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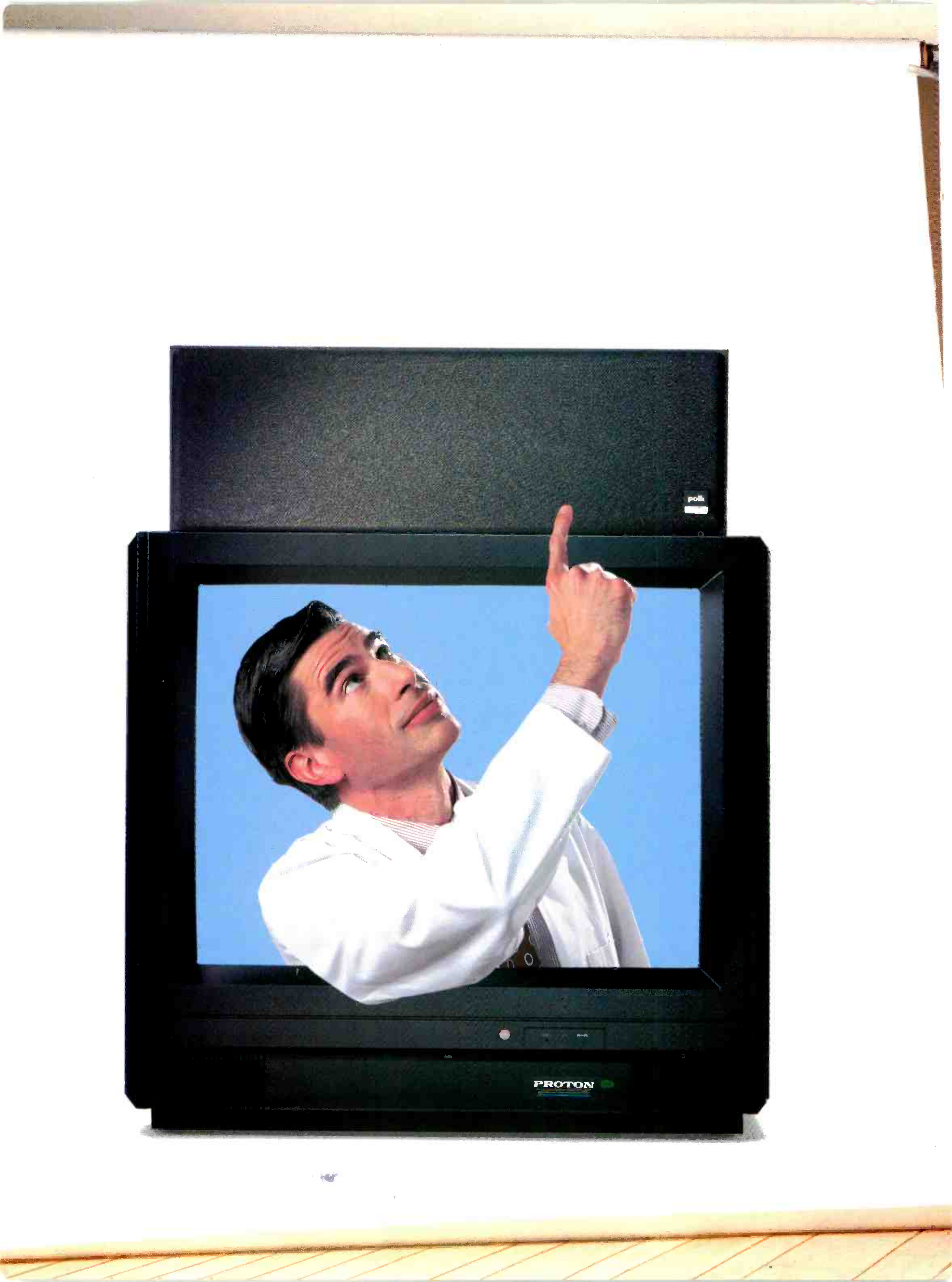
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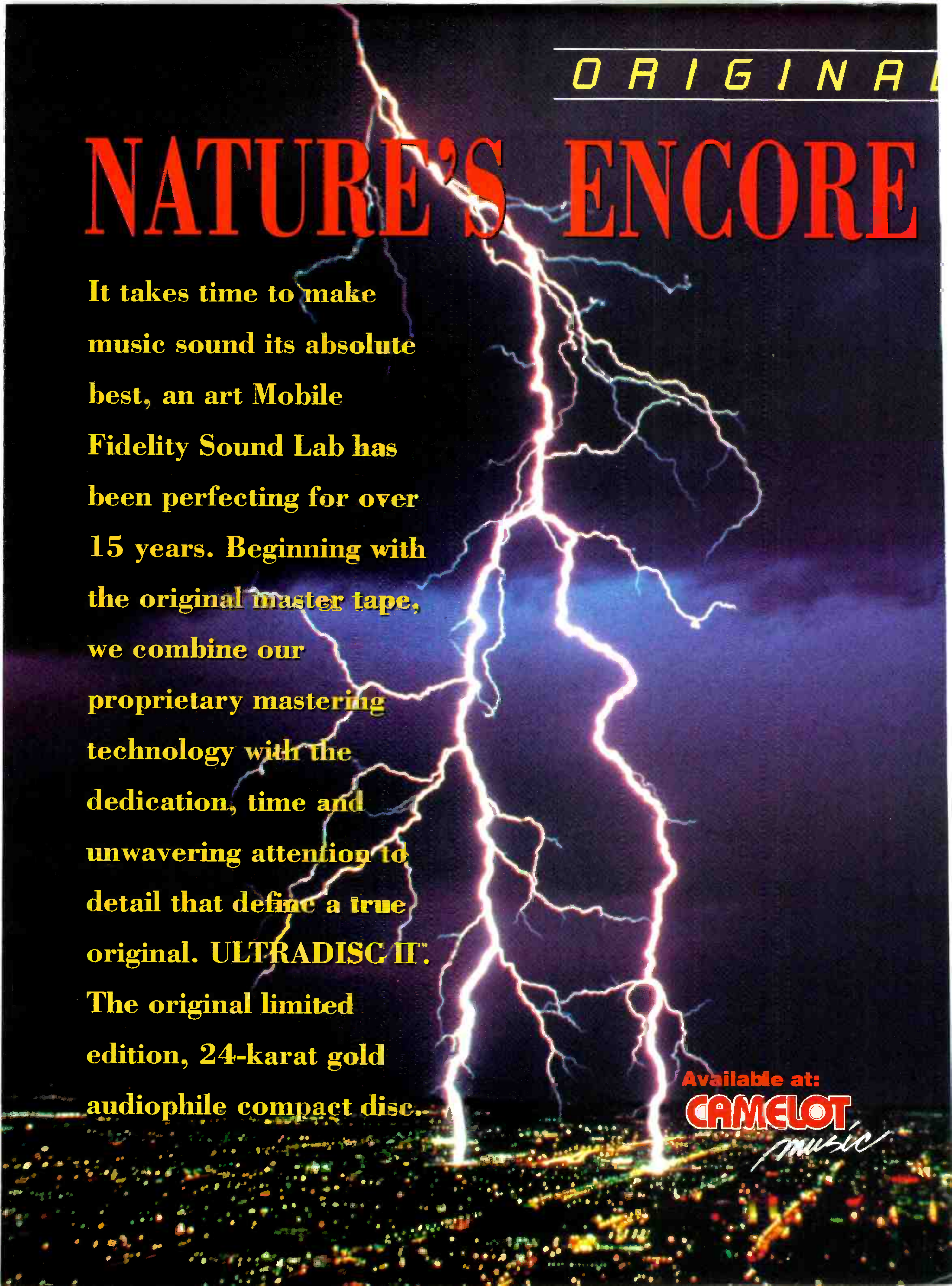
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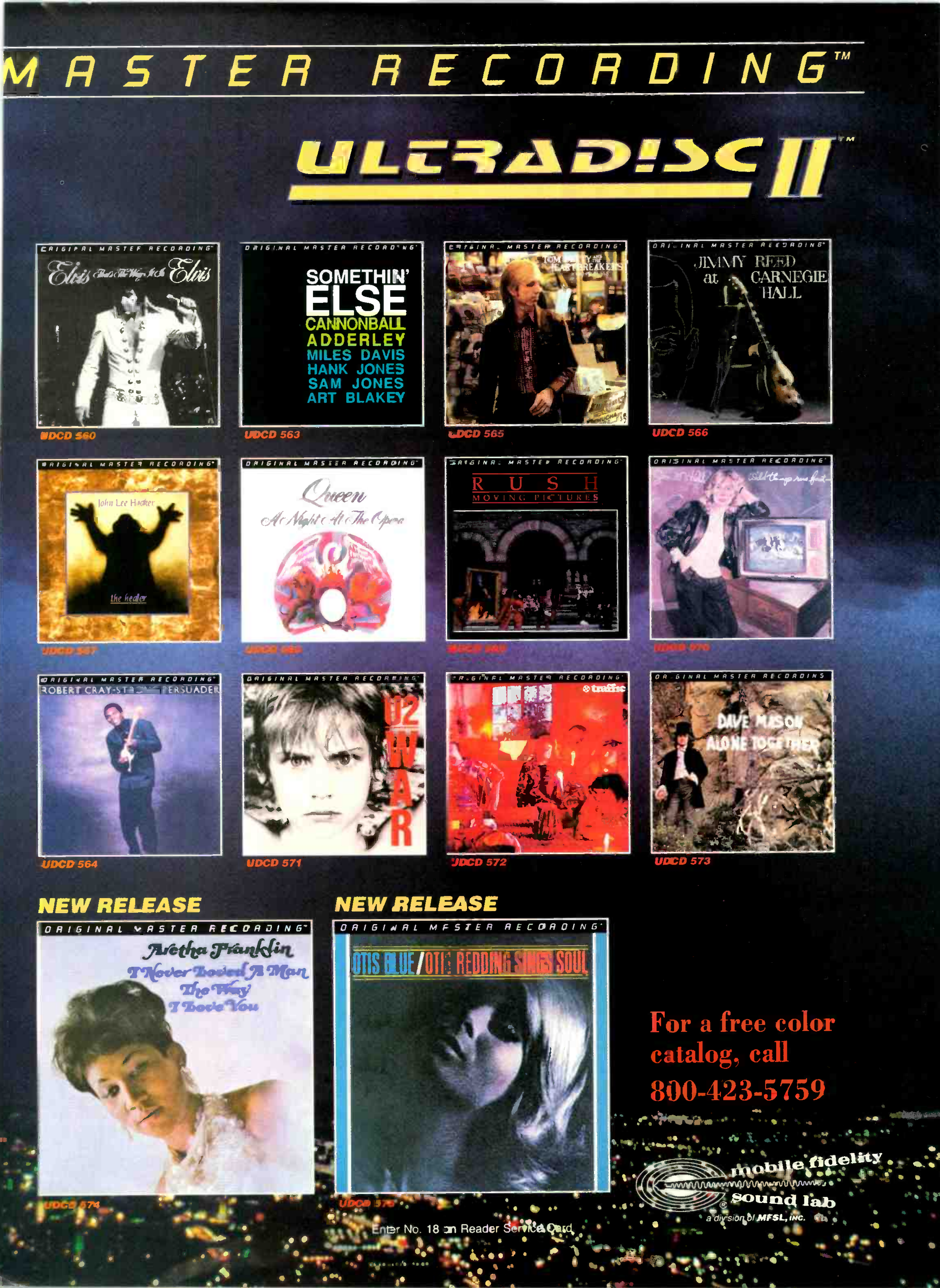

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APRIL 1993 VOL. 77, NO. 4

AUDIO

Center Channel, *page 26*

Technics, *page 40*

Classical, *page 80*

Soundstream, *page 70*

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Nº 30

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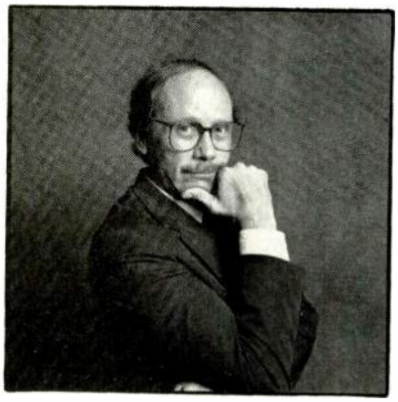
FAST FORE-WORD



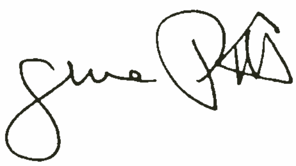
For most of the past three days, I have been dealing with a change in the reference speakers we use in our listening room at *Audio*. I won't say that I've spent every minute boxing and unboxing speakers; I have taken and made quite a few phone calls, read a few galley proofs, and written a few letters. But since we don't do this as often as every year, it's worth discussing why and how. We're changing from Thiel CS5s to B & W 801 IIIs for several reasons. The principal one has to do with a recent move from one listening room to another and dealing with a space that has different and poorer dimensions. The other reason is simply my desire to use the same reference as our principal speaker reviewer, Don Keele.

Both speakers are fine examples of the science and art of loudspeaker design, and the change should not be taken as a knock on the Thiels or as an indication that I feel the B & Ws are superior. Indeed, I probably would not have changed had we still been in our old listening room, which was good enough that the Thiel folks wanted to know the dimensions so as to pass them on to those who wanted to build a room in which the CS5s would sound good. While a "good-sounding room" partially has to do with the interaction of woofer elevation and the three room dimensions, I suspect that no speaker would have sounded out of place in that room.

But as I say, I've spent about three days on this change, and I haven't yet gotten to listen to the new speakers. The reason for this is the extraordinary regard the Thiel people have taken for the safe transport of the CS5s, a regard I wish every speaker maker showed for the fruits of his labor. Now, the CS5s are rather heavy, at 180 pounds each, so the firm sends these speakers out in pairs of individual crates, each of which is big enough for a large man to lie in. The pairs of crates are tied together with four additional boards, and each crate is built with dozens of large wire staples. Inside each crate, strips of wonderfully resilient ethafoam are put into strategic positions using hot-melt glue. I had two strips come loose when I opened up the second crate and leaned on them; the hardware store around the corner from our offices sold me a spray can of 3M Type 76 adhesive that worked very well with a double application.

I do not think that all speakers need to be shipped in crates, but I certainly do feel that the use of such resilient foam should be all-but-standard in the industry. We use only three shipments via common carriers to get speakers through our review system, but the most usually used foam simply shatters and shreads at the first good impact, making it nearly worthless. Even with relatively lightweight items, such as tuners, this foam too often isn't up to the second shipment, and needs to be supplemented with whatever is at hand—bubblewrap, newspapers, other publishers' magazines, foam peanuts, etc.

So, thanks, Thiel, for the loan of the CS5s, and for using that foam. It would certainly make my life easier if other speaker makers followed suit.



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Lirpa's Not Off His Rocker

Dear Editor:

Not so long ago I was a distressed person, acquainted with every grief of the dedicated hi-fi listener. Delving into various audio publications (mostly small ones) of the so-called subjective persuasion, I was able to alleviate my affliction by doing various little tweaks, such as dyeing the rims of my CDs with methyl rosaniline chloride, as well as mounting my two loudspeakers on little (non-inverted!) pyramids of tungsten.

My happiness would have been unalloyed had I been able to indulge in both of my dearest enjoyments simultaneously—sitting in a rocking chair and listening to music. As it was, that old bugbear of Doppler distortion I thought I had banished by acquiring a pair of Lirpa Labs Full-Range Electrostatics (50 kHz to d.c, ±2 dB) was raising its ugly head again. The music varied in pitch as I was rocking toward the speakers or away from them.

What with his formidable credentials (absolute pitch being the least among them) and the geographical proximity of his Research Institute to Finland, Prof. I. Lirpa was the logical choice as the person to tackle the problem. He quickly came up with a reciprocating linkage system, whereby the rocking chair, the speakers, and any objects with surfaces causing early reflections all moved in unison and equidistant to each other. Aurally, the improvement was out of this world; visually, the impact was no less dramatic.

This was not to be the ultimate system, though. After a while, all those joints, linkages, and cams tended to develop noises; anticipating this, Prof. Lirpa had specified a complete lube job every 21,000 rocking cycles (peak to peak). Still, the whole setup looked too Rube Goldberg-esque to satisfy Prof. Lirpa's tastes for neatness and elegance. It so happened, about a year later, that there was a considerable increase in number-crunching power at Lirpa Labs with the acquisition of their latest-generation YARC IV mainframe computer. At about the same time, I got my first six-channel home theater system, which was a lot more than the original linkage system could handle. However, for the genius of the Professor it was no big deal to develop a computer program to simulate the mechanical system by means of digital delay and acceleration circuits. Instead of moving the speakers, the program "changes" their positions with far greater subtlety.

Sitting in my rocking chair surrounded by that glorious sound, I have but one complaint to make: The video screen has me seeing red shift.

Matti Salonen
Kuusankoski, Finland

Prof. Lirpa's Reply: The computer program does, in fact, include automatic adjustments for the video signal—and I personally verified all audio and video connections while supervising the installation in your house. Perhaps your problem is atmospheric. The position of Kuusankoski just above latitude 60° not only places you at the southern edge of your country's Lake District—where the constantly moist air is known to affect visibility—but also situates you within the Earth's northern *auroral region*, the area of greatest northern-light activity according to S. Chapman's accepted plot of auroral geography. To learn how to reduce reflections of these lights in your home theater, I recommend a new book by Prof. Anni-Frijid Pink: *The Auroral Aura in the Aural/Visual: An Oral History of Normal Cure-alls.*

The Last of the Elcasets?

Dear Editor:

In your 45th-anniversary-year supplement (September 1992), you ask, "What Ever Happened to Elcaset?" My Sony Elcaset deck still makes wonderful recordings. Sony no longer makes blank Elcaset tapes. I am interested in buying any tapes your readers may have.

Ray Warns
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Every so often, a product is introduced that's so good, it serves as the benchmark for an entire industry. Yamaha's critically acclaimed DSP-A1000 is such a product.

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AUDIO CLINIC

JOSEPH GIOVANELLI

Yesterday's Truths, Today's Errors

I've taken this title from a history lecture I attended some years ago, because history—specifically, audio history—is involved in a valuable lesson I've just learned.

Back in the '50s, when I was designing and making loudspeakers, I was a frequent guest on radio shows about high fidelity. A lot of my air time was spent pleading with listeners not to use the 22-gauge wire often sold as "speaker cable." For all I know, I may have been among the first to understand and speak about the importance of keeping cable resistance low. I followed my own advice, using 16-gauge wires for my own speakers; they proved heavy enough.

Recently, a fledgling speaker designer came over with what he knew, or thought he knew, was the greatest speaker ever. I disconnected my speakers and hooked his to my existing cables, then played program material with which I was completely familiar. The speakers sounded mediocre to poor—even the designer said so. But he also said his creations never sounded that way in his living room, where his amplifier was near the speakers, connected to them by short lengths of exotic, heavy cable.

The way my room is laid out, the run to the speakers is about 40 feet, which I admit is starting to push what can be expected from 16-gauge line. As I had no heavier wire, I moved my amplifier near the speakers so that my longest run of 16-gauge wire would be about 5 feet. I then needed to lengthen the interconnect cables between my preamp and my amp. Because my preamplifier's output impedance was low, I still had a flat frequency response over the audio range.

