft, etc.)

Capacitor-coupled inputs can have the same problems if there is sufficient leakage current through the capacitor, or transient charge/discharge currents if the DC voltage level changes. DC current flowing through a transformer input can fully or partially saturate the magnetic core, producing much the same kind of distortion.

Another problem occurs when HF noise such as from a switching-type (inverter) power supply travels out of the device over the DC power wiring, and then into another device over its power cable because both units are connected to the same battery. Using a power distribution panel that has filters at each output socket will help to eliminate this noise source. To be most effective, the filters should incorporate a parallel capacitor (to short out most of the higher frequencies before they can pass though to the next stage), followed by a series inductor (to block the remainder of the higher frequencies from passing through).

The most common connector used for low-voltage power distribution is the four-pin XLR, with Pin 4 positive and Pin 1 negative. Each pin is rated for 5 amps. This is sufficient to operate most devices, but may not be for recharging larger 12-V batteries. On my battery charger cable and the mating receptacle on the battery pack, I jumper Pin 1 to Pin 2, and Pin 3 to Pin 4, thus doubling the current-carrying capacity. WARNING: Some power systems use Pin 2 and/or Pin 3 for other voltages or charger inputs, so be careful not to use this high-current jumper format with them.

Editor's note: Subsequent installments will deal with transformer balancing, optimal cable wiring practices, sound cart construction to minimize grounding problems and other practices to assure safe and noise-free operation.

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When Sound was Reel-9

Custom Quad-Format optical recording, using specialized laser imaging system. (Courtesy NT Audio)

In the previous issue of "When Sound Was Reel," we examined the development of optical recording technologies for general 35mm film releases. In this installment, we cover the next generation of technology designed for discrete multi-channel theatrical exhibition.

Digital Comes to the Cinema

Although the development of Dolby Stereo, as conceived for encoding four channels of audio onto a two-channel release print, was a huge step forward in terms of sound quality for standard 35mm film releases, it could still not rival the quality of a good four-track or six-track magnetic release (at least when the film and heads were still in good condition). Besides the advantages of a superior signal-to-noise ratio and wider bandwidth, discrete magnetic recording systems were also free of the compromises inherent to the 4-2-4 matrix, which meant for Dolby Stereo there would always be some crosstalk issues between channels.

While this issue was minimized by careful channel placement during re-recording, it was still a far cry from the luxury offered by independent mag tracks on either 35mm or 70mm film. This was not lost on the engineers at leading suppliers to the film industry, who realized that further development would be needed if they were going to maintain a lead in the marketplace.

Kodak Gets Into the Sound Business (Again)

Despite the early efforts Kodak made in developing stereo analog optical soundtracks (which later became the basis for Dolby SVA) in the late 1980s, they once again saw an opportunity to advance the state of the art when it came to sound for release prints. As 16-bit digital audio became an accepted standard for consumer audio, Kodak, in partnership with Optical Radiation Corporation, invested a significant amount of money in developing a six-channel system that could record discrete digital soundtracks onto standard 35mm prints.

Determining how much data could be jammed into the area presently occupied by the analog soundtrack was the first design hurdle. Kodak engineers worked on developing a new sound negative film stock that had sufficient resolution to encode a data block only 14Xm in (14 micrometers). While the print stock used during this era could support the miniscule size of the data block, a new fine grain negative stock (2374) was needed to handle the recording of

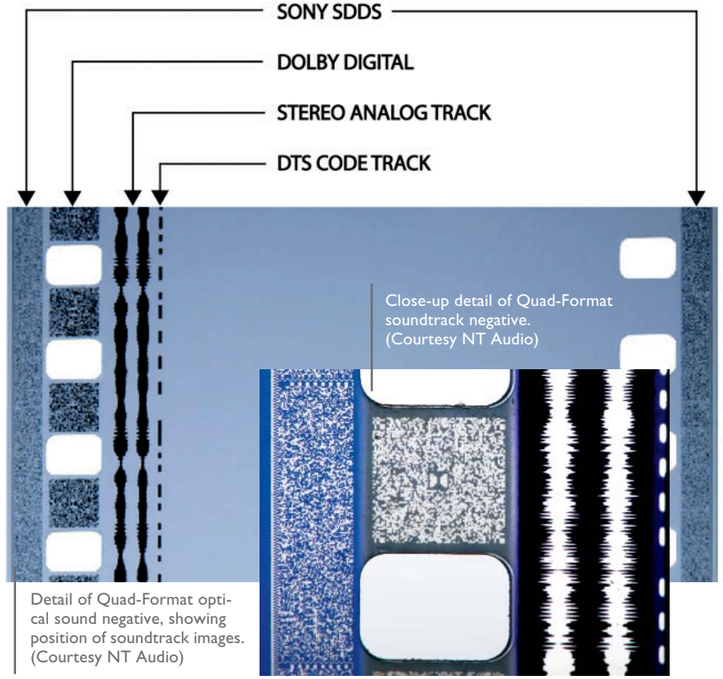
the data. With this aspect of the system solved, they determined that a 16-bit PCM signal could be reliably encoded using data compression. In practice, the system eventually employed a Delta-Modulation scheme, whereby the original 16-bit audio was compressed onto a 12-bit word. Even with this compression scheme, though, the bit stream rate worked out to be 5.8 MB/per second, nearly four times the data rate of a standard audio CD. The resulting system was named the Kodak Cinema Digital Sound system (CDS for short).