Now, when we replayed the same program through his speaker systems, it was as though we had connected a completely different pair of speakers! Where there had been virtually no bass at the start, bass was now solid. Serious midrange aberrations were gone: The over-forward sound was gone, and I was listening through *the speakers, not* to *them. Even the highs were smoother and more open.*

When the listening tests were done, I asked him more about his design. His speakers' impedance, while 8 ohms in the midrange, was only 4 ohms at low frequencies and had also fallen off at high frequencies.

Then, it all made sense. My original wire had a somewhat high d.c. resistance of about 0.3 ohm. Very little of the midrange was lost in the cable. But because of the speaker's low impedance at low frequencies, the bass was more heavily affected; it's a simple matter of voltage division. And because of the low impedance at high frequencies, the extreme highs were also lost in the cable.

SPEAKER WIRING THAT SUFFICED IN TUBE DAYS WON'T WORK AS WELL WITH SOLID-STATE AMPS.

Up until now, when a reader asked whether his power amps should be closer to his speakers or his preamp, I've usually suggested that power amplifiers, which usually aren't decorative, should be hidden in the equipment cabinet, provided that, if the cable runs were long, wire of at least 16-gauge was used. That's more or less true even now—but only if the speakers have an impedance of 8 ohms or more across most of their bandwidth.

Table I—*Wire size versus resistance.*

Wire Size, AWG	Resistance per 1,000 feet, Ohms	Maximum Length for 0.1 Ohms, Feet
6	0.8	125
8	1.3	78.1
10	2	50
12	3.2	31.3
14	5.2	19.2
16	8	12.5
18	13	7.7
20	20.6	4.9
22	32.6	3.1

When I started recommending 16-gauge cable, I was giving good advice. But that was in tube days, when the resistance of amplifiers' output transformers was a factor. Now, when most amplifiers are solid-state designs with far lower output resistance and impedance, it's time to update my recommendation. In this case, yesterday's truth is definitely today's error. From here on in, I'll tell anyone who asks that he should keep the d.c. resistance of his speaker cables under 0.1 ohm, either by using heavy cables or by moving the power amplifiers as close to the speakers as possible (see Table).

Noisy Muting

Q. *My preamplifier has a muting switch, which can be helpful when the phone rings and instant quiet is needed. But there is some kind of electronic transient noise when I switch the unit to "Mute." There is no noise when I switch from "Mute" to "Operate." I took the preamplifier to my dealer and he found no problem. Where do you suggest I go from here?*—Nelson A. Cusher, Buffalo Grove, Ill.

A. I do not know if the sound you hear when the preamplifier is switched to "Mute" is normal or not. If it is normal, then no servicing is needed. You should check with the manufacturer of the equipment about this.

For the moment let's say that the noise is normal. If your power amplifier has input level controls, turning these down a bit will likely reduce the sound to tolerable limits. Of course, you should not turn the input controls so far that you cannot obtain adequate listening levels.

Unloaded Output Stage

Q. *I am using a stereo amplifier to drive just one loudspeaker; this is done so that I can have a center channel in a theater system. One channel of this amplifier is unloaded. Will this do harm to my amplifier? Is there anything I can do to eliminate any possible damage?*—Bordir Luoh, Pittsburgh, Pa.

A. Your system will probably run just fine with one channel unloaded, as long as you don't feed any signal into the unused channel. If you believe that the amplifier is unstable when unloaded, place an 8-ohm resistor across the unused pair of output terminals. The resistor can be of almost any wattage; a 10-watt resistor will be fine. A

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1633 Broadway, New York, N.Y. 10019. All letters are answered. In the event that your letter is chosen by Mr. Giovanelli to appear in Audioclinic, please indicate if your name and/or address should be withheld. Please enclose a stamped, self-addressed envelope.

Turn Your Stereo Into An All-Out Dolby Surround Pro-Logic System.

NEW FROM CAMBRIDGE SOUNDWORKS

Our new PL100 Dolby Pro Logic decoder with 3-channel amplifier; magnetically shielded Center Channel speaker; The Surround II dipole radiating surround speakers. Factory-direct price, $799.

Until now, adding Dolby Surround to a stereo system has been complex and expensive. Add-on decoders were inadequate, costly, and often required separate amplifiers. We've changed all that with our affordable, high performance Pro Logic Add-On Systems.

Both systems are centered around our new PL100–a Dolby Pro Logic decoder with three channels of amplification (40 watts to the center channel, 15 watts to the surround channels) and a wireless remote. Its built-in signal generator enables precise balancing of the left, center, right and surround speakers. The signal delay applied to the surround channel is selectable for room size. Other controls include master volume, rear and center level, and a Phantom mode enabling the use of the PL100 without a center speaker. Purchased separately, the factory-direct price of the PL100 is $399.

Our new PL100 Dolby Pro Logic decoder with 3-channel amplifier; low profile Center Channel Plus speaker; The Surround dipole radiating surround speakers. Factory-direct price, $999.

$799 Dolby Pro Logic Add-On System.

The center channel speaker in our $799 Dolby Pro Logic Add-On System is our new magnetically shielded Center Channel (see ad on following page). The rear/side speakers are a pair of The Surround™ II. Unlike any other surround speaker in its price range, The Surround II uses advanced dipole radiator technology. Properly mounted on the side walls of a listening room, their high frequency drivers direct out-of-phase sound signals towards the front and rear of the room. The sound then reflects off the surfaces in the room, finally reaching listeners from all directions, "surrounding" them with sound.

Because the drivers are out of phase with each other, they create a null area directly in front of the speakers, so listeners can't pinpoint the source of the sound. The result is surround sound the way it was meant to be heard.

$999 Dolby Pro Logic Add-On System.

Our $999 Dolby Pro Logic Add-On System combines the PL100 with our new low-profile Center Channel Plus speaker and our highly acclaimed surround speaker, The Surround. Center Channel Plus is a magnetically shielded speaker with four 3" long-throw woofers and a ring radiator tweeter. Because of its wide, low profile (25" wide, 4" high, 6½" deep), it is ideal for placement directly on top of, or, with optional support unit, *beneath* a TV. The frequency range of the outer pair of 3" woofers is intentionally limited to maintain proper dispersion. We don't know of any speaker, at any price, that outperforms Center Channel Plus.

The surround speakers in this system are The Surround, a dipole radiating speaker with higher volume level capability than The Surround II. We feel The Surround is one of the very best surround speakers made, despite the fact that it costs hundreds less than competing models.

So if you already own a fine stereo system, TV and VCR, why not create an all-out home theater with one of our Dolby Pro Logic Add-On Systems?

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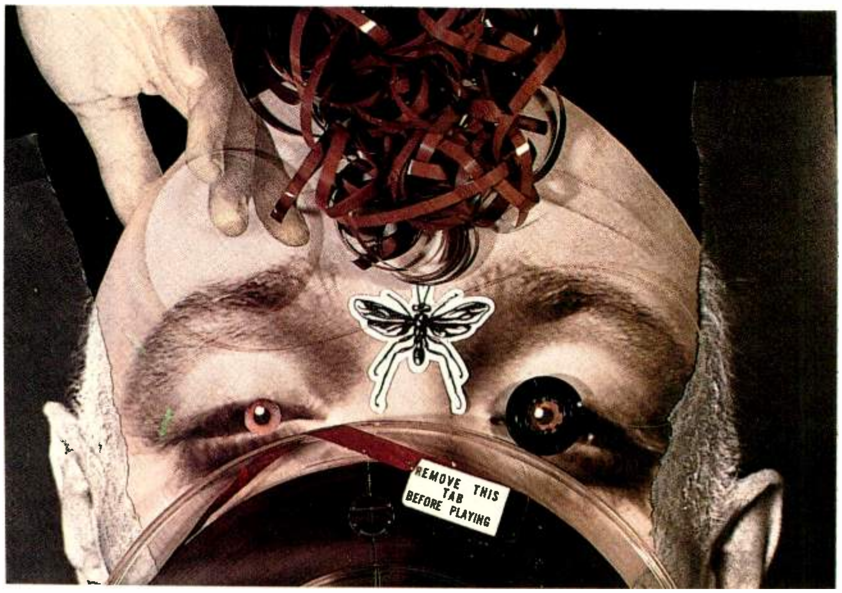

Illustration: Ian Colliety

Somewhat forbidding, *archival* is a word that has been buzzing lately, like the Connecticut gnats that bite me for half the year. Relentless. Evermore frequently we hear and read, "Is it of archival quality?" Librarians, at least, will be happy. It is their word.

Archival is the adjective form of archives, but it is the operative term these days, full of an almost ominous intensity. Will our enormous and ever-growing volume of recorded sound *last*? Not until next week or next year, but for the ages, the length of our continuing civilization. Not mere decades but centuries, perhaps millenniums. Or should I say millennia? A big order, and we really haven't given it much thought. Too busy! Tomorrow is more important. But is it?

I'd hate to subject one of those new out-loud reading machines to this word! It would probably search its memory and come up with something like *ar-chives*, a new variety of salad onion. Or, split at a line end, *arch-ives*, like an archduke.

Either way, we cannot avoid it. We must take audio preservation very seriously, because after so many centuries of total silence, the historical record now is full of sound. It's becoming a major part of the recorded flow of civilization itself. And that's after so few short moments compared to the other forms of historical record. We are just beginning to think, to be aware.

AS WE REACH A TURNING POINT, WE MUST DECIDE WHAT FORM ARCHIVAL AUDIO SHOULD TAKE.

Does this sound obvious? Of course. But how much have we done about it? Not much, in comparison with other older disciplines.

In our tiny span of existence we already have more than a century of recorded sound history. The earliest part, mostly short and unintelligible, isn't of much use. But around 1900 or so, the mass of it becomes significant. People! Those ancient recordings tell us as much about celebrities as the gaudy covers on today's magazines. Teddy Roosevelt's voice goes perfectly with his pictures. I can even imitate it, as of circa 1902! That's history, all right.

On magnetic tape, we have much more than on early disc and cylinder, a mountain of sound after some 45 years. And now we reach the ultimate, which lifts our tape medium to equality with all the older evidence of history: Digital. Only a dozen-odd years so far, but with vast consequences for the future.

We are thus at a turning point. We begin to understand, and to worry. Can we meet this challenge? That is, are we up to it technically? If so, how? What optimum form should *archival* audio take?

Should it be tape? Let's begin with that. Analog tape, digital tape, and the transfer of analog to digital for more permanence. As of now, we have nothing else comparable in our present collections. Not so you'd notice. We are awash in tape (if dry), thousands, millions of miles of tapes-to-keep. *Should we trust tape?*

Or should we, on the other hand, transfer our tapes, as systematically as we can, to a safer, better-lasting medium? What dangers, what safety, does tape offer in the *very* long run? In its present ultimate form, digital, is it truly *archival*?

Sometimes it's better to ask rather than try to answer such questions. The best I can do is simply to bring up matters that need discussion on the most professional level. Things that maybe have not got through to your attention. What about your own tapes, whether professional or of the home back-closet type? From dusty audio cassettes on the living room floor to those huge shelves of big

boxed tapes in the large record companies' files, had you thought about them in the long, the *very long* future? More important, how about your predecessors—especially back in the early tape years?

I was around in those years, using tape, and I know the general attitude. Unroll a reel of tape on the floor, and gasp at its length! We all, pro and amateur, had a feeling that tape must not be wasted, especially since it could so nicely be recorded over again or erased in bulk. For a while almost everybody, and far too many pros, recycled tape to a fare-thee-well. Maybe okay from an ecological viewpoint but not at all archival. Nor did we do much to protect tapes that we wanted to keep. They lay around in piles, loosely wound, out of their boxes, and dusty—even in professional places. "Old" tapes we used again and then again, erased, as casually as we throw out plastic plates and bags today. Even now, how many tapes get the full archive-type treatment, carefully wound (at playing speed), boxed, with white leaders and full information? I wouldn't guess 100%, even for big record producers. People are human. Archives are not.

Think long, long in time. What of the tape base, the plastic? Already much history there. Our best current tape, suitably protected and carefully played, could last a very great time, I suspect. Tape formulations were erratic in the early days, but most early tapes have lasted too—so far. Most of my earliest, some of them loose on the reel, dusty and unboxed, still play exactly as they did 40-odd years ago. That's impressive, if not yet long enough. But oddly, every so often I run into a tape that breaks and breaks—deteriorated base material. Looks okay. But snaps at the slightest pull. To save such a tape, you must play and splice, play and splice; it's an awful job, until you have safely copied it to a more reliable base. I worked on one of these last summer and gave up halfway through.

Why just these few? Was it my subsequent fault? Or was it in the manufacturer's particular formulation? Unsettling, even if most tapes are okay.

After the early years, a million miles of such as Scotch 111 and Audiotape, came a sensation—an "unbreakable" new plastic, Mylar. It was admirably stable, for more exact timing; it was humidity-proof, and it would not snap. Yet Mylar turned out to be deadly in any emergency, when the machinery went out of control. It didn't break, it stretched—not linearly but all of a sudden. Admirably firm under slight overstress, but when the tension suddenly increased, as in a tape drive malfunction, it just let go—all resistance ceased. (Well, most of it.) In a trice, 3 feet of Mylar tape became 6 feet of narrow curled-up tubing—the geometry of stretching requires the curl. Total loss. The signal is stretched too, but that's academic—it won't play.

Non-Mylar tapes are less stable and more subject to humidity and heat, vital factors. But these tapes snap easily and predictably under stress, in zigzag breaks, and there lies a bonanza—you can reassemble the bits like a jigsaw puzzle and splice them back together for the original sound.

ANCIENT RECORDINGS TELL US AS MUCH ABOUT CELEBRITIES AS THE GAUDY COVERS ON TODAY'S MAGAZINES.

Which type of tape, then, is *archival*? I really do not know. Virtues and faults in both.

How about the magnetic coating? Yes, some formulations have been subject to serious peeling off the base. No remedy for that. One can only hope for the future that it doesn't happen.

I have in my hand a parallel example, a glass positive stereo photo plate I printed (from film negative) in 1929. The glass plates were good for viewing and impervious to curl—but after a few years the emulsion began to peel. This one shows a tantalizing inch or so of Alpine scenery at one end, still peeling; the rest is clear glass. Poor archival choice.

What is really extraordinary is the permanence of the magnetic trace on tape. Hard to believe. True, a ghost of a magnetic field can kill it, but fields like that are generally rare. I can hardly believe the perfect sound I hear after more than 40 years. That is a big plus for tape.

These are major factors in *archival* sound that most of us never think about. We are much more concerned with the original recording process, including bias, equalization, signal level. Important! But again, not an *archival* consideration, assuming it is done right to begin with. We are now talking about long-term preservation of what we have already achieved. Not easy for any working sound engineer. Nevertheless. . . .

Another "minor" question: Do we rule out any type of tape *cartridge*, home or pro, for archival audio? Does the enclosure provide any real benefit for the very long haul, the centuries? I doubt it. Will the mechanism inside hold up or disintegrate? The little audio cassette does an excellent short-term job, we have to admit, for tapes left on the living room floor or lost down a crack in the family car. (The outer box is another matter, hopelessly fragile and clumsy to boot, like its first cousin, the CD jewel box.) But again, none of this is *archival*, or so I see it. There isn't much professional recording in cartridge form that needs to be kept, unless it is those glorious commercials that are the sonic ornament of our age. Keep the reeled originals, if you must.

Oh yes—how about reel-to-reel tape boxes? A silly thought, and yet not so silly. They are mostly cardboard and tend to give way at the corners. Has anybody thought of a better (and more expensive) container? It should stay strong, slightly flexible and reinforced at the corners, not subject to drying out, splitting, or other deterioration. For archives, cardboard is a very poor idea. Ask your librarian. How about a heavy vinyl tape box? One of the best nonrigid plastics around.

Too late here to go into a vital element in tape preservation—splices. Tapes that are assembled in segments via white "sticky" patching. I have a quarter-century of radio tapes with millions of these splices. If they fail, you must resplice. What about 100 years from now? My earliest splices were dismally short-lived. After only months, like other sticky tapes, they went sleazy and gummy and instantly let go when the tape was played. But there was a change—a vital change. I did two multi-spliced "live" shows (on tape) in 1969 and 1973. In 1992 I played both of them dozens of times, with never a failure. All the splices held. The tapes were perfect. Will they last another quarter-century? Or 100 years? If so, they are definitely *archival*, splices included. A

IVAN BERGER

RADIO ON DISPLAY— AND VICE VERSA

Want RDS? Delco is ready when you are—as is almost everybody else.

Is your car radio trying to tell you something? It may be, soon. The Radio Broadcast Data System (RBDS) Standard is finally out. And because most car audio manufacturers already make radios for Europe's similar "RDS" system, the radios should be here soon. And to save those manufacturers retooling, the logo will be "RDS" here, too.

Want to buy the record you're hearing on FM? The RDS display will tell you its name, the artist, the label, and maybe even which local stores carry it. It will also tell you the station's call letters and where it is located. If you tune in during a commercial, it will tell you the station's program format, so you know whether to hang around and listen or dial on. When you're driving where you don't know the local stations, you can tell the radio what kind of programs you want and have it find them for you.

The RBDS Standard provides coding for 29 program formats. Car radios won't have room for 29 format buttons, so RDS models will probably let you program in five or six favorite formats; fancy radios might even store format choices separately for each family member.

This goes beyond the program-scanning ability of the ID Logic system in the Panasonic car unit *Audio* reviewed in May 1992. That system included a database of stations, with provisions for updating a few entries as stations changed. But it couldn't adjust to stations that change formats during the day. With RDS, the program code changes when the program does. Nevertheless, an enhanced ID Logic is part of the RBDS Standard. It will serve as an FM program-finder until more stations transmit RDS, and will continue as a way of identifying AM stations and programming. An AM station can't transmit the RDS subcarrier, but an RDS FM station can update an RDS radio's ID Logic database of AM stations.

When a station fades out, the radio could automatically scan for similar programs on other stations, or even retune to a new frequency carrying the same program. In Europe, where network programs are still common, the system will switch you to another station. Here, it's more likely to work only for repeaters (also called translators), auxiliary transmitters that fill holes in a station's coverage area. I'm told that in places like Denver, with twisty mountain roads, a station may have 12 such alternates.

The system can enhance not only your listening pleasure but your driving pleasure and safety. It can warn you of traffic, accidents, weather, or other emergencies—even if you're listening to a tape or disc—as long as your tuner is on an RDS station. Future models may turn themselves on when a warning comes over the air, or even contain a second front end that stays tuned to an RDS station while you listen to a non-RDS one. The system can also be used for paging, to reset your car's clock, and maybe even for navigation.

Already, 42 FM stations broadcast RDS; 10 are in Las Vegas, where they demonstrated it at the Consumer Electronics Show in January. There are 5 in Detroit, to impress car makers. And by the time the Summer CES opens in Chicago, that city should have more than the two RDS stations it has now. Eventually, RDS stations stand to make money by incorporating brief commercial notes ("Buy this record at Joe's") and to stand out in ratings sweeps by plastering their logos ("HOT 93") on listeners' radio displays.

The radios are on the way. Philips and Denon should have RDS models on sale by the time you read this; others were shown at CES by Blaupunkt, Kenwood, and Sony (not to mention an Onkyo home tuner and a Grundig portable). And though Delco, the biggest car audio company, makes no RDS radios yet, it has a prototype ready to roll "as soon as our customers know what it's about and want it."

White Sound

Dashboards are black. Car radios are black. Boring, ain't it?

But there are alternatives. White stereos are readily available—from marine suppliers. Marine models (available from Jensen, Kraco, Pioneer, and Standard Communications, and probably from others as well) are not only a sporty white but are also weatherproofed like crazy—just the thing if you sometimes forget to put your convertible's top up when you park. Jensen also makes a yellow model, rugged and weatherproofed for off-road vehicles. And I've seen a handful of colored car stereos in Japan over the years.

Now if only someone besides the high-end companies could do something about boring black equipment for the home. . . .

Bass Pacer

How low does your car's woofer go? What frequency excites that rattle in the dashboard, and just what's rattling? You can answer these questions with a calibrated sine-wave generator or a generator and a frequency counter. You can also answer them with your car's CD player (or a portable, if you connect it to your system) and the *Autosound 2000 101* test disc.

Some of the material on the disc may duplicate the material on test discs you already own, such as tracks of 1-kHz tones at fixed and varying levels and tracks of test tones and sweeps. Other tests, such as a series of positive and negative pulses for checking absolute polarity, and low-frequency tone bursts, are less common. And tracks 10 through 98 are unique: Sine waves whose frequencies match their track numbers. Want to see if your woofer can go down to 30 Hz? Set normal levels, then play track 30 and find out. Want to pinpoint a resonance? Play a series of tracks, and note which track excites the resonance in question.

This disc is not only neat, it's cheap: $25 (plus $2.50 shipping) from Autosound 2000 (2563 Eric La., Suite D, Burlington, N.C. 27215).

Illustrations: Beata Szpura

DSProgress

Digital signal processing (DSP) promises to be a wonderful new way of overcoming problems with car acoustics. It's also a powerful means of screwing up the sound beyond belief—if you simply play with the controls instead of using them intelligently.

One DSP demo at a Consumer Electronics Show proved this, but it probably wasn't the product's fault. Perhaps because it was the first day of the show, the company had left their DSP demo car unmanned, with all and sundry free to come in and play with its controls. Operating on the "more of anything is better" principle that makes people set equalizer controls into a "U," the dealers who preceded me into the car had set the DSP controls for maximum everything.

As a result, when I played my favorite Elisabeth Schwarzkopf recording, she sounded as if she were singing from the bottom of a rain barrel back at the rear right of the car instead of sounding like a live singer on center stage. The poor salesman trying to demonstrate the system spent several minutes gradually restoring each parameter and control to normal, and he was still at it when I had to leave for my next press conference.

The other DSP demos I heard were similarly flawed, but it was the old demo syndrome: If you're showing something new, exaggerate it until the listeners realize they're hearing something. I still think that DSP can actually improve car sound, if it's done right (i.e., to *my* taste). But, like most audio processing, DSP should be used in such moderation that you're not consciously aware when it's on but miss it when it's off.

The debacle of the initial demo gave me some ideas about how DSP units should be configured. First, the controls that can do the most damage should be concealed, to be adjusted only during initial setup. (I've seen a Sanyo prototype that works this way.) People seem reluctant to adjust controls that are out of immediate reach, even when those controls need adjusting.

However, people are eager to play with any controls that are easy to reach (like the ones on TV remote controls or the dashboard controls of car stereo systems). That's why my Proton TV, with remote control of such picture parameters as color, black level, sharpness, and so on, has a "Reset" button that erases any horrible settings made by overly eager fingers and restores everything to factory normal. Car DSP units should also have reset buttons. And to prevent playful friends from storing rain-barrel effects in memory, there should be some simple but nonobvious code system (such as pressing two unrelated buttons at once) to protect memories from being altered by accident or from ignorance or malice.

Or you could just limit the user's options from the outset. That's easiest when the system is factory-installed, since the DSP unit can be preprogrammed to match the characteristics of the car it's made for. The first such systems I've seen, in the Acura Vigor GS and some Ford models, do precisely that. Users can choose from any of six digitally simulated environments at the touch of a button, and can turn DSP on and off, but that's all. This makes for simpler driving but could be a problem if you disagree with the factory settings.

In any case, be prepared for a DSP deluge soon. Prices of DSP chips are coming down, and low-voltage versions (which cost less to incorporate in car stereos) are available from such companies as Analog Devices.

CURRENTS

JOHN EARGLE

ROOM REMOVER

The Sigtech DSP unit can make many of the acoustical problems in a room disappear.

With the domestic economy clearly on the mend, dealers and manufacturers alike were far more upbeat this January in Las Vegas than at recent Consumer Electronics Shows. But the signals are mixed. At home, personal income is up, and the industry had very encouraging holiday sales.

THE TECHNICAL HIGH POINT OF THE SHOW WAS A NEW USE FOR DIGITAL SIGNAL PROCESSING.

On the other hand, the jobless rate is climbing, and overseas markets, which had been a bright spot for many export-minded companies, are down. Cautious optimism best describes the general feeling.

Neither MiniDisc nor Digital Compact Cassette has taken a commanding position in the market. Product launches for both media were beset by late deliveries, incomplete lines, flawed performance, and high costs to the consumer. They may both be in for hard times, and it will certainly take a couple of years before a clear winner emerges.

Video and the automotive aftermarket continue to dominate consumer entertainment electronics, with both areas posting major gains in pre-holiday sales last November and December compared to the year before. According to the Electronic Industries Association, the car stereo aftermarket increased nearly 38% last November over the same month in 1991, once again underscoring the fact that most people in the United States still have their biggest *audio-only* investment in their cars, with their home systems centering around video.

In video, the growth has been led by stereo sets and stereo VCRs as well as by a move to larger picture tubes. At its most upscale, current TV transmission can be viewed over new sets with a wide-screen aspect ratio of 9:16, rather than the standard 3:4 ratio. The new wide-screen sets offer the user several viewing options, including monitoring two or more stations at once, cropping standard transmissions to fit the wide aspect ratio, and of course direct viewing of "letterbox" wide-screen prerecorded video programs.

All of this is, of course, intended to bring the home video experience a little closer to that in an actual motion picture theater by adding the new shape to Dolby Stereo soundtracks now encoded in VHS and LaserDisc source material. At its very best, home theater can be a good show indeed. All it takes is a data-grade projector with line doubler, a surround decoder, and a LaserDisc player. This, plus some of the dedicated loudspeaker systems designed for video applications, will produce excellent NTSC-based video. Of course, you do not need to go to this extent for an exciting video experience. One requisite, however, is a reasonable picture size, but beyond that there are a number of mini-loudspeaker systems, acting as satellites with a common subwoofer, that will provide a remarkably good illusion of surround sound without taking up an undue amount of space.

In pure audio terms, the technical high point of the Show was the use of digital signal processing, or DSP, to cancel out certain room effects in stereo listening environments. Work has been going on in this area for some time, but recent developments have made it possible to do an excellent job at reasonable cost. SigTech, of Cambridge, Mass., was clearly at the forefront of what I saw at the show, so I will make their demonstration the basis for our discussion.

Assume that you have spent heavily for loudspeakers and associated equipment and that your listening room, while not an acoustical

GCD-600 CD Carousel

It has been, perhaps, Adcom's toughest act to follow. The GCD-575 CD Player achieved breakthroughs in musicality unsurpassed by CD players at almost any price. *Stereophile* writes, "...in the under $1000 class the Adcom is the player to beat — or, more to the point, the player to buy."* *Stereo Review* credits the GCD-575 with "in general pushing the state of the art in digital-disc playback."**

So when the engineers at Adcom went back to the drawing board to try to top their latest success, they were hard-pressed to find areas for improvement. The electronics and sound reproduction were already near perfect. And then, *Voila!* The idea: add a carousel changer.

Round and round she goes.

One disc, superbly reproduced, was a magnificent accomplishment...but five discs mean five times the enjoyment. In typical user-friendly fashion, the Adcom GCD-600 lets you change four discs while one is playing, offers true random capability for one disc or all five, allows direct clockwise or counter-clockwise access for faster searches, and plays 3" discs without an adapter. The standard remote control gives you complete access to all playback features—including variable volume control—from the comfort of your favorite chair.

Class "A" without compromise.

The GCD-600's Class "A" analog audio amplifier section uses very fast, low noise, linear gain semi-conductors. These no-compromise audio circuits — based on the proprietary amps used in Adcom's GFP-565 preamplifier — more clearly define low-level information for superior resolution and dramatically more musical CD reproduction. You will not find such superb component parts in any other CD player at any price.

The cure for "digititis".

The GCD-600's technically advanced analog and digital circuits and the user-selectable polarity inversion switch are designed to overcome the problems inherent in CD sound. Midrange harshness and glare are dramatically reduced. Sound stage imaging is deeper, more focused, more musically natural. The benefits of digital sound are realized, without the accompanying drawbacks.

Take the GCD-600 for a spin.

If you've been searching for a CD player that offers the convenience of a carousel changer *and* the sonic superiority of high-end single-disc models, take the GCD-600 for a spin at your authorized Adcom dealer. You won't have to go round and round to decide which CD changer gives you the most sound for your money.

*Peter W. Mitchell, *Stereophile*, Vol. 12 No. 6, June 1989
** *Stereo Review*, 1989

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nightmare, falls short of an ideal monitoring environment. One approach here is to fine tune your room through judicious application of sound absorption and diffusion, and there is certainly no lack of qualified consultants to show you how. If, in fact, your aim is to make your listening room into a professional reviewing room for audio programs, this is really the only way to go.

On the other hand, if your listening room is well appointed and is intended to also be a major living space, you may not want to change it at all. Fortunately for you, DSP can now provide another solution for about $5,000, which is considerably less than a remake of the room itself would cost.

The SigTech demo was held in one of the typical rooms at the Sahara Hotel's Bi-level complex. The space was about two-thirds to one-half the size of the average living room, and most of the larger pieces of furniture had been removed in normal show fashion. The room had noticeable standing waves in the lower midrange (below about 600 Hz) and the loudspeakers had been placed asymmetrically in the space. A single seat was located at the sweet spot and an A/B switch allowed an immediate comparison of the straight-through signal and the corrected signal.

Earlier, SigTech had placed a microphone at the listener's head location and measured the complex transmission function from each loudspeaker to that zone, including influences of direct and reflected paths. This information was stored and used to construct a digital filter that provided corrected signals that could be applied to the loudspeakers. When this was auditioned, the listener heard many of the room's acoustical problems substantially disappear.

SigTech had documented all of this and presented graphs showing the "before" and "after" net result of the filtering. Other graphs showed the effect of the filter over short time intervals, pointing out clearly that the correction varies from instant to instant—just as the room reflections themselves do. In general, most of the correction was done below about 1,000 Hz, with broadband smoothing employed at higher frequencies.

I had brought along a copy of *Engineer's Choice* (Delos DE 3506), the content of which I know very well, and I can attest that the before-after differences were significant. (*Editor's Note:* John, you are too modest about being the "engineer" on this compilation of superb recordings!—*E.P.*) With the filtering bypassed, stereo imaging was about as I had expected it would be: Somewhat indistinct, due to the random peaks and dips in each channel. With the filtering engaged, imaging improved immediately because each channel's response had been made much flatter. This was particularly clear on piano music, where the spectrum is especially prominent in the midrange.

In normal application, the SigTech unit will store three settings, allowing the user some flexibility in seating, or in subtleties of room treatment. The actual setup of the unit in one's home is not done by the user but by a qualified dealer who performs all measurements and enters the proper filter coefficients into memory.

I am convinced that we are about to see a big burst of activity in this area. A

more

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S T E R E

Tomlinson Holman

Stereo in the movies has some fundamental differences from stereo at home. While home stereo relies mainly on two channels, as any surround sound aficionado knows, films recorded in Dolby Stereo (and Ultra Stereo) have left, center, and right front channels and a surround channel. These four channels are encoded onto the two tracks of videotapes and videodiscs, from which they are extracted by surround decoders in home playback [1]. These added channels have some rather obvious, and some other not so obvious, benefits.

The development of film stereo in the United States grew out of work conducted at Bell Labs in the 1930s. There, it quickly became clear that there were problems with two-channel stereo for presentation to audience members sitting at many different angles from the sound system. The main problem is, of course, that center-channel information, when delivered by means of two equally driven loudspeakers forming a phantom image, appears to shift left or right according to the location of the listener. Thus, if one is sitting off the centerline to the left, sound images that should appear in the center usually appear to the left, even all the way to the left loudspeaker. It is interesting that home stereo has long required the listener to sit on the central axis of a pair of speakers to get a solid center image, and that this problem has only recently been ameliorated with such developments as the original dbx SoundField speakers developed by Mark Davis. Still, most people, most of the time, do not spend their home stereo listening time precisely on the centerline with their heads precisely fixed, so image shifts in home reproduction are extremely common.

Film sound solved this problem early on: Even when film sound grew from a single, center loudspeaker to a number of front speakers, there has always been a separate electrical center channel and associated loudspeaker to anchor the center image. With an actual loudspeaker position at the center of the screen, it is easy to get the whole audience to

T H E M

O F O R

the center channel

perceive the sound as coming from the center. Just feed the electrical signal to only that loudspeaker and everyone will hear the mono component of the stereo sound field properly reproduced in the center.

Beyond the simple localization issue, there lies an interesting story. The nature of "phantom" center images (made between two loudspeakers by feeding some proportion of signal to each of them) and "hard" ones (coming from a single loudspeaker) is different in other ways. In an experiment I conducted at Lucasfilm, three front-channel loudspeakers (left, center, and right) were very carefully aligned for equal loudness, frequency response, and directivity. (This is a complicated process: See "How Lucasfilm Matches Channels.") Then, an A/B comparison was made between a phantom image formed from left and right loudspeakers, and the hard image from an actual center loudspeaker. While a stereo left-right "bed" of program material provided a "space" for this experiment, center dialog was alternately added to the mix by way of either a phantom or a hard image. To make the comparison free from artifacts, the subjects were instructed to sit precisely on the centerline and not move their heads.

Tomlinson Holman is associate professor at the University of Southern California School of Cinema-Television and corporate technical director at LucasArts Entertainment, where he works in such technical areas as the THX program, whose initials may stand for Tomlinson Holman's eXperiment. He cofounded Apt Corporation, which made the Apt/Holman preamplifier, and was chief electrical engineer at Advent Corp. Holman was twice a Governor and is now a Fellow of the AES. He is also a Fellow of the Society of Motion Picture and Television Engineers, which presented him with the Samuel Warner medal in 1987 for progress in film sound. He holds three U.S. patents and has won two Hi-Fi Grand Prix awards for product designs.

O V I E S

How Lucasfilm Matches Channels

To match the level and equalization of the three channels in use for the experiment, a dummy mannequin called KEMAR (Knowles Electronics Mannequin for Acoustic Research) was used. This mannequin faithfully models the head and torso, outer ears, and ear canals, with a precision microphone at each ear-drum position. Identical signals were fed in turn to each of the three speakers, and the level and equalization were adjusted for equality across the channels by using a multiplex switch to alternately feed the signals from each "ear" into an analyzer that measured level versus frequency.

The first impression one had of the phantom center-image system was remarkable positional definition. For example, "S" sounds from vocalists did not splatter to the sides and reveal the speaker placement, a typical problem in stereo systems. This probably occurred due to the care with which the channels had been matched, as was needed to make the experiment valid. Thus, it is true that with a very well-matched pair of speakers in a symmetrical space, the center image is robust when the observer sits on the centerline and does not move his head. This indicated to me that the efforts made by Snell, KEF, and others to carefully match pairs of speakers for two-channel stereo are very worthwhile, despite the expense that such matching adds. It also means that symmetrical placement of loudspeakers and listeners with respect to the room boundaries is also worthwhile in the home, since this helps match channels at the listener's ear.

The remarkable thing to do is to switch from "phantom center mono" to an actual center loudspeaker. With all other factors that usually obscure differences removed (loudness, frequency response, directivity), simply stated, the center-channel loudspeaker sounds "clearer" than the phantom image. This is hard to describe because most of our judgments in comparisons of reproduction are based on changes in just those factors that we've held constant here. One impression that I had was that understanding dialog seemed to take less work. Although I could understand dialog just about as well with either system, it just seemed to be easier in the hard-imaged system. If the dialog is of poor quality to start with—reverberant, distorted, or poorly articulated—it may be far harder to understand on a phantom-channel system than one with a center speaker. Perhaps this is a factor in the film sound community's insistence on having a hard center channel.

Getting the loudness and timbre to match demonstrates another issue affecting the choice of two- or three-channel front systems. In the phantom center system, as sound is panned electrically from one loudspeaker to the other, humans perceive a timbre shift due to a frequency response change in the center of the sound field. The reason for this shift is shown in Fig. 1: A sound from the right speaker reaches the left ear later than an identical sound emitted simultaneously from the left speaker, due to the right-channel signal's longer path around the listener's head. This time difference will cause dips to occur at frequencies where the two sounds arise out of phase. Complete cancellation does not occur, because the diffraction of sound around the head varies with the angle of arrival, but a noticeable 2-kHz dip and smaller dips at higher frequencies do occur. As one might expect from basic acoustics, sounds arriving from different directions produce different responses at the ear-drum due to the interaction of the head and outer ears with

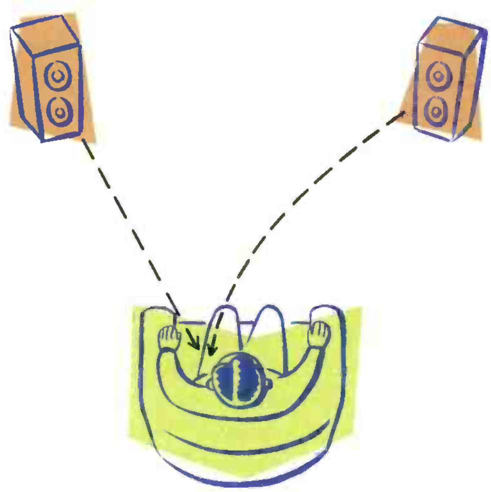

Fig. 1—Identical sounds coming simultaneously from the left and right speakers will reach the left ear at different times. (The same process occurs at the right ear, of course.)

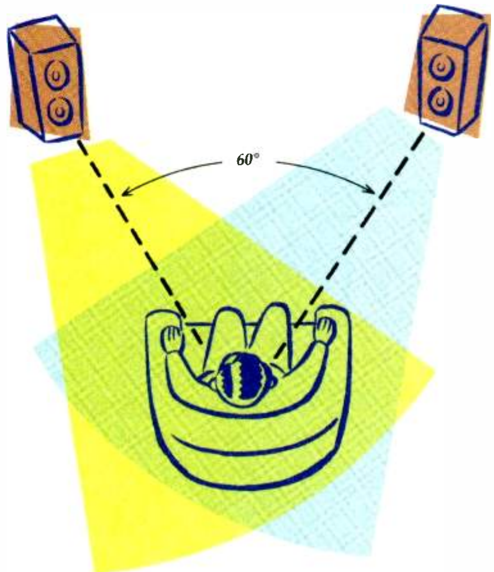

Fig. 2—The most commonly recommended setup for two-channel stereo listening is with the speakers 60° apart from the listener's viewpoint.

the sound field; after all, the head is a rather large object, acoustically. At least part of the clarity difference heard in my experiment is probably due to this.