This presented a real challenge when it came to reliably streaming data from a reader on a standard projector. Because of this, early installations incorporated modifications to the projector transports to provide more stable scanning of the optical track across the sound head.

After a period of initial development, Kodak and ORC premiered their system with the release of the film *Dick Tracy* in June of 1990, in both 35mm and 70mm versions, two years before the release of *Batman Returns* in Dolby Digital.

While the system was generally well received, it had one fatal flaw: no backup track. Since the digital soundtrack occupied the full area previously inhabited by the analog soundtrack, this meant that any failure of the reader would result in no sound being heard at all. (It should be pointed out that the engineers involved in the development were in strong opposition to this approach, but management dismissed their concerns.) It was this aspect of the system (along with the nearly $20,000 theater conversion costs) that would ultimately spell its demise two years later, with only nine films having been released using the system.

Thus came to an end, Kodak's second foray into sound recording systems for film.



Detail of Quad-Format optical sound negative, showing position of soundtrack images. (Courtesy NT Audio)

Dolby Digital 1.0

In about 1988, nearly a decade after the release of *Star Wars*, Dolby engineers began development work on a completely new soundtrack format, one that would no longer rely solely on analog recording for release prints. At this juncture, nearly five years had passed since the introduction of the CD players into the consumer market, notably Sony's CDP-101. Just as the quality of consumer audio systems outpaced the typical sound system found in theaters during the 1950s and 1960s, the introduction of digital audio to the marketplace would once again lead the film industry into a new series of engineering challenges.

As part of their engineering mandate (no doubt strengthened upon witnessing the demise of the Kodak/ORC system), Dolby made the two decisions pertaining to the Dolby Digital system design:

- The system had to be backwards compatible, and
- The soundtrack had to be carried on the film itself (i.e.: not on a separate medium, such as a separate interlocked player or dubber).

These mandates posed some serious constraints as to how much data could be recorded onto the film. Since the format had to be backwards compatible, this meant the existing optical soundtrack had to remain in place. Since there was no option for moving the picture image, this meant that the only significant area left was either between the perforations area and the outside of the film (an area about 3.4mm wide), or between the perforations themselves (about 2.8mm wide). Dolby engineers chose the latter as the area that held the most promise, reasoning that the area outside the sprockets was more prone to damage.

Moreover, Kodak (and others) used the area outside the sprockets for latent image key codes, making it unsuitable for soundtrack imaging. While the theory that the space between the perforations was a more protected had some merit (as experienced by Kodak with their CDS system), the unfortunate reality was that many film projectors still produced a significant amount of wear in the perforation area, making robust error correction and a backup analog soundtrack a must.

Despite these hurdles, Dolby engineers managed to produce a system that was quite reliable, given the constraints that they had to work with. In its original configuration, Dolby Digital consisted of a bit stream encoded at a constant rate of 320 kB per second, with a bit depth of 16-bits. While the bit rate was only about one-quarter that of a standard audio CD, it did for the first time, make possible a system which could record six discrete audio channels on a 35mm release print and was also backwards compatible with existing 35mm analog soundtracks.

However, despite Kodak's exit from the market, Dolby engineers were not the only ones in the game when it came to digital soundtrack development.