Since doing this work, I learned from George Augsburger, a recording-studio acoustical consultant, that this problem is often perceived in very well-aligned stereo music studios—one can hear a timbral shift as sound is panned, with a notch centered around 2 kHz and smaller aberrations at higher frequencies appearing in the center of the sound field. (The response difference from phantom images was first published by Günther Theile, but this did not come to my attention until well after the work reported here was done [2]. Thus, when a producer places instruments and vocalists in the center of the stereo field, their apparent frequency response will be different than if they are positioned left or right. (This is why, in pop music recording, sources are usually panned into position first, and then equalized.) The hard-center system greatly reduces the response shift, since the center is an actual loudspeaker that does not suffer from this problem.

There is evidence that our hearing sums both ears' inputs to determine timbre [3]. However, a shift is to be expected when one is dealing with a phantom image composed of left and right sources, instead of an actual source at the same location as the phantom, simply due to the gross change that the head causes when placed in an acoustic field. (Even placing a small precision measurement microphone, ½ inch in diameter, in a sound field disturbs the field enough to cause differences of up to 4 dB in frequency response below 20 kHz [4].)

Timbre phenomena (which are mostly due to frequency response shifts in this experiment) and localization phenomena should not be confused, but it is easy for humans to misperceive differences in these areas. Localization processes are among the fastest in the brain, with a just noticeable difference of under 10 µS! But it takes the ear 2 mS to perceive changes of timbre—200 times as long as it takes for localization. This means that the sounds by which we determine timbre occupy a much larger time window than those we use to determine localization. Since this larger window may include reflections or other sources, the operating-time difference of the two mechanisms can throw off our ability to judge both localization and timbre for the same source.

Another issue is loudspeaker placement. Music producers and expert home users usually employ a subtended angle between left and right loudspeakers of 60° for the principal listening location (Fig. 2). Film sound adds another major requirement though: The picture must correspond with the sound. It is silly for us to see Indiana Jones enter the darkened cave near the beginning of *Raiders of the Lost Ark* on the left side of the screen but hear his footsteps from many feet and many degrees away, localizing to the left-channel loudspeaker. Such breaking of the picture image from the sound image causes a conscious or subconscious discontinuity—it just isn't real. There is nothing wrong with 60° for home stereo except that video pictures can't yet stand the kind of blow-up required to produce an image that wide. Even with film projection of high quality, we use a 50° angle for left to right side, with the loudspeakers just inside the picture image, putting the left and right loudspeakers about 45° apart.

The best reason for higher definition TV that I know is that it permits bigger pictures. Since the acuity of the human eye is well known, it is necessary to transmit only a certain amount of information to yield enough sharpness to satisfy the eye. What HDTV allows is bigger, more engaging pictures for definition equal to "perfect" with a correspondingly wide stereo image. (We would have to sit further away from an NTSC picture to get the same apparent sharpness.) So HDTV isn't about sharpness, it's about size, and one of the greatest benefits of big, wide-screen television is better matched sound and picture imaging.

Another factor in the use of a center channel has to do with film program material. Probably the most important story-telling element of a soundtrack is its dialog. When ste-

Charts: Stanford Kay/Paragraphics

Setting Up The Center

A variety of speaker configurations can be used to reproduce left, center, and right information. The surround decoder settings used depend on the configuration chosen. (For example, for systems with no center speaker, the decoder's "Phantom" postion should be used.) The following recommendations apply only to Dolby Pro-Logic decoders, however, as settings for other decoder types are not standardized; non-logic Dolby Surround decoders typically lack center outputs, and therefore have no center-mode settings.

First, let's look at systems that do not use separate subwoofers. If three matched, full-range front speaker systems are used (Fig. B1), the Dolby Pro-Logic decoder should be set to "Wide" (also called "Full," "Fullband," "Wideband," or "Large Center," by different manufacturers.) When a smaller speaker is used at the center, the decoder should be set to "Normal" (also called "Bass Split" or "Small Center"). This redirects the center channel's low-frequency content to the full-range left and right speakers, which can properly reproduce it (Fig. B2). This setup is frequently used because small speakers are easier to fit above or below a video screen, and they're usually less expensive. However, the results will not equal those from systems with three matched speakers. In the middle and upper frequencies, where all three speakers operate together, the center speakers should have not only the same amplitude and phase response as the left and right speakers do but the same directivity as well. Cabinet size affects directivity, though. This is not so much a problem in the vertical plane (which is affected by cabinet height) as in the horizontal plane (affected by cabinet width); directivity in both planes is also affected by the driver configuration. If the center speaker's directivity does not match that of the side speakers, the ratio of direct to reverberant sound will change as a sound is panned from side to side, causing centered sounds to seem recessed.

Fig. B1—Matched left, center, and right speakers.

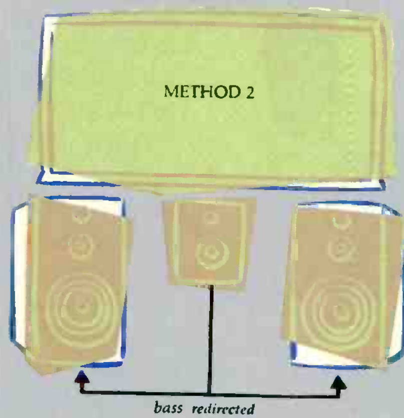

Fig. B2—Matched left and right speakers with smaller center speaker; note that bass is redirected from the center to the sides.

If subwoofers are included in the system, they can be placed wherever they look and sound best, as long as the crossover frequency and slopes are well chosen. The steeper the slope, and the lower the subwoofer's upper cutoff, the more freedom you have in placing the subwoofer while still achieving a seamless blend between its sound and that of the other speakers. Regardless of the subwoofer position, the smaller left, center, and right speakers provide the imaging associated with the picture. Using identical left, right, and center speakers is even more strongly recommended in systems with subwoofers than in systems without them to ensure best imaging and front-stage continuity.

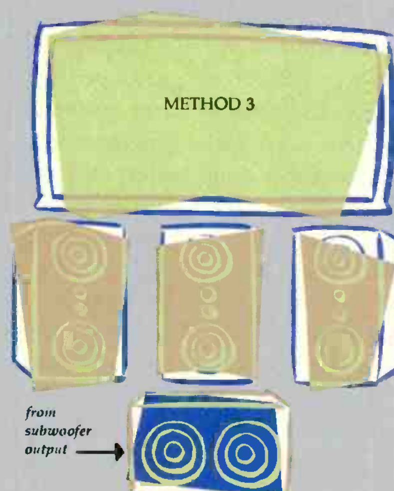

Fig. B3—Left, right, and center speakers used with subwoofer fed from decoder's subwoofer output.

Most surround decoders have separate subwoofer outputs. If that output is a sum of all three decoded front channels, or of the left and right stereo signals that are fed into the decoder, the Dolby Pro-Logic decoder should be set to its "Wide" mode.

If the subwoofer output is a sum of the left and right decoder outputs only (Fig. B3), the decoder should probably be set to its "Normal" mode. However, there is no standard in this area, so it pays to consult your decoder's instruction manual and to listen to see whether the "Wide" or "Normal" setting works best in your setup. For your listening tests, use sounds rich in bass that pan from left or right to center; the setting that yields the least change in timbre as the sound pans is the correct one.

Fig. B4—Left, right, and center speakers used with subwoofer fed from undecoded left and right stereo signals.

If the decoder has no subwoofer output, feed your woofer the undecoded left and right signals, and set the decoder to "Normal" (Fig. B4). By redirecting bass information from the center channel to left and right, this setting ensures that sound panned from one side to the center does not lose bass due to the subwoofer's lack of a center-channel input. Use a crossover with both left and right line- or speaker-level inputs; many subwoofers have such summing crossovers built in.

Charts: Stanford Kay/Paragraphics

reo first came into the movies, dialog was routinely panned across the front loudspeakers to indicate the position of the talker. With the revival of stereo movies brought about by Dolby Stereo in the '70s though, it has become much more common to pan dialog only infrequently. A valid question is: "Is this a ploy on the part of producers to make the product cheaper, or is there a psychoacoustic background behind it?" Stereo in 1950s' movies had a noticeable problem. As Ioan Allen of Dolby points out, because loudspeakers were more poorly matched than they usually are today, an actor could enter one side of the scene a tenor and exit the other a bass, due to timbral shifts caused by the differing frequency responses of the loudspeaker systems. However, even after better speaker matching became routine and eliminated this problem, panned dialog did not regain its popularity.

What is wrong with panned dialog? Several psychological factors seem to come into play. Although our vision has become adapted to seeing picture discontinuities (cuts) through experience with film and television viewing, our hearing is not so trained. Picture editing is truly an art form, expressing "film grammar" perhaps better than any other element of filmmaking. By grammar I mean that we carry around in our heads a set of rules for where we are from the camera's point of view and what the meaning of a cut from wide shot to close-up is. But sound editing of perspective shifts seems more discontinuous—breaks from reality rather than smooth transitions of it. One reason for this may lie in the construction of the brain. The part of the brain responsible for speech perception is well separated from the part that processes other sounds, such as music and noise. Could it be that the added task of detecting directional changes in speech, and perceiving the speech at the same time, complicates the process by occupying more of the brain and causes greater difficulty in comprehension?

Dialog is routinely panned to the center, with the exception of lines that are supposed to be off screen or ones where the actor is at the extreme left or right of the picture and the line is heard in isolation from others. But a common misconception is that the center channel is devoted to the dialog *only.* This is simply not so: During film post production, mixers consider the center to be exactly the equal of left and right, with sound effects and music as likely to occur there as elsewhere. Music mixing for film always involves a minimum of three mixdown channels—left, center, and right.

Considering how all of the preceding should affect the design of home systems for surround sound leads to three important conclusions. First, the center-channel loudspeaker should match the left and right ones in directivity and in both amplitude and phase response, at least for frequencies above about 80 Hz; this will allow panned program material to have invariant timbre as it moves across the front stereo stage. (Timbre should be maintained well enough to eliminate the 2-kHz notch that appears in the center of a phantom image stereo field since this notch does not occur in nature from real images. Timbre variance for different directions of arrival at the head, due to interactions with the head and outer ears, still occurs and helps to localize sound. According to Theile's Association Model theory, the effect of response differences caused by the direction of arrival is subtracted out in the "location determining stage" of the auditory system before the "recognition of Gestalt" [roughly, the timbre of the source] occurs [2].)

Second, the power available for the center channel should match left and right because it is equally as likely to have high power requirements as the left and right do. And finally, the center channel should have wide and even horizontal coverage to present the same experience to all listeners in the room. (See "Setting Up The Center.")

A hard center channel with an actual loudspeaker provides much better-centered imaging as one moves around the room, greater clarity of center-channel information and less timbral shift as sound is panned, and greater ease in distinguishing dialog. Three channels are much better than two, and an old axiom of the industry that a center channel is essential is as true in 1993 as it was in 1931. The coming of CDs encoded with Dolby Surround (which started with movie music on BMG and has expanded to other titles and companies), along with the thousands of LaserDisc and videocassette titles recorded with Dolby Surround, means that there is plenty of software around that can show the advantage of having a real center channel. The improvement in reproduction quality from having a hard center far outweighs the additional cost and space requirements of adding the needed amplifier and loudspeaker. A

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TAKING UP RESONANCE

finding room modes on your computer

JOHN F. SEHRING

For quite a long time I have wanted to try a subwoofer in my audio system at home because I like listening to large orchestras and pipe organs. A long organ pipe can put out large amounts of energy at very low frequencies, and CDs can carry high-level signals at frequencies as low as 10 Hz (Table I). I wanted to hear some of that bass energy in my listening room!

In selecting a subwoofer though, it's important to know that each room has its own signature frequency response and low-frequency cutoff. At the frequencies that subwoofers handle, the room's response can strongly dominate that of the loudspeaker [1]. We need to select the most appropriate subwoofer in terms of its low-frequency response. The loudspeaker and room act together as a resonant *system*—both affect what we hear.

Many resonant effects can be easily visualized by watching a vibrating guitar string. If you pluck that string, it will vibrate at its own natural (resonant) frequency, which depends, among other things, on its length. As the energy in the string bounces back and forth against its fixed ends, a pattern is set up due to resonance. If you look closely, you can see that the center of the string vibrates most and the ends not at all. Though the string itself is vibrating, the pattern (the locations of the string's maximum and minimum vibration points) is stationary. This is a *standing wave.*

The frequency at which the whole length of the string vibrates is called its *fundamental* and is the string's lowest natural frequency. But the string will also vibrate at frequencies that are integral multiples of that fundamental frequency called *harmonics.*

Frequency and wavelength are inversely related. When one is large, the other is small, and vice versa. So the harmonics, being higher in frequency, have shorter wavelengths than the fundamental. For example, the wavelength of a second harmonic is just half the length of the original.

Rooms, too, have resonances. But while the resonances of guitar strings are usually excited by the guitarist's fingers, room resonances are excited by sounds of similar frequencies. Instead of vibrating between the endpoints of a string, the sound energy in a room bounces back and forth between rigid wall surfaces. And sounds at the room's resonant frequencies also set up standing waves, with points of high and low sound pressure.

Because of this, perception of bass frequencies in small, regularly shaped rooms can be highly variable and depends on where you are relative to standing waves generated by resonances. The room's response can be strongly imposed on a loudspeaker's output. That's why moving either the listener or the loudspeaker just a few feet can sometimes make a considerable difference in bass loudness.

The lowest (fundamental) resonance of a room occurs at the frequency whose wavelength is equal

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PHOTOGRAPH: MICHAEL GROEN

to twice the room's length. (The factor of two is involved because we can have a *half*-wavelength standing wave.)

The lowest resonant frequency of a room can be obtained by dividing the speed of sound by twice the room's length. Taking the speed of sound as 1,141 feet per second (it actually varies slightly with the temperature, altitude, and humidity), we get a figure of 29 Hz for a room 20 feet long. *This is the lowest frequency at which we can generate loudness with reasonable efficiency in a room this size.* The only way to lower it would be to increase the room's length.

Below this frequency, we can't establish even a half wavelength in the room, so a standing wave can't exist. As a result, there won't be a point of maximum acoustic pressure where a loudspeaker could be most efficiently coupled to and excite the lower frequency.

A subwoofer whose frequency response rolled off below 29 Hz would be adequate to excite the lowest frequency in this room. There are, of course, other important subwoofer parameters to consider besides frequency response.

The room's *length determines* the lowest *frequency* at which *a subwoofer can* work efficiently.

Resonant Modes

Since a rectangular room has three principal dimensions (length, width, and height), it will have three different fundamental resonant frequencies, as well as harmonics of higher frequencies (which have shorter wavelengths). Energy can bounce off all surfaces and in all directions in a room, setting up numerous combinations of resonances (fundamental and harmonics) related to the room's geometry. These combinations are called *modes.*

The strength of each mode is different and the entire collection of modes defines a room's frequency response. Different standing-wave patterns of sound energy can be set up in a room depending on which modes are excited.

At low (base) frequencies, the modes are generally separate and distinct. At high frequencies, they are so numerous and bunched together that they form a continuum. We will be looking at only the low-frequency modes here.

Any resonant mode of a room may be calculated from the formula:

$$F = \left(\frac{C}{2}\right) \times \sqrt{(i/L)^2 + (j/W)^2 + (k/H)^2}$$

where F is the frequency of the mode in hertz, C is the speed of sound in air, and L, W, and H are the room's length, width, and height in feet.

If all we really *cared about was* resonance, we'd *put our speakers* in the center *of the room.*

TABLE I—*Compact Discs with audible components below 32 Hz. (Louis D. Fielder and Eric M. Benjamin, "Subwoofer Performance for Accurate Reproduction of Music,"* Journal of the Audio Engineering Society, *June 1988.)*

FREQUENCY, Hz FOR 120 dB	FREQUENCY, Hz FOR 110 dB	COMPOSER/ ARTIST	SELECTION	RECORD LABEL	CATALOG NUMBER
10	12.5	Tchaikovsky	1812 Overture	Telarc	CD-80041
16.5	16.5	Dupré	Symphony in G Minor	Telarc	CD-80136
15	17.5	Grofé	Grand Canyon Suite	Telarc	CD-80086
18	18	Hindemith	Organ Sonata No. 1	Argo	417159-2
18.5	18.5	Jongen	Symphonie Concertante	Telarc	CD-80096
12.5	22	Flim & The BBs	Big Notes	dmp	CD-454
16.5	22	Strauss	Also sprach Zarathustra	Telarc	CD-80106
22	22	Bach	Kyrie, Gott heiliger Geist	Telarc	CD-80097
24	24	Saint-Saëns	Symphony No. 3	Telarc	CD-80051
25	25	Williams	"Star Wars" Theme	Telarc	CD-80094
19	25	Bach	Toccata and Fugue in D Minor	Telarc	CD-80088
29	29	Billy Cobham	Warning	GRP	GRD-9528
29	29	Various	Movie soundtrack, "Country"	Windham Hill	WD1039

TABLE II—*Room modes for a room 20 feet long, 11 feet wide, and 8 feet high, as calculated by the program in Table III.*

MODE (L,W,H)	FREQ (Hz)	MODE (L,W,H)	FREQ (Hz)
0 0 0	0	0 0 1	71
0 0 2	143	0 1 0	52
0 1 1	88	0 1 2	152
0 2 0	104	0 2 1	126
0 2 2	177	1 0 0	29
1 0 1	77	1 0 2	146
1 1 0	59	1 1 1	93
1 1 2	155	1 2 0	108
1 2 1	129	1 2 2	179
2 0 0	57	2 0 1	91
2 0 2	154	2 1 0	77
2 1 1	105	2 1 2	162
2 2 0	118	2 2 1	138
2 2 2	186		

The variables i, j, and k require a bit more explanation. Together, they form a three-part "mode number" that defines a mode's relationship to the dimensions of the room; i is associated with the length, j with the width, and k with the height. These numbers take on only integer values such as 0, 1, 2, 3, etc. For example, the lowest room mode would be 1, 0, 0, representing the fundamental of the length-related resonance, with no contribution from the width and height; the 0, 2, 1 mode would represent the second harmonic of the width-related resonance mode and the fundamental of the floor-to-ceiling resonance.

The mode numbers i, j, and k each take on integer values, 0, 1, 2, 3, etc., and are associated with the resonant modes of the length, width, and height, respectively, of the room [2]. Table II is a computer printout of the lower modes of my listening room. From it, you can derive the following examples:

1. My listening room measures 20 × 11 × 8 feet. The lowest room mode, at 29 Hz, is i = 1, j = 0 and k = 0 (abbreviated 1, 0, 0). Since j, which corresponds to the width, is zero, and k, which corresponds to the height, is zero, those dimensions do not contribute to this mode.

2. The next lowest frequency mode, 0, 1, 0, involves only the fundamental frequency associated with width (j = 1), which is 52 Hz.

3. The next two modes are 2, 0, 0 at 57 Hz and 1, 1, 0 at 59 Hz and involve the second harmonic of length and the fundamental of both length and width, respectively. They are close to mode 0, 1, 0 in frequency and might combine with it to some extent.

Computer Program

The above formula is tedious when evaluating many modes, so I wrote a short computer program (Table III) that calculates modes in any regularly shaped room.

It is desirable to have a large number of closely spaced (but not identical) resonances in a room, as they will smooth the overall room response rather than appear as individual resonances. It is the lower modes that are responsible for conveying most of the low-frequency energy in a room.

Optimizing Loudspeaker Locations

The best place to excite the largest number of modes is from the corners of a room. This is the point of highest sound pressure for all of the room's modes, including the lowest one. It is where a loudspeaker is most efficiently coupled to the room's resonant modes. Since a subwoofer is used to excite the lowest room modes (typically below 75 or 100 Hz) it should be placed there [3]. Placing full-range speakers in corners unbalances overall response and causes boomy bass. But when only subwoofers are placed there, the response can be balanced by turning down the power in the subwoofer channel, reducing potential distortion in both the bass amplifier and the subwoofer.

If all we cared about was regular frequency response, the ideal position for the main speakers would be at the precise center of the room—halfway up from the floor as well as centered over it—where it would excite the fewest possible modes and where the room's irregular effects on response would be at a minimum. The room's ex-

TABLE III—*This BASIC-language program computes the whole-number frequency of the lower room modes, from 0,0,0 to 2,2,2, and shows them on the screen and, if desired, the printer. Table II was generated by this program. Most personal computers come with some form of BASIC interpreter or compiler, such as BASICA, GWBASIC, QuickBASIC, QBASIC, TurboBASIC, Applesoft BASIC, etc.*

You can type and enter the program in the BASIC environment. An easier way is to use a word processing program (which makes typing and editing easier) that can save files in ASCII text format for later BASIC use.

When entering the program, do so *exactly* as it is shown here and save the file under the name ROOMODE.BAS.

```
1 REM: PROGRAM COMPUTES FREQUENCIES
OF NORMAL ROOM MODES
10 CLS
20 PRINT "INPUT ROOM LENGTH, WIDTH,
AND HEIGHT (IN DECIMAL FEET),
SEPARATED BY COMMAS:"
30 INPUT L, W, H
40 PRINT
50 PRINT "MODE (L,W,H)"; TAB(15);
"FREQ(HZ)"; TAB(41); "MODE (L,W,H)";
TAB(55); "FREQ(HZ)"
60 FOR I = 0 TO 2
70 FOR J = 0 TO 2
80 FOR K = 0 TO 2
90 FREQ = 571 * SQR((I/L) ^ 2 + (J/W)
^ 2 + (K/H) ^ 2)
95 FREQ = INT (FREQ + 0.5)
100 PRINT I; J; K, FREQ;
109 REM: (LINES 110-120 FORCE 2-COLUMN
DISPLAY SO NUMBERS WON'T SCROLL OFF)
110 COL = COL + 1
120 IF COL = 2 THEN COL = 0: PRINT
PRINT TAB(41);
130 NEXT K
140 NEXT J
150 NEXT I
160 PRINT: PRINT
170 PRINT "(TO PRINT, PRESS SHIFT &
PRT-SC KEYS TOGETHER WITH PRINTER ON
LINE)"
```

When using the program, enter room dimensions carefully—this program has no error trapping. This program should give you a good general picture of your room's resonances and help you select a subwoofer to use in that room.

Calculating room *modes can be* tedious, so here *is a computer* program to figure *it out for you.*

There's not much *sense paying for* a 10-Hz subwoofer *if it will be* used in a 29-Hz *listening room.*

TABLE IV—*Frequencies of multiple ("degenerate") modes in a cubical room 20 feet on a side.*

FREQUENCY (Hz)	NUMBER OF MODES
29	3
40	3
57	3
64	6
70	3
81	3
86	3

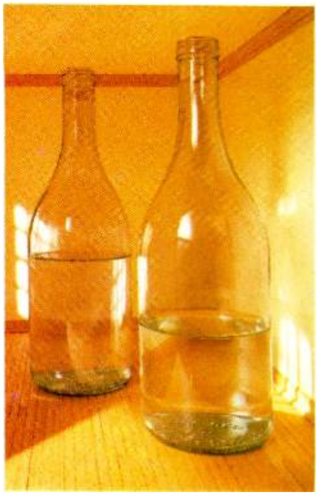
act center is at a low-pressure point for most of a room's modes, which makes them more difficult to excite. Typically, only about 10% of the total modes will be easily excited there. Only those modes that have only even mode numbers (such as 2, 2, 2 or 0, 2, 4) will be well excited by a center-mounted speaker [3].

However, resonances are not the only considerations. In the real world, such factors as minimizing early reflections, maintaining separation between the two speakers of a stereo pair, traffic patterns in the room, and practical seating positions take precedence over this ideal.

TABLE V—*Room-dimension ratios based on third-octaves (see text).*

	H	:	W	:	L		H	:	W	:	L
Small room	$2^{0/3}$	:	$2^{1/3}$	:	$2^{2/3}$	=	1	:	1.25	:	1.6
Average room	$2^{0/3}$	:	$2^{2/3}$	:	$2^{5/3}$	=	1	:	1.6	:	2.5
Low ceiling	$2^{0/3}$	:	$2^{4/3}$	:	$2^{5/3}$	=	1	:	2.5	:	3.2
Long room	$2^{0/3}$	:	$2^{1/3}$	:	$2^{5/3}$	=	1	:	1.25	:	3.2

As with most things, loudspeaker placement is a compromise. Putting speakers at the room's center (as closely as we can approximate it in practice) will yield smoothest frequency response and best stereo imaging—but bass response is compromised there. For the strongest bass response, the corners are best. Use of a subwoofer allows us to take best advantage of both locations.



Room Shapes

If any of a room's dimensions are too close to being whole number (integer) ratios of each other, two or more "degenerate" modes at or close to the same frequency will occur. The resonant rise at these frequencies will be much more than at any frequency corresponding only to a single mode, because the degenerate modes combine their effects. Also, their standing waves will be spread out over a larger volume of the room, making them harder to avoid.

The more symmetrical a room is, the more irregular its response will be. The worst case is a cubical room, whose three dimensions are equal, causing many of the modes to wind up at the same frequencies. This leads to very strong standing waves at just a few widely spaced frequencies, causing very ragged room response. Such a room would have large amplitude peaks and wide frequency gaps between peaks. Also, such a room would have no central "sweet spot" where few modes are excited.

Up to mode 2, 2, 2, there are 26 modes in a room. In a 20 × 20 × 20 foot cubical shape room, there are seven frequencies at which multiple modes exist (Table IV).

In a cubical room, 24 of the 26 modes (92%) are degenerate. In the worst case, at 64 Hz, six modes combine to produce a very large resonant peak in the room. This is a listening-room shape to avoid! Round and elliptical rooms have this kind of (and other worse) problems.

Suggested ratios for room dimensions are based on third-octaves, $2^{n/3}$, where n is any integer not divisible by 3 (e.g., 0, 1, 2, 4, 5, 7, etc.)[4]. These ratios give well-spaced room mode frequencies. Table V shows some examples.

We pay a great deal of attention to loudspeaker frequency response. But we often don't realize that the room also has a very strong effect on what we hear, especially at low frequencies. So we need to consider both together. The computer program in Table III lets you easily find out what these effects are in your room. This can help you make intelligent choices about loudspeaker performance and positioning and about selecting a subwoofer that is appropriate for your room. After all, there's not much sense paying for a 10-Hz subwoofer in a 29-Hz room. A

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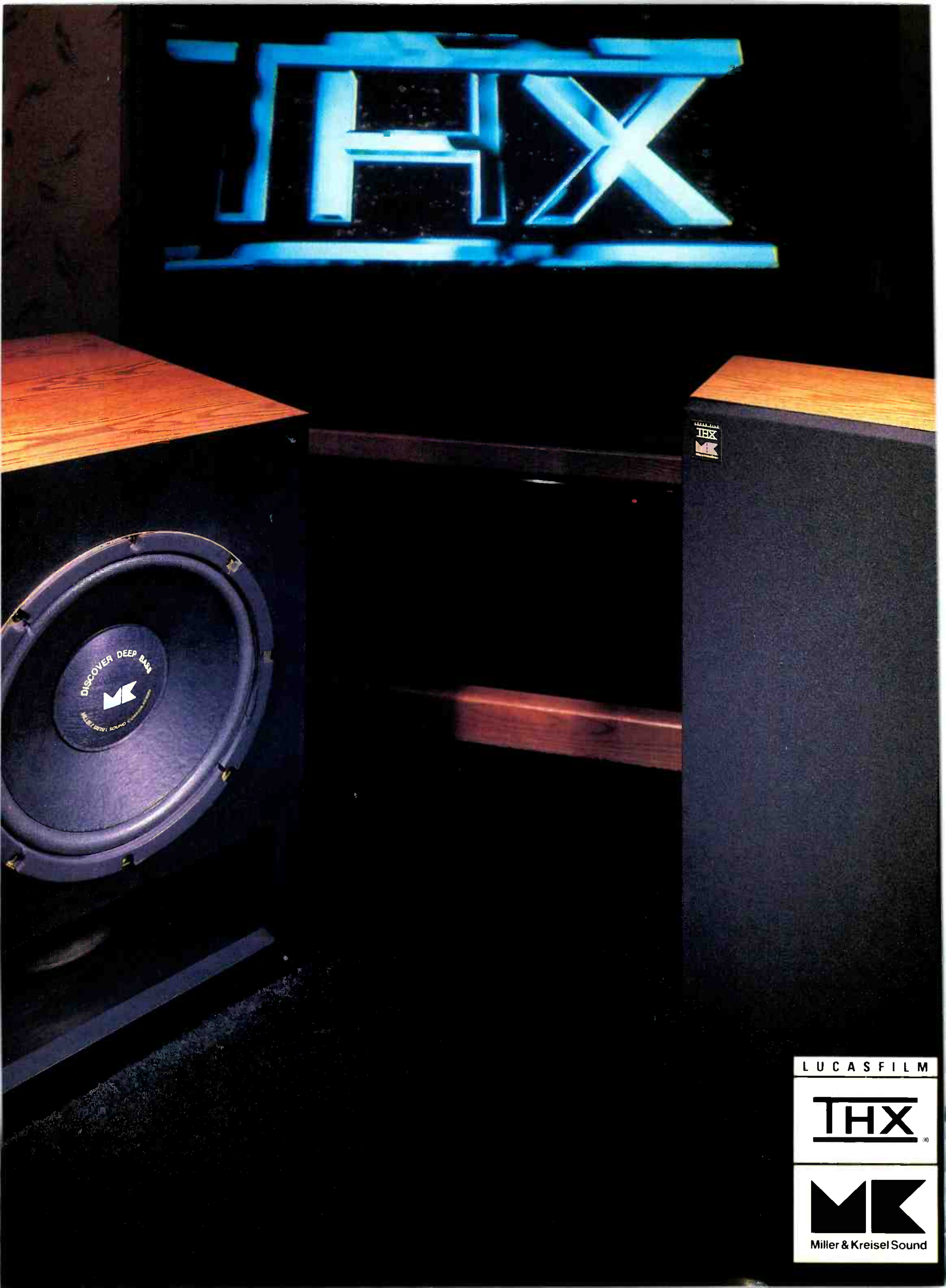
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DISCOVER DEEP BASS
LUCASFILM
THX
Miller & Kreisel Sound

TECHNICS RS-DC10 DCC RECORDER

So far, I have tested and evaluated three Digital Compact Cassette (DCC) recorders. In case anyone tells you that all DCC machines are pretty much the same, let me assure you that they are not. I found the Technics RS-DC10 to be the easiest to use, requiring the fewest references to its owner's manual (which has 61 pages). Perhaps that's because I've already worked my way through two other DCC machines, but I think it's more a matter of better ergonomics and better labelling and positioning of controls.

Like all DCC recorders, the RS-DC10 automatically distinguishes between DCC and conventional analog tapes. Its two-motor drive system uses separate d.c. motors for the capstan and the reels. The chief difference between this transport and previous cassette drive systems lies in its servo control. A DCC deck records at constant speed but makes slight adjustments during playback. DCC decks also buffer recovered data to help minimize wow and flutter.

The RS-DC10's turnover head assembly uses a magnetoresistive thin-film head that includes nine tracks with 0.5-micron gaps for digital recording, nine tracks with 0.3-micron gaps for digital playback, and two analog playback tracks. No erase head is needed; digital recording is done by overwriting, and the RS-DC10 does not record analog tapes.

DCC TRANSPORTS MAKE SLIGHT, CONTROLLED SPEED ADJUSTMENTS DURING PLAYBACK.

To convert analog signals to digital format, the RS-DC10 uses a one-bit A/D converter and two delta-sigma modulators with 64-times oversampling. This A/D converter also has a built-in digital filter and sample-and-hold circuitry. The playback circuitry uses a one-bit D/A converter with third-order noise shaping. All of the PASC bit-rate reduction processing associated with the DCC format is accomplished by four chips.

One difference between DCC and analog cassette decks manifests itself as soon as you load a DCC tape: The deck winds the tape for a few seconds to read its Table of Contents. (Similar TOCs are found on CDs, MDs, and prerecorded DATs.)

Control Layout

The RS-DC10 provides just about every feature of the DCC format. The power switch is at the lower left of the front panel. Above it is a "timer" switch for use when an external timer has been connected to the unit. Further up is the section for marker controls. Its six buttons are used for writing track-start markers automatically or manually, renumbering tracks, writing "Next" and "Reverse" markers, and erasing markers. In playback, when a DCC machine finds a "Next" marker, it switches from side A to side B (or vice versa), rewinds to the beginning of that track, and then starts play. When the machine finds a "Reverse" marker, it switches tape sides and then starts play immediately.

Next to "Timer" is a noise-reduction switch, with settings for Dolby B and C NR (and an "Off" position) for use when playing back analog cassettes. Flanking the cassette drawer at the upper midsection of the panel are four tiny buttons for resetting the counter, selecting repeat play, changing mode of the counter display, and selecting text information. (The amount of text available on a prerecorded DCC tape is dependent on the software manufacturer and may include such things as overall album title, artist's name, and track title. Further to the right are the "Open/Close" button for the cassette tray and three controls used in recording: An input selector (with settings for unbalanced analog, fiber-optic digital, and coaxial digital inputs), a large master level control, and a channel-balancing pot.

Along the lower edge of the front panel are buttons for "Side A/B" selection, forward and reverse track-skip, "Append" (to find the end of a partially recorded tape), and the usual tape-transport functions (recording, playback, rewind, "Stop," fast forward, and auto record mute for recording blank spaces between tracks). Farther to the right are the headphone jack and its level control.

Below the cassette drawer is the display. The display's alphanumeric section shows counter number or time (total remaining, total elapsed, or elapsed within the track), transport mode, and any text available on a DCC recording. It also shows track numbers for all prerecorded DCC tapes and for all home-recorded tapes whose makers have specifically included them. In addition, small flags light up to inform you about tape direction (side A or B), Dolby NR status, marker types and locations, sampling frequency, selected input, and, when applicable, digital copy-prohibition. (United States law now requires SCMS

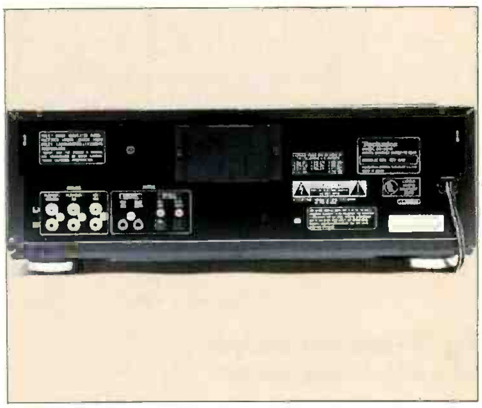
NONE OF US HEARD ANY DIFFERENCE IN MUSICAL INTEGRITY OR ACCURACY BETWEEN CDs AND DCCs MADE FROM THEM.

copy-limitation circuitry in all home digital recorders, and SCMS is therefore included in the specifications for both DCC and its rival MiniDisc format. All home DAT recorders now include SCMS, too.)

The supplied remote control duplicates just about all of the front-panel control functions and has numerical buttons for direct access to any track and a button for scanning and playing back the first 10 S of each track on a DCC tape. The remote also has buttons to control the variable-level output jacks on the rear of the RS-DC10. That rear panel carries jacks for fixed-level analog output, analog input, and both coaxial and optical digital inputs and outputs.

Measurements

In testing the performance of the RS-DC10, I first checked record/playback frequency response using the analog inputs and outputs to record a sweep of frequencies onto a blank DCC tape. Results are shown in Fig. 1A, with response perfectly flat from 20 Hz to 20 kHz and a minor channel imbalance of less than 0.3 dB.



SPECS

Digital Cassette (DCC)

Frequency Response: 44.1-kHz sampling, 10 Hz to 20 kHz, ±0.2 dB; 48-kHz sampling, 10 Hz to 22 kHz, ±0.2 dB; 32-kHz sampling, 10 Hz to 14.5 kHz, ±0.2 dB.

THD: Playback, less than 0.003%; record/playback, less than 0.005%.

S/N: Playback, greater than 98 dB; record/playback, greater than 92 dB.

Dynamic Range: Playback, greater than 95 dBA; record/playback, greater than 92 dBA.

Channel Separation at 1 kHz: Playback, greater than 95 dB; record/playback, greater than 80 dB.

Analog Cassette

Frequency Response: Type I tape, 30 Hz to 15 kHz, ±3 dB; Type II tape, 30 Hz to 16 kHz, ±3 dB; Type IV (metal) tape, 30 Hz to 17 kHz, ±3 dB.

S/N (re: 250 nWb/m with Type II Tape): Without noise reduction, 56 dB; with Dolby B NR, 66 dB; with Dolby C NR, 74 dB.

Wow and Flutter: 0.07% wtd. rms, ±0.12% wtd. peak.

Input & Output Levels

Minimum Analog Input Level: 60 mV.

Fixed Analog Output Level: 500 mV (maximum, 2 V).

Headphone Maximum Output: 30 mW/channel, 32 ohms.

Headphone Matching Load Impedance: 8 to 600 ohms.

General Specifications

Fast Forward/Rewind Time: Approximately 100 S with D-60 tape.

Power Requirements: 120 V a.c., 60 Hz, 42 watts.

Dimensions: $16\frac{15}{16}$ in. W × 6 in. H × $13\frac{7}{16}$ in. D (43 cm × 15.3 cm × 34.1 cm).

Weight: 18.3 lbs. (8.3 kg).

Price: $999.95

Company Address: One Panasonic Way, Secaucus, N.J. 07094.

For literature, circle No. 90

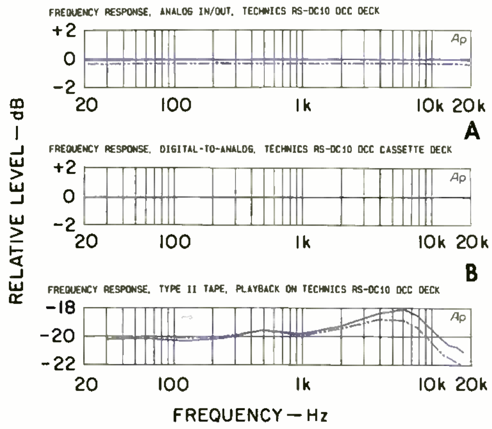


Fig. 1—Frequency response for record/play via analog (A) and digital inputs (B) and for playback of Type II analog cassette (C).