DTS Throws Down the Gauntlet

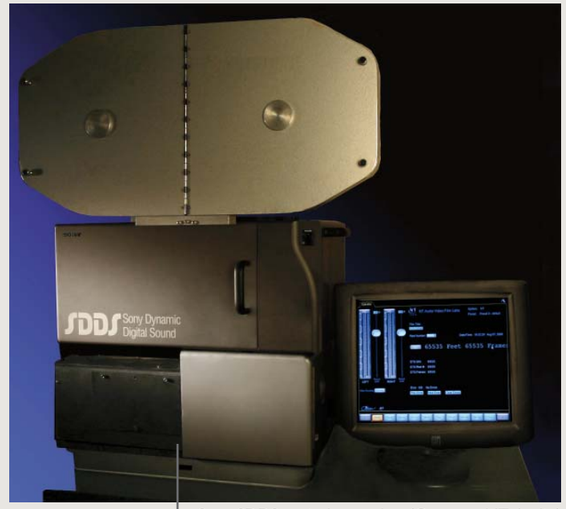
While engineers were toiling away at Dolby, other entrepreneurs were looking at similar possibilities for marrying a digital soundtrack to film. A notable example was Terry Beard, who ran a small company called Nuoptix, which had specialized in producing upgraded recording electronics for analog optical recorders. These systems became the basis for many of the Dolby Stereo variable-area optical recording systems installed as Dolby Stereo achieved a greater market penetration.

Beard chose to take a slightly different approach to the conundrum of how to fit sufficient data onto the minuscule area available on standard 35mm prints. Instead of recording the audio signal directly onto the film, he chose instead to simply record timecode in the very small section between the picture frame and inside edge of the analog soundtrack. This timecode was in turn used to slave playback from a specially modified CD player that could carry up to six discrete channels of high-quality audio. Known as "double system" in industry parlance, this approach had been used in the past for specialty releases like *Fantasia*, all the Cinerama films, as well as and the original Vitaphone disk releases from Warner Bros. In general, this approach was not well received in the industry, due to problems associated with separate elements for picture and sound. Besides the possibility of an element becoming lost or separated, there were huge synchronization headaches.

Beard, however, was convinced of the viability of the format, and continued to press on in development of what would become known as DTS. After a chance encounter with Steven Spielberg, Beard had the opportunity to showcase the system to him in August of 1992. After some further work and demos to execs at Universal, Spielberg was convinced of the viability of the system, and by February of 1993, Digital Theater Systems was officially formed, with Spielberg himself signing on as one of the investors.

With *Jurassic Park* scheduled for release in June of that year, Beard and his team had only four scant months to assemble enough units to supply theaters to support the wide opening planned. Undaunted by this nearly impossible deadline, Beard and his staff managed to deliver 900 processors to theaters by the second week of the film's run! Fortunately, most of the technology needed to actually go into production had already been vetted, so the primary hurdle was simply building enough units to supply the theaters.

While this "double system" approach was still not generally well received by distributors (disks could be lost or damaged), it did provide for high-quality reproduction of discrete soundtracks with a minimal amount of data compression. In the early 1990s, there were few options available for compressing audio data onto limited carriers. After reviewing the options, Beard chose a system developed by Audio Processing Technology (APT) out of Belfast, Northern Ireland. Data reduction is a tricky business. The APT system was unique in that it used only a predictive mathematic table to encode and reconstruct the data, as opposed to techniques employing "masking" of the signal. As the system offered an off-the-shelf solution, it made it very attractive to DTS, as it meant they didn't have to develop their own data-reduction system.



Sony SDDS optical recorder. (Courtesy NT Audio)

A further feature of DTS was that it could seamlessly adjust for any missing frames in the film, automatically compensating for the lost timecode by providing a large buffer between the disk and the system output, which could make up for dropped frames.

In its original configuration, the DTS system had been designed in two versions; a full six-channel discrete system, as well as an economy two-channel version, which could utilize the same encoded L_t/R_t signal as analog Dolby Stereo. This was, in fact, the version that was delivered to most theaters during the initial *Jurassic Park* run. However, there were some problems involved with properly setting up the processors in this configuration, and in the end, it was decided that only six-channel systems would be installed.

The deployment of tracks was the same 5.1 approach as used by Dolby Digital, so the only expense incurred by theaters was the installation of the timecode reader on each projector, along with the DTS disk player.

OK, That's Three. Let's Add Another Format!

While most industry observers would likely contend that jamming three audio formats onto a single piece of film was probably sufficient, that is not the way the film business works. Not wanting to be left behind, execs at Sony/Columbia decided that they too needed to develop a multi-channel digital sound format for theater exhibition. However, by this point, space was running out on the print, so the only option landscape left was the area between the sprockets and the outside film edge, as well as a very small space between the picture frame and inside of the analog soundtrack (which was already occupied by the DTS timecode).

Undaunted by these constraints, Sony engineers contracted with Semetex Corp., a manufacturer of high-precision photodiode array devices, to design a system which could resolve miniscule amounts of data from the area between the sprockets and outside edge of the film. This system would become known as Sony Dynamic Digital Sound, or SDDS. However, unlike Dolby Digital and DTS, the system boasted

eight independent channels of audio! In practice, however, few films ever took full advantage of the full eight-channel capability, due to the costs associated with both mixing and equipping theaters with additional speaker systems.