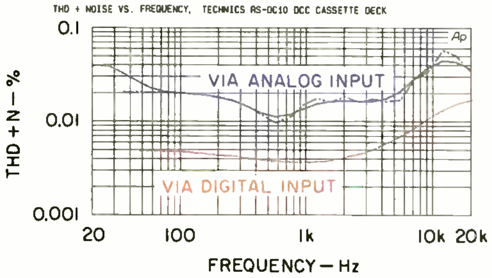


Fig. 2—THD + N vs. frequency for DCC record/play.

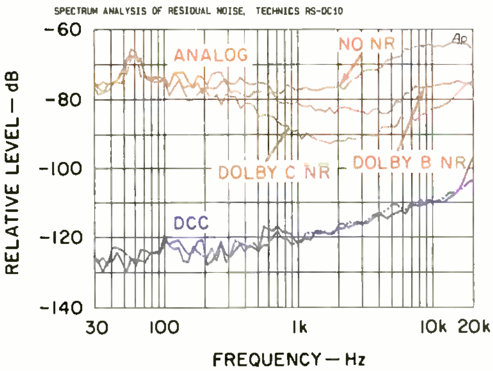


Fig. 3—Spectrum analysis of residual noise; see text.

For Fig. 1B, I fed a digital frequency sweep from my Audio Precision system to the RS-DC10's digital inputs. Response is even flatter than before, and this time there is no measurable amplitude difference between channels. Since one of the features of the DCC format is its backwards compatibility with analog cassettes, I next checked frequency response for playback of a Type II cassette, using a BASF test tape with spot frequencies from 31.5 Hz to 18 kHz (Fig. 1C). Response is actually much better than claimed by Technics; it extends out to the top test frequency of 18 kHz, with no more than about 1 to 1.5 dB of attenuation at that frequency and a slight rise from about 2 to 10 kHz. That's considerably better than many high-priced analog cassette recorders can do.

Returning to DCC mode, I measured THD + N versus frequency (Fig. 2). For analog input signals, the results range from about 0.01% to 0.02% over much of the audio spectrum, increasing to around 0.04% at 20 Hz and at 20 kHz. As expected, THD is even lower for digital signals fed via the coaxial input, just under 0.004% at 1 kHz and rising to 0.018% at 20 kHz.

To isolate the actual harmonic distortion components from the residual noise of the system, I conducted an FFT spectrum analysis of a 1-kHz digitally recorded signal at maximum level (not shown). The most significant actual harmonic was at 2 kHz and was 103 dB below maximum recorded level, which corresponds to a THD percentage of less than 0.001%!

Signal-to-noise ratio of the RS-DC10, for a "digital zero" signal recorded through the digital inputs, was 98 dBA for the left channel and 98.6 dBA for the right channel. It is worth noting that a spectrum analysis of the residual noise (Fig. 3) shows not the slightest trace of the 60-Hz a.c. line frequency or its harmonics.

Returning to analog tape, I played back a previously recorded "no-signal" Type I analog cassette and measured its signal-to-noise ratio without and with Dolby B and C noise reduction. The A-weighted readings were 57 dB without Dolby noise reduction, 66.2 dB using Dolby B NR, and 73.6 dB using Dolby C NR. Of course, these results would be different if I had used another tape formulation or brand. A spectrum analysis of residual noise for playback of the analog "no-signal" tape (Fig. 3) clearly illustrates the beneficial effects of Dolby B and C NR.

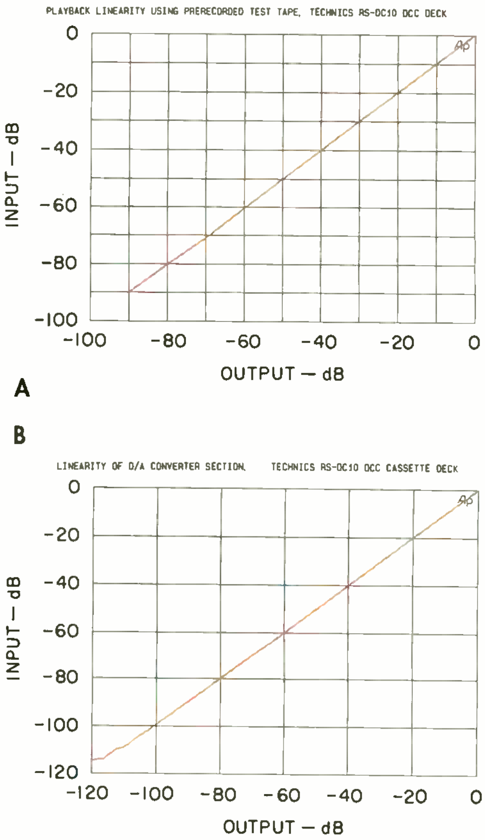


Fig. 4—Input vs. output linearity, for prerecorded DCC test tape (A) and for record/play via digital input (B).

ON ANALOG TAPES, THE RS-DC10 IS FLATTER THAN MANY EXPENSIVE ANALOG DECKS, AND ON DCC IT'S FLATTER STILL.

THE DIGITAL DECONVOLUTION AUDIO SYSTEM™...

WHAT AUDIO DSP WAS MEANT TO BE

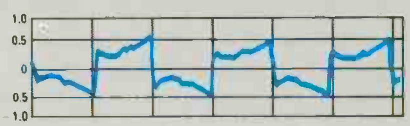
An ideal loudspeaker would convert electrical signals to sound pressure signals with "flat frequency response" and "zero phase nonlinearity". In practice, however, all loudspeakers, no matter how expensive, exhibit significant imperfections. Technically, the electrical signal is improperly dispersed (blurred) by the loudspeaker resulting in audible distortion. This blurring effect is the result of a physical phenomenon called "CONVOLUTION". Until now, it has been the dream of the hi-fi enthusiast to have a blur-free loudspeaker.

The DDA-1 amplifier contains a digital signal processing (DSP) module to which the incoming audio signal (digital or analog) is routed. At the heart of the DSP module is a proprietary, state of the art, application specific integrated circuit (ASIC) developed by DGX.

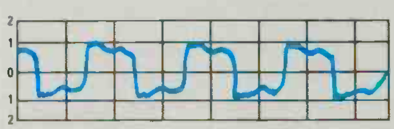
The DGX Deconvolution Processor

Using a patented algorithm, 383 numbers describing the loudspeaker characteristics are provided to the ASIC, whose sole purpose, through DECONVOLUTION PROCESSING, is to prevent the speaker from blurring the signal. With a pair of high quality DGX loudspeakers, whose coloration (blurring) is virtually eliminated by the deconvolution process, the sound produced by this revolutionary system is so pure and clean, we dare say it is better than any audio system available, regardless of price.

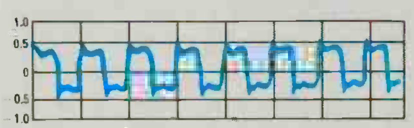
Speaker sound pressure measurement for square wave input.



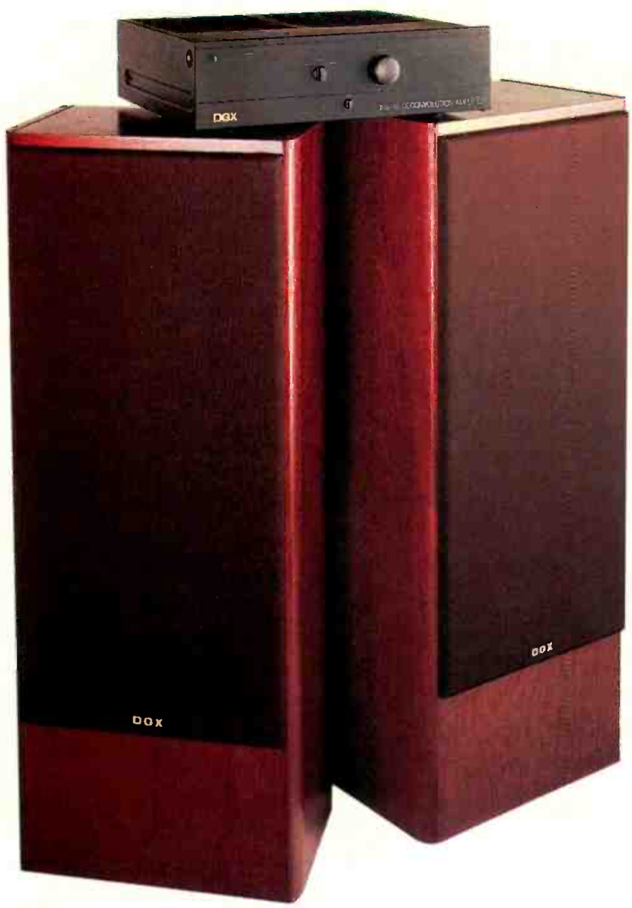
100 Hz Response



500 Hz Response



1 kHz Response



DDA-1 DIGITAL DECONVOLUTION POWER AMPLIFIER

POWER AMPLIFIER

Construction	Dual mono
Rated power output (per channel)	100 W min @ 8 Ohms 140 W min @ 4 Ohms
Power bandwidth	20 Hz-20 kHz
Power supply filter capacitance	60,000 microFarads
Damping factor	150
THD at rated power	0.01%
IM distortion at rated power	0.16%
IM distortion at 1/8 W output	0.02%
Residual noise	0.3 mV unweighted

ANALOG TO DIGITAL CONVERTER

Type	Oversampling delta-sigma modulation
System sampling rate	44.1 kHz
Internal oversampling	64 X with quadruple integration
Dynamic range	92 dB
S/(N + D)	90 dB

DECONVOLUTION FILTER

Type	Finite Impulse Response
Filter length	383 taps
Arithmetic unit	Fixed point 16 bit multiplicand 16 bit multiplier 36 bit accumulator Automatic roundoff
Multiply-accumulate time	54 nsec.
Overflow detect	1 second LED indication Supressed polarity reversal

DDL-1A LOUDSPEAKERS

Shown with optional Rosewood veneer finish

Power rating	150 W
Input impedance	8 Ohms
Drivers	1 inch ferro fluid cooled soft dome tweeter 2 inch ferro fluid cooled soft dome mid-range 12 inch high young's modulus mica/pp cone with die cast frame woofer
Construction	Simulated or real wood veneer over 100% MDF
Dimensions	39.5H x 15.6W x 11.0D
Weight	68 lb.

SYSTEM

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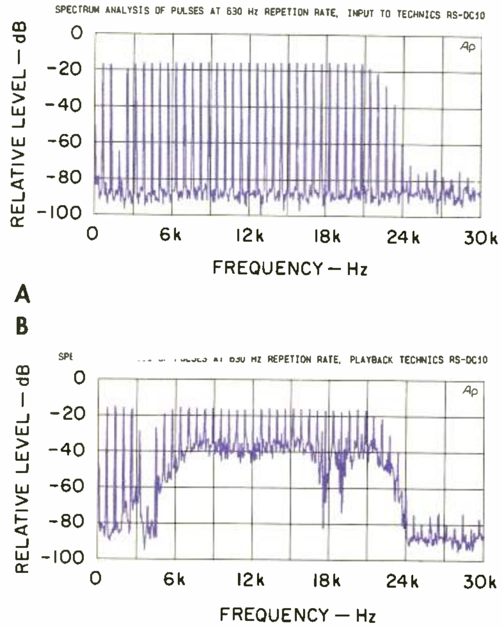

Fig. 5—Spectrum of digital pulse signal with 630-Hz repetition rate, as fed from CD through RS-DC10 (A) and after record/play (B).

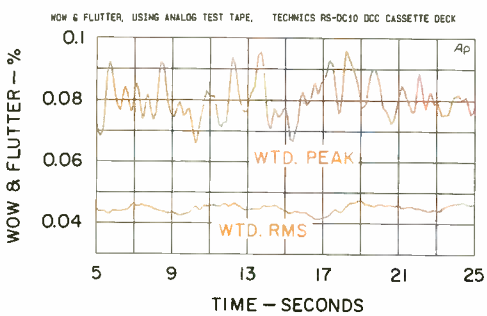

Fig. 6—Wow and flutter in analog playback.

Once again in the DCC mode, I measured the linearity of the system. Figure 4A shows the results for playback of a prerecorded test tape supplied by Philips; there is virtually no deviation from perfect linearity over the range from 0 dB (maximum digital recorded level) down to –90 dB. Using digital signals from my Audio Precision test set, I could measure down to –120 dB (Fig. 4B), finding nearly perfect linearity down to at least –100 dB.

As in previous tests of DCC recorders, I wanted to see if I could detect the action of the PASC bit-rate reduction system. Because ordinary single-tone test signals will not serve to illustrate this action, I had to use a special signal consisting of a unit pulse having a repetition rate of 630 Hz, which I fed from a Philips test CD via the RS-DC10's digital input. Figure 5A shows the harmonics in the complex input signal, prior to recording and playback. By contrast, Fig. 5B shows what happens to this signal when it is encoded and decoded for playback using the PASC bit-rate reduction system. As in a test of another DCC recorder, the noise floor over much of the audio spectrum increases by nearly 40 dB. Listening tests using music, however, revealed that this increase in measured noise has no audible effect. Neither I nor several guest listeners were able to detect any difference in musical integrity or accuracy when comparing DCC recordings with the CDs from which they were made. Interestingly, this was not the case when I first listened to such comparison tests more than a year ago. It seems obvious to me that the PASC encoding algorithm has been tweaked since then; the PASC system allows improvements in encoding to be heard even without improved decoders.

For my final bench test, I reverted to analog tape to measure the transport mechanism's wow and flutter. (There is no measurable wow and flutter when playing back DCC tapes.) The wtd. rms reading hovers between 0.04% and 0.05%, as can be seen in Fig. 6, while the wtd. peak (IEC) wow and flutter ranges from about 0.07% to about 0.095%. These are very respectable results for any analog cassette player.

Use and Listening Tests

As I indicated at the beginning of this report, the RS-DC10's layout is superb, as is its styling. Mechanically, the unit performed flawlessly. I was particularly impressed by its excellent text display facilities and by its truly full-function remote control. With the remote, you can control all recording or playback functions, including track marking and numbering, from the comfort of your listening position.

The folks at Technics were kind enough to send along a prerecorded DCC sampler from GRP (GRX-9997). This tape has a wide variety of big-band music, including such favorites as "Fascinating Rhythm" interpreted by Dave Grusin and "In the Mood" by the Glenn Miller Orchestra. All

THE PASC ENCODING SYSTEM HAS OBVIOUSLY BEEN IMPROVED SINCE I FIRST HEARD IT.

12 tracks were reproduced flawlessly. I particularly enjoyed the noise-free reproduction of this and other DCC prerecorded cassettes I have collected.

However, I am still somewhat bothered by the slow access times of the DCC decks I've reviewed so far. To play track 6 of the GRP sampler (the last track on side A of the cassette), I had to wait 90 S while the mechanism wound its way from the start of side A to the last track on that side. The actual playing time of tracks 1 through 5 that had to be traversed was only 23 minutes, 35 seconds. I guess I'm just too used to the instant access of CD players and the more rapid (though certainly not instant) access of DAT recorders. Of course, this will be of little concern to me when I play classical DCC tapes from start to finish, but I recognize that most DCC tapes (whether prerecorded or user-recorded) consist of several short tracks. Accessing a track that's deep into a tape side just seems to involve an endless wait.

As a home DCC deck, the Technics RS-DC10 is an outstanding example of superb mechanical and electronic engineering. Its suggested retail price of just under $1,000, however, suggests to me that it may be a fairly long time before DCC replaces analog cassette—especially since inexpensive personal portable players are now the chief hardware used for playing music from analog tapes. *Leonard Feldman*

SPECIAL ADVERTISING SUPPLEMENT

SOUND THAT MOVES

America's almost century-long love affair with the automobile and the lifestyles that relationship has created are unique in all the world. Nowhere else has so much effort and energy been expended on the adaptation of hardware to the special needs of the mobile audiophile.

The challenges laid down by automotive sound have created a whole industry and allowed the development of a global marketplace for American technology and engineering excellence.

What began long ago as a afterthought is now a multi-billion dollar business responsible for some of the most creative and unique technical innovations ever brought to the world of audio. When this all began a half century ago who would have imagined the power and precision reproduction available today with the first dedicated car radio speakers and electronics.

The stories that unfold on the following pages tell the history and show the drive and dedication of the all-American innovators who gave the world "sound on the move."

CAR ELECTRONICS

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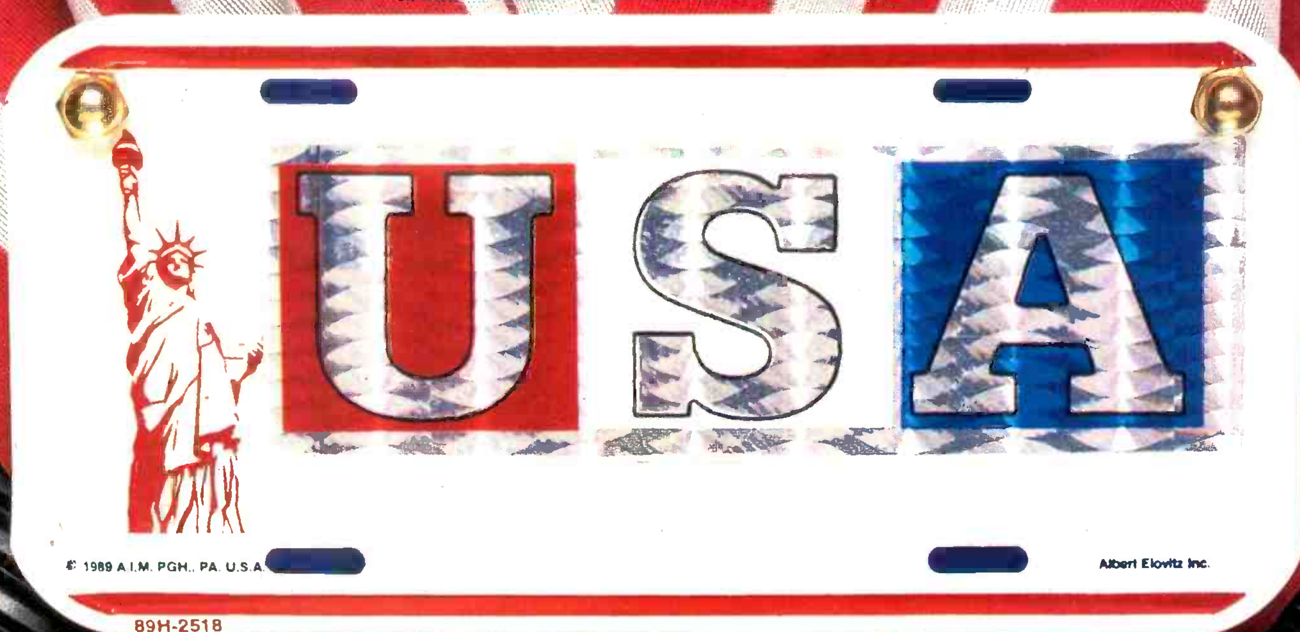


PYLE

For more than four decades the American heartland has been home to a company whose name is synonymous with superior quality, high power loudspeakers. Pyle Industries, in Huntington, Indiana, is a classic example of American entrepreneurship, dedication to quality, and the best traditions of all-American craftsmanship.

Collectively, the key members of the Pyle team have amassed more than three centuries of experience in the design and engineering of loudspeaker products. This amazing resource base was started when key individuals at Pyle were also an integral part of another legendary name in American audio—Utah. That company's loudspeakers, made just a few miles from the current Pyle factories, led the way in innovative engineering throughout much of the 1950s, 60s and the early 1970s.

Frank Pyle and his son Frank Pyle Jr., along with other family members and associates, founded Pyle and are still actively involved in every facet of the business. This homegrown, individualistic and uniquely personal style is refreshing in an industry often known more for its faceless mega-corporations. Pyle's more personal approach allows them to produce products that deliver performance without compromise.

That same style continues throughout the organization, all the way to the factory floor. For example, in an industry where many companies mass produce thousands of drivers each hour and batch test just a few on automated equipment, *each and every speaker* Pyle produces is built by hand and individually tested and approved before packaging and shipping.

Pyle

Pyle Industries' personal approach allows them to produce products that deliver performance without compromise.

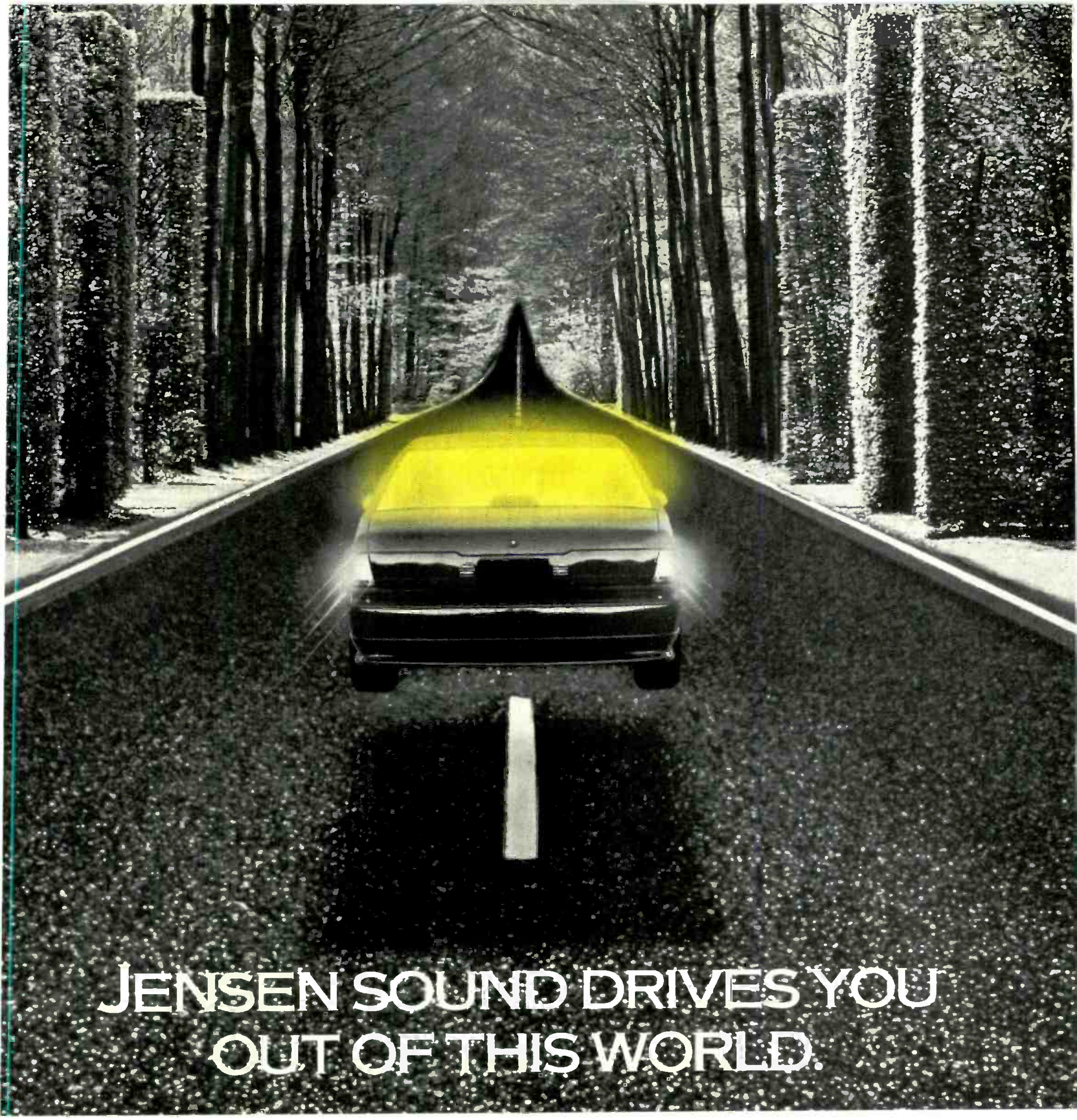
The workforce at Pyle takes great pride in being able to marry the latest technologies and materials with the superior, artisan-like quality that this personal attention provides.

Ever since the company developed and marketed the first genuine high power woofers in the late 1960s, it has sought to extend the potential for mobile audio to new levels. This desire produced the now legendary Pyle Driver and multi-element car stereo speakers in the 1970s. In the 1980s, Pyle engineers, pushed by a passion for audio perfection, designed a series of enclosed systems optimized for specific types of vehicles, again breaking new ground in mobile fidelity and power. By doing this they were able to maximize performance for their customers and eliminate many of the variables that negatively impacted real-world installations.

Now in the 1990s, Pyle again has raised the standard with the introduction of its World Class subwoofers, full range Pounder(R) systems and Toobz™ bass systems. The all-American technological basis for the sonic and mechanical performance of the company's loudspeakers is the merging of IronCloth™ spider material with IronGlaze™ magnet wire coating to produce IronMax™, the industry's most indestructible voice coil and motor assembly.

By integrating and controlling a proprietary mix of precision materials, Pyle has created a series of subwoofers and other products that exceed every measurable standard for ruggedness, resistance to failure, and pulse-pounding performance. The use of massive magnetic configurations, vent-cooled motor structures, high energy rare earth NeoDome™ tweeters, ProLinear™ polyfoam suspensions, and polymer laminate cones provide the professional mobile sound installer and audio enthusiast with a carefully crafted collection of units to meet any requirement.

The multi-generational heritage of innovation and no-compromise engineering has built Pyle into one of America's leading mobile sound technology companies. As the choice of enthusiasts worldwide, Pyle is now guiding the development of products that will continue to change the rules for sound on the move.



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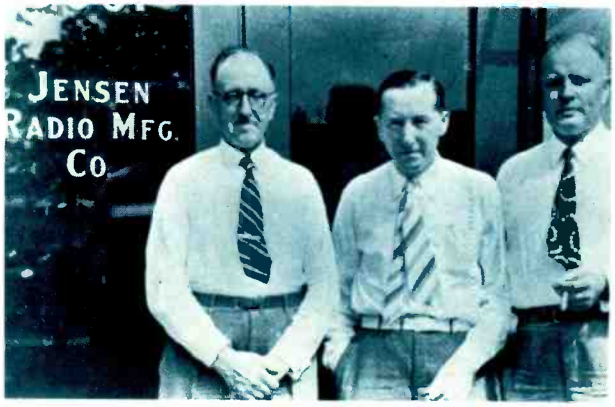


Jensen

Creativity and innovation continue to be essential parts of the Jensen philosophy.

Made in the U.S.A.? You bet. International Jensen Incorporated (IJI) is the largest vertically integrated manufacturer of car speakers in the USA. It started more than three quarters of a century ago when a brilliant young Danish immigrant named Peter Jensen invented what we know today as the modern loudspeaker. That single device was the foundation upon which the power of American innovation built the high-fidelity industry.

In 1927, the Jensen Manufacturing Company produced the world's first commercially available moving-coil direct radiator loudspeaker, the first permanent magnet dynamic loudspeaker, and the first commercially available compression-driven horn tweeter, followed soon by the first molded hi-fi speaker diaphragm.

Creativity and innovation continued to be essential parts of the Jensen philosophy. In 1932, the company produced a series of loudspeakers specifically designed to match the first automotive radios, produced by another all-American pioneer, Paul Galvin of Motorola. Once again, Jensen was the trailblazer in opening another new market and creating another whole industry—mobile audio. The pursuit of ever-higher fidelity in the automobile, exemplified by the explosive growth of FM radio, brought forth the first true high-fidelity car stereo speaker in 1972.

The mid-1970s saw the birth of a legend in automotive sound—the Jensen Triaxial(R) 3-way car stereo speaker system. Suddenly the performance capabilities of home audio were available in the car.

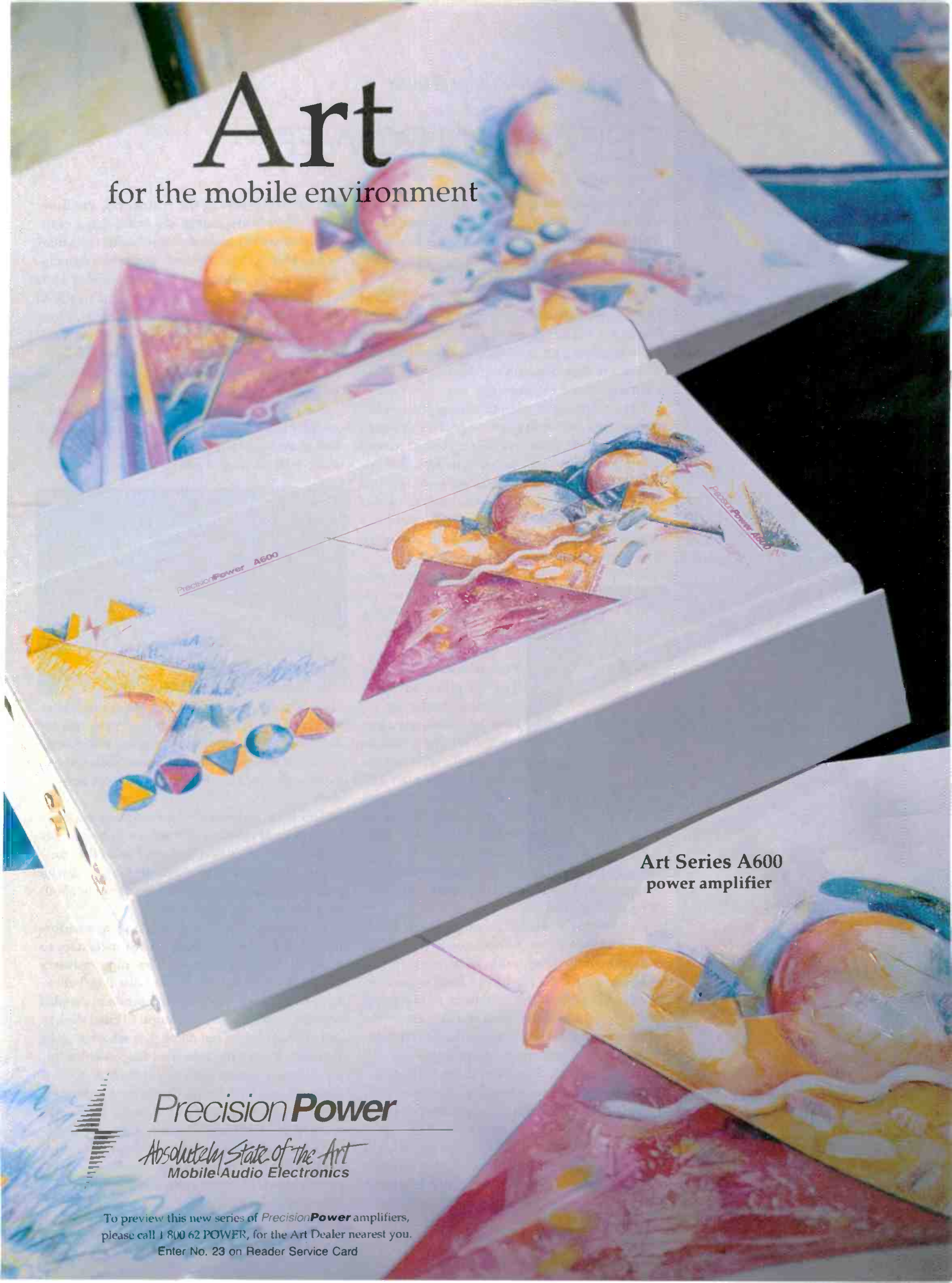
The Jensen legacy of American engineering excellence and innovative products is now part of International Jensen Incorporated. The IJI family of companies includes: Acoustic Research, Advent, Advent Mobile, Day Sequerra, Magnat, NHT, and Phase Linear. Although its headquarters are in Lincolnshire, Illinois, IJI manufactures its own metal and plastic in Pennsylvania and magnets in Texas.

Voice coils and cones are made in their North Carolina plants, where final assembly occurs. These companies prove that Made in the USA means high-quality, globally competitive products.

Industry recognition of the commitment to engineering and design excellence at IJI was shown when the company received an impressive six Design and Innovation awards at the 1992 Summer Consumer Electronics Show. Among those was an award for the unique Jensen BBE amplifier and the newest Jensen Triaxial.

Today, Jensen has 1,600 employees across the U.S. who are continually refining and improving the products. Jensen has recently introduced a new series of receivers featuring detachable receiver security panels. Advent Mobile's U.S.-made speaker line with ICT (Inductive Coupling Technology™) is unique in America because the ICT plug cannot be blown like a conventional tweeter. The low-profile design fits behind virtually all OEM grilles. And its performance has been acclaimed by critics from sea to shining sea. The Phase Linear car audio line has graphite cone speakers that offer superior responsiveness, and Phase Linear Series 48 models allow the purchaser to customize and grow their system, since the speakers operate in 4- or 8-ohm loads.

The long heritage and many firsts associated with the Jensen name continue to drive the engineering and product development professionals at IJI who are dedicated to producing American-made quality audio systems.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PRECISION POWER

The American entrepreneurial spirit is alive and well in the Valley of the Sun in the heart of the American southwest. Phoenix, Arizona is the home of Precision Power, Inc., a unique company now celebrating its tenth anniversary.

In an industry often perceived to be dominated by large, internationally based suppliers, Precision Power has been immensely successful at finding and capitalizing on the needs of those who will settle for nothing less than the absolute state of the art in automotive electronics.

The creation and manufacturing of amplifier and preamplifier components especially designed to maximize the head unit to loudspeaker transfer path is a complex and competitive area. But because Precision Power has focused on only this area, it is able to respond almost instantly to market demands and produce those specific products needed by the mobile audio installation and system design professionals around the world.

The ability to move quickly and deliver very high quality comes as a result of the two individuals who founded the company in 1983. Jeff Scoon, President and CEO, and Ted Guenther, Secretary Treasurer, both take active, hands-on management roles. The combination of Jeff's work on the daily business plan and Ted's focus on managing the production side of the company allow their individual talents to shine while maintaining the driving, competitive all-American spirit that created Precision Power.

Precision

The drive to be the best, not the biggest, allows Precision Power to rely on the dedication and craftsmanship of its workforce.

That drive to be the best, not the biggest, has allowed Precision Power to continue to rely on the dedication and craftsmanship of its workforce to build as much of the product by hand as possible. The involvement of the workforce in every step builds pride and commitment and also allows the company to incorporate state-of-the art technology and the best components wherever needed.

This approach is showcased in the recently introduced Art Series amplifiers. By offering innovative solutions, this series of amplifiers resolves a number of persistent problems faced in higher power mobile applications. The heat sink designs of typical mobile applications are not very effective unless mounted straight up and down to permit the required convective flow. Since this option is not often possible in the real world, Precision Power decided to change the entire shape of the amplifier and eliminate the "fins" at the same time.

In addition to the "finless" design, this series incorporates the results of a long and detailed study of the concepts and techniques used in PWM (Pulse Width Modulation) power supplies. Using inductor/capacitor averaging circuitry, PPI's engineers were able to overcome the complex problems presented when adapting this technology to mobile audio applications.

Because of their love of sound and Scoon's philosophy that life is too short to devote it to a job that provides only a paycheck, the company has made it an intentional part of their growth plan to

identify and recruit individuals whose collective expertise, enjoyment of both high performance audio and high performance vehicles, and willingness to go above and beyond insures their drive to make each Precision Power product the best-in-class.

This team understands the company's responsibility to build products that are not only sonically stunning but physically attractive as well. Transparent audio performance must be integrated with units that make a clear, positive statement about the individual who owns them.

An approach that embodies taking up a performance challenge and doing what is necessary to meet it, even if that means bucking industry trends, lets Precision Power do what they believe in. This approach to design and product, coupled with the intense American passion to build the best and still have lots of fun doing it, is what has given Precision Power the unrivaled success it has enjoyed during the last four years at the I. A. S. C. A (International Auto Sound Challenge Awards). No other American amplifier company has earned more awards and First Place trophies.

This unparalleled recognition of the company's Pride through Performance goals is clear and unequivocal evidence that innovation and excellence are still worth pursuing.

EQUIPMENT **PROFILE**

PARADIGM STUDIO MONITOR LOUDSPEAKER

The recently updated Paradigm Studio Monitor is their top-of-the-line and most-expensive system. It is part of the five-system, high-performance "Monitor Series," which has existed for about 2½ years. After my excellent experience with the firm's 7se (Sept., 1989), I was interested to see if the Studio Monitor continued the fine tradition; the system did not let me down.

The Monitor Series is intended to compete sonically with such high-end systems as B & W, KEF, and Thiel, but at about half the price. Paradigm has applied all the knowledge and technology they learned through their close association with Canada's National Research Council to produce what they believe is a highly accurate, low-distortion system at a very affordable price (see "Testing At Canada's National Research Council," Sept., 1989). Paradigm now depends much less on the NRC because they have established their own in-house R & D and manufacturing facility, which includes a large anechoic chamber (40 feet × 33 feet × 28 feet), along with two world-class listening rooms.

The Studio Monitor is a large and fairly heavy, three-way system that uses a pair of parallel-connected 8-inch woofers, operating in a vented (bass-reflex) box. Paradigm manufactures the woofers, crossovers, and cabinets for the Monitor line but obtains the midranges and tweeters from Vifa, which makes them to Paradigm's specifications. The system, which is deeper than it is wide, is nearly 4 feet tall. It contains a vertical array of drivers with the two woofers on the bottom, and the midrange and tweeter mounted above, all on the center line of the front panel.

The high-excursion, 8-inch woofers use large, 40-oz. magnets and 1½-inch diameter voice-coils, and are mounted in die-cast aluminum frames. The motor drive uses "focused-field" magnetic geometry and high-temperature precision-wound voice-coils mounted on a vented, aluminum and Kapton former. In order to minimize distortion, Paradigm uses a special cone and surround material that they call a "mineral-filled copolymer polypropylene joined to a

SPECS

System Type: Three-way, quasi-third-order resistive-port system.

Drivers: Two 8-in. cone woofers, 5-in. cone midrange, and 1-in. aluminum-dome tweeter.

Frequency Response: 30 Hz to 20 kHz, ±2 dB, on axis; 30 Hz to 15 kHz, ±2 dB, 30° off axis.

Sensitivity: 87 dB at 1 meter with 2.83 V rms applied.

Crossover Frequencies and Filter Slopes: 275 Hz (second-order electroacoustic) and 2.5 kHz (third-order electroacoustic).

Impedance: Nominal, 6 ohms; minimum, 4 ohms.

Recommended Amplifier Power: 15 to 300 watts per channel.