In its original implementation, the Sony system used a 7.1 speaker system. However, unlike 5.1, the Sony system utilized five full-range screen channels, along with stereo surrounds, a layout similar to the original Todd-AO six-track 70mm format (with five screen channels but only mono surrounds). This was quite different from what eventually evolved into Dolby Digital 7.1.

Similar to both Dolby Digital and DTS, the system also required some data compression. To achieve the needed data rate, Sony utilized the ATRAC data compression scheme, which allowed for a compression ratio of about 5:1. Sony also provided for redundancy of the primary eight channels by including four backup channels, in case damage to the film caused data dropouts on the main channels. In practice, this proved to be a necessary feature of the system, as prints were frequently damaged by careless handling on platter systems.

Although Sony had originally planned to deploy the SDDS in December of 1991 for the release of *Hook*, the work needed to refine the system delayed its release an additional year and a half. It premiered instead with the release of *Last Action Hero*. Since Sony at that time owned its own theater chain (later sold to Loews), it could leverage its exhibition position to gain market penetration that would have otherwise been difficult to garner in the face of competition from Dolby and DTS. Further, via their ownership of Columbia/TriStar, they could create demand for the system by releasing all of their films with SDDS.

Alas, despite their advantage in the exhibition market, the only other theater chain that signed onto the SDDS system was the AMC chain, who struck a deal with Sony in 1994 to include the system in the new auditoriums they were constructing during their expansion phase. While the much touted eight-channel could theoretically offer an improved theater sound experience, the reality was that fewer than 100 films ultimately used the full capabilities of the format. Further, theaters were reluctant to invest in the needed hardware and speaker system upgrades necessary to realize the full potential of the system.

Although the system did gain favor with many of the studios for release of bigger budget films, most independent films during this period were being released primarily in Dolby Digital (and possibly DTS), which meant that the capabilities of the SDDS theaters went underutilized.

With market penetration stalled, and facing strong competition form Dolby and DTS, Sony ultimately made the decision to abandon manufacturing of the system in 2004. However, support for existing systems will continue until 2014, and new titles are still being released utilizing the SDDS format.

Review

With the variety of competing formats, it is interesting to take note of the bit stream rates and channel configurations employed by each of the competing systems:

Kodak CDS System (for both 35mm and 70mm film):

Data Rate: 5.8 mb/sec
Sample Rate: 44.1 kHz
Bit Depth: 16 Bits
Data Compression: Delta Modulation

Channel Configuration:
Five Channel (5.1 with LFE) (Left/Center/Right/Left Surround/Right Surround)

Dolby Digital (for 35mm film):

Data Rate: 320 kb/sec
Sample Rate: 48 kHz
Bit Depth: 16 Bits
Data Compression: AC-3

Channel Configuration:
Mono (Center Channel)
Two-channel stereo (Left + Right)
Three-channel stereo (Left/Center/Right)
Three-channel with mono surround (Left/Right/Surround)
Four-channel with mono surround (Left/Center/Right/Surround)
Four-channel quadraphonic (Left/Right/Left Surround/Right Surround)
Five-channel surround (Left/Center/Right/Left Surround/Right Surround)

Additionally, each of these formats can utilize an extra-low-frequency channel (designated the ".1 channel"), which is usually assigned to a separate subwoofer.

Dolby also provides for 6.1 and 7.1 formats in the Dolby Digital Surround EX format, which implement mono rear surrounds and stereo rear surrounds respectively.

DTS

Data Rate: 1.536 mb/sec
Sample Rate: 44.1 kHz
Bit Depth: 16 Bits
Data Compression: APT-X100

Channel Configuration:
Five Channel (5.1 with LFE) (Left/Center/Right/Left Surround/Right Surround)

SDDS

Data Rate: 2.2 mb/sec
Sample Rate: 44.1 kHz
Bit Depth: 20 Bits
Data Compression: ATRAC2

Channel Configuration:
Five Channel (5.1 with LFE) (Left/Center/Right/Left Surround/Right Surround)
Seven Channel (7.1 with LFE) Left/Left Center/Center/Right Center/Right/Left Surround/Right Surround)

Virtually all of the systems boasted a bandwidth of 20-20kHz (for the primary channels), along with a noise floor that was virtually silent in even the best theaters. Further, they did away with the compromises inherent in the 4-2-4 matrix used for Dolby Stereo analog. While debate still rages among aficionados as to which of the systems sounds the best, there can be no doubt that all them provided a major step forward for sound reproduction in a theatrical environment.

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