Dimensions: 43½ in. H × 12¼ in. W × 16½ in. D (110.5 cm × 31.1 cm × 41.9 cm).

Weight: 93 lbs. (42.3 kg) for single system excluding stand.

Price: $1,899 per pair. Available in natural oak, dark oak, and black ash wood veneers; walnut veneer, $50 per pair extra. Comes with adjustable spiked feet.

Company Address: AudioStream, M.P.O. Box 2410, Niagara Falls, N.Y. 14302.

For literature, circle No. 91

In Vienna,

where they live and breath music, a survey of 17 D to A converters was conducted by the noted musicologist and audio critic, Dr. Ludwig Flich. Only two converters earned the "Reference Class" status. One of these converters sells for $13,500. The other, at one seventh the price, is pictured below.

In Tokyo,

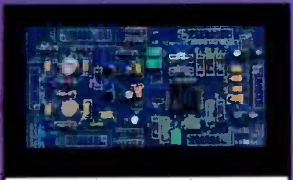
where they live and breath consumer electronics, and where one can purchase anything made by anyone in the world, that same D to A converter was chosen as 1992's **Component of the Year.**

Unique in the world,

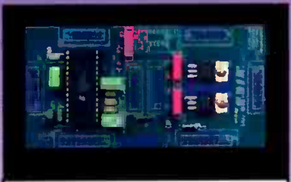
the Counterpoint DA-10 's DACCards let you listen to multibit, Sigma-Delta 64X or BitStream DAC's. Only the DA-10 has two digital-domain tape loops, four digital inputs with coaxial, TOSLINK or AT&T ST-type optical formats, and is a *complete digital studio.* Only the DA-10 has user adjustable DAC trimming. It even uses *zero feedback* in its I to V converter. In short, *the world's most musical D to A converter is also its most advanced.*

Below, a sampling of available DACCards

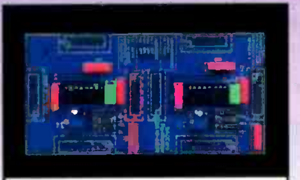
UltraAnalog Dual 20-bit Audio DAC



Philips 20-bit Bitstream DAC



Crystal Semiconductor 18-Bit Sigma Delta DAC



Analog Devices 20-bit/multi-bit DAC

COUNTERPOINT 2281 Las Palmas Dr. Carlsbad, Ca. 92009
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high-hysteresis synthetic butyl suspension" (sounds impressive). The similarly designed Ferrofluid-cooled midrange utilizes a curvilinear cone of the same materials that exhibits "exceptional stiffness versus mass and excellent internal damping."

The Ferrofluid-cooled tweeter uses a low-profile, convex aluminum dome, (which is said to push the dome's first breakup-resonance frequency far above the audible range) and a treated textile suspension. The tweeter utilizes a close-mounted diffraction lens over the center of the dome to smooth and widen its response. Coupled with other design features, the tweeter is said to exhibit exceptional power handling and freedom from dynamic compression.

ABOVE 500 Hz, THE PARADIGM'S POWER HANDLING KEPT UP WITH ANY SYSTEM I'VE TESTED.

The Studio Monitor's crossover contains four resistors, one rheostat, four inductors, and six capacitors, not counting paralleled units. All parts are high quality and very close tolerance (±2%). The rheostat, a factory-only adjustment, allows the level of the tweeter to be set for close unit-to-unit matching. The woofer and midrange inductors use iron and ferrite cores, respectively, while the tweeter coil is an air-core type. The crossover is said to be of quasi-Butterworth, electro-acoustic design. The crossover is wired point-to-point on two hard boards; one is the rear terminal board, and the other is a smaller board for the low-frequency components.

The rear of the cabinet contains the large connection panel, with three pairs of heavy-duty, double-banana jacks for the woofers, midrange, and tweeter. This allows bi-wiring or tri-wiring the system. (The cable manufacturers love Paradigm! Actually having the three parts of the system separately available is a boon to us reviewer types who like to investigate crossover relationships, roll-off slopes, etc.). The holes of the jacks will accept large cable, up to 0.2 inch (#4 AWG) in diameter. In standard, single-wiring configuration, four gold-plated straps are provided to connect the three sets of terminals.

The main structures of the Studio Monitor's cabinet are constructed from high-density composite hard board, which is said to have high internal damping to minimize resonances. Platform braces, made from Medite fiberboard, located around the full perimeter, also reduce resonances. The "Co-Spun" damping material used to reduce internal standing waves is said to be acoustically transparent at lower frequencies where the vented-box cabinet operates. The midrange operates in its own tubular sub-enclosure that connects the front and rear of the cabinet. Real wood veneer is used on the top, sides, and rear of the cabinet, while the front panel is finished in Paradigm's traditional metallic.

Measurements

Figure 1 shows the on-axis anechoic frequency response of the Studio Monitor, taken with and without the grille. Measurements were taken at a distance of 2 meters from the cabinet's front, on the tweeter's axis, with a voltage of 5.66 V rms, and referenced back to 1 meter. The response below 600 Hz was derived from 2-meter ground-plane measurements with input reduced to 2.83 V rms to compensate for the ground plane's 6-dB boost.

The only significant trend in the response is a gradual slope in the response of about 0.8 dB/octave from about 70 Hz to 9 kHz (drops about 5.5 dB in this seven-octave range). Along this slope, the response is quite smooth and exhibits no significant peaks or dips. From 9 to 20 kHz, the response rises about 3 dB. Even including the gradual roll-off and the rise in response above 9 kHz, the overall response from 37 Hz to 20 kHz stays within a fairly tight window of ±3 dB referenced to 1 kHz.

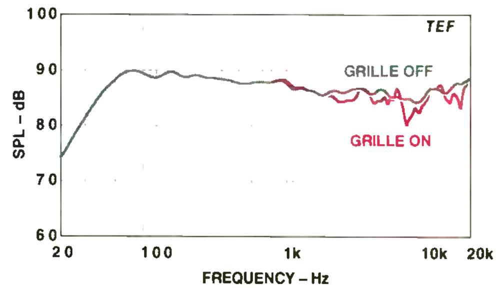


Fig. 1—Anechoic frequency response.

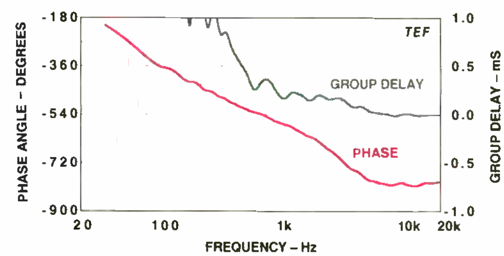


Fig. 2—Phase response and group delay.

Below 10 kHz, the main effect of the grille is a 4-dB notch in the response at about 7 kHz. Otherwise the grille's effect on the response is minimal. Averaged over the range from 250 Hz to 4 kHz, the sensitivity of the system is 86.9 dB, essentially equalling Paradigm's 87-dB rating. Right-left matching was a very tight ±0.5 dB from 100 Hz to 20 kHz.

Figure 2 shows the phase and the group-delay responses of the Studio, referenced to the tweeter's arrival time. Both these curves are quite smooth and well behaved. Between 1 and 20 kHz, the phase curve rotates a significant 216°. This rotation is due to a combination of crossover design and midrange/tweeter acoustic-center offset. Between 1 and 3 kHz, the midrange output lags the tweeter by about 0.17 mS.

These days "home theater" is a term liberally applied and widely advertised.

But having defined the category in the first place, we reserve the right to redefine it. So here goes: True home theater must rival or exceed the very best movie theaters.

Not just in the quality of picture but in the quality of

We invented the liquid-cooled, aspherical lens to deliver the highest resolution on the widest screen.

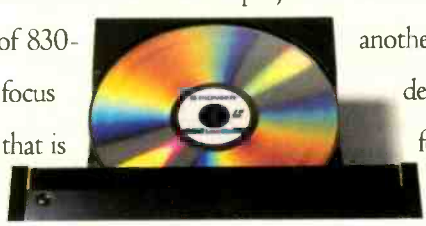
Of course, no television can be better than the medium it projects. So at the heart of our system is the Elite LD-S2 LaserDisc Player. The most accurate device for the reproduction of a moving picture and sound in the home. Any "home theater" without a laser picture source is not a contender.

Which brings us to the receiver: The Elite VSX-95. It

[THE ELITE HOME THEATER. IT STANDS AT THE VERY PINNACLE OF THE CATEGORY WE CREATED.]

sound. As does the extraordinary system pictured here.

Dominating center stage is the Elite® PRO-96 Projection Television. It's the top of a new line which once again sets the standard for projection television. The liquid-cooled aspherical lens – our own invention – projects an incredibly sharp picture of 830-line resolution. A new short focus lens system creates a picture that is 25% brighter. And contrast is dramatically improved by its new black screen. Finally, a three-line digital comb filter has significantly enhanced color accuracy.



Any LaserDisc outperforms any videotape. And the LD-S2 outperforms all other LaserDisc players.

The result is the brightest and most vivid colors ever seen on an electronic screen.

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BY PIONEER

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The system's energy-time response is shown in Fig. 3. The test parameters were chosen to accentuate the 1 to 10 kHz response, which includes the upper crossover region. The main spike, at 3 mS, is quite compact and narrow, which indicates coherent summing of the midrange and tweeter outputs. A delayed spike, about 22 dB down from the peak, 660 μS after the main arrival, seemed to be related to diffraction from the edges of the cabinet, because the height and timing of the return depended on the horizontal angle at which the energy/time response was taken (curves not shown).

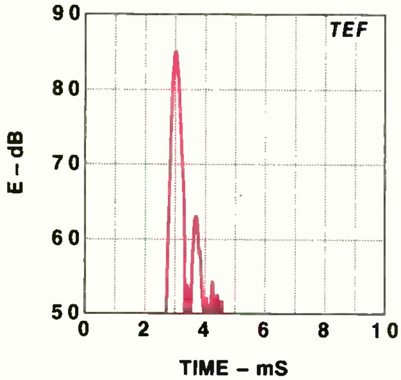

Fig. 3—Energy/time response.

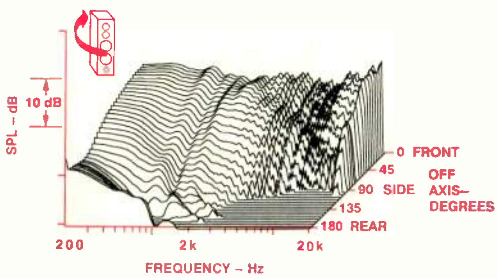

Fig. 4—Horizontal off-axis frequency responses.

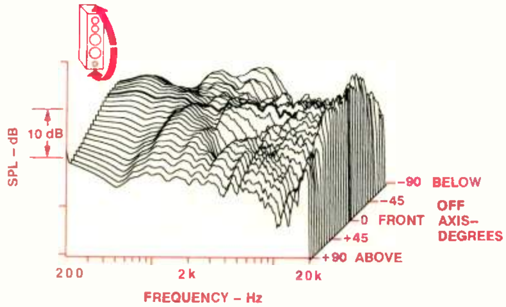

Fig. 5—Vertical off-axis frequency responses.

The horizontal "3-D" off-axis responses of the Studio Monitor are shown in Fig. 4. The curve at the rear of the graph is the on-axis response. The horizontal coverage of the system is very even because the details of on-axis response are essentially the same as those of the off-axis curve. The narrow ridge on the right side of the curve set indicates a high-frequency broadening of coverage. Display of an individual curve from the set, at any angle beyond 25° off axis, shows a narrow, third-octave-wide peak at 18 kHz, which is about 10 dB in level above the nearby response. This dramatic directional widening of response may be due to the previously mentioned diffraction lens placed over the center of the tweeter dome.

Figure 5 shows the vertical off-axis curves of the Studio. The bold curve in the center of the graph (front to rear) was made on axis. The response curves in the range of ±15° are quite symmetrical up and down and do not exhibit any major dips in the high-frequency crossover range within ±10° of on axis. Beyond about 30° off axis, the response is actually a bit flatter for down angles than up angles. The same sharp off-axis high-frequency peak noted in the horizontal responses is evident in the vertical responses beyond about ±30°. Overall, the vertical coverage in the main listening window is quite uniform.

I investigated the crossover's phase relationships by inverting the polarity of the midrange, using the tri-wire input connectors. With the midrange reversed, deep nulls in the on-axis response appeared at both crossover points. This indicates near-ideal driver-to-driver phase relationships through both crossover regions. For broadest vertical coverage and a forward-facing directional beam at crossover (minimum lobing error), the high- and low-frequency drivers need to be in phase with each other throughout the crossover range. The strong anti-phase behavior of the Studio monitor's crossovers, with the midrange reversed, indicates that its crossovers are nearly ideal in the standard connection.

Figure 6 shows impedance versus frequency over the extended range from 10 Hz to 20 kHz. A minimum impedance of 3.2 ohms occurs at 85 Hz and a maximum of 14.2 ohms at 5 kHz. This max/min variation of about 4.4 to 1 (which equals 14.2/3.2) means that the system will be somewhat sensitive to cable resistance. Thus, cable resistance should be limited to a maximum of about 0.050 ohm (50 milliohms) to keep cable-drop effects from causing response peaks and dips greater than 0.1 dB. For a typical run of about 10 feet, 14-gauge or larger low-inductance cable should be used. Smaller-diameter wire can be used but will result in higher peak-to-dip variations in frequency response. The 4.3-ohm minimum at 24 Hz occurs at the vented-box tuning, where the enclosure's resonant loading is greatest. Interestingly, the impedance is fairly flat and stays above 10 ohms, over a wide range extending from about 400 Hz to 10 kHz.

THE STUDIO MONITOR'S PORT TURBULENCE AND VENT NOISE WERE THE LOWEST I HAVE EVER MEASURED.

Figure 7 shows the fairly well behaved complex impedance, plotted over the range from 5 Hz to 30 kHz. The impedance phase (not shown) reached a maximum of +46° (inductive) at 262 Hz and a minimum angle of –30° (capacitive) at 13.5 kHz. A cute little curlicue, of little significance (I believe), is exhibited at 2.9 kHz. Although the phase angles are not excessive, and the impedance is quite high over a significant part of the audible range, the low impedance in the bass range will make the system fairly demanding on a power amplifier.

On a high-level, low-frequency, sine-wave sweep, no significant cabinet reso-

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nances were exhibited. A mild front-panel resonance at about 300 Hz was evident, with maximum activity at a point halfway between the midrange and tweeter.

As compared to the port-covered condition, the port reduced the woofers' excursion over a wide range from 19 to 45 Hz, with a minimum excursion at 25 Hz, the system's vented-box tuning. At this frequency, the vent reduced the excursion of the top woofer by a healthy 75% and the bottom woofer by only about 50% (again as compared to the vent-covered state), even though both woofers are in parallel and thus should theoretically have the same excursion! This loading difference could be due to nonuniform sound-pressure distribution in the enclosure.

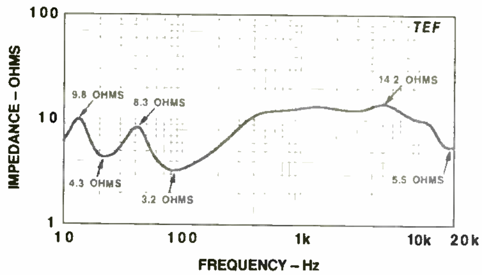

Fig. 6—Impedance.

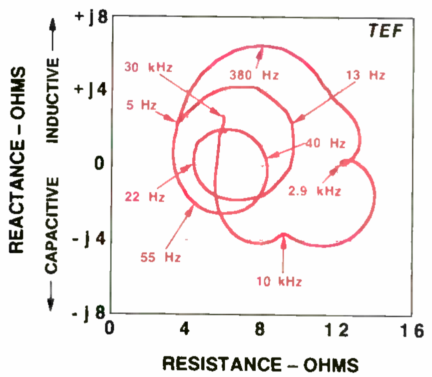

Fig. 7—Complex impedance.

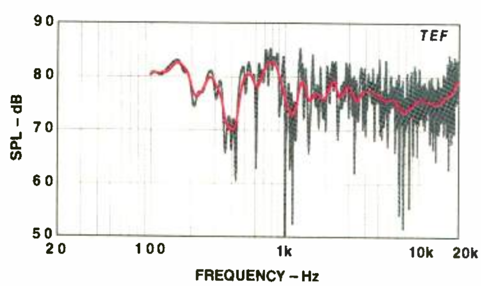

Fig. 8—Three-meter room response.

At power levels of 100 watts or less (about 25 V rms), at frequencies near box resonance (between 20 and 30 Hz where port air velocity is maximum), vent noise and turbulence were the lowest I have measured. The system always sounded quite clean and effortless at all bass frequencies above 18 Hz. Although Paradigm describes the low-frequency part of the system as a quasi-third-order resistive-port system, the system performed as a well-tuned pure vented-box system. Visual inspection of the port reveals no added resistive material; the port is completely clear on the inside.

The maximum excursion of the 8-inch woofers was a generous ½ inch peak to peak, with a linear excursion of about 0.4 inch peak to peak. The woofers overloaded quite gracefully and exhibited no dynamic offset problems.

The Studio Monitor's 3-meter room curve is shown in Fig. 8 with both raw and sixth-octave smoothed responses. The system was in the right-hand stereo position, aimed at the listening position, and the test microphone was placed at ear height (37 inches) at the listener's position on the sofa. The system was driven with a swept sine-wave signal of 2.83 V rms (corresponding to 1.33 watts into the rated 6-ohm load). The direct sound plus 13 mS of the room's reverberation are included. Above 1 kHz, the curve is fairly smooth but tilts up above 13 kHz. Peaks at 170 and 800 Hz occurred but, excluding the room-effect dip at 400 Hz, the averaged curve fits into a 10-dB (±5 dB) window from 100 Hz to 20 kHz.

Single-frequency harmonic distortion versus power for the musical note E_1 (41.2 Hz) is shown in Fig. 9. Distortion plots for the usual 110-Hz and 440-Hz tones are not shown because the distortion was so low that it was below the floor of my measuring gear! The power levels were computed using the rated system impedance of 6 ohms. A maximum power of 100 watts (24.5 V rms) was set as the upper limit. At maximum power, the distortion reached 4.9% second and a fairly high 18.6% third. The fifth was the only significant higher harmonic, at 5.6%. At 100 watts, the system generates a loud 105 dB SPL at one meter at 41.2 Hz.

Figure 10 displays the IM created by tones of 440 Hz (A_4) and 41.2 Hz (E_1) of equal input power. The IM distortion rises

PHASE RELATIONSHIPS IN THE STUDIO MONITOR'S CROSSOVER REGION ARE NEARLY IDEAL.

only to the low value of 5.3% at full power, because the system's lower crossover, at 275 Hz, separates the two IM test tones and thus minimizes the distortion.

Shown in Fig. 11 are the short-term, peak-power input and output capabilities of the Studio Monitor, as a function of frequency, measured using a third-octave bandwidth 6.5-cycle tone burst. The peak input power was calculated by assuming that the measured peak voltage was applied across the rated 6-ohm impedance.

The peak input power starts out high, at about 160 watts at 20 Hz, rises to a maximum of 400 watts at the 25-Hz box tuning, falls somewhat to 150 watts between 40 and 50 Hz, and then rises thereafter, reaching 8 kW (220 V peak). Above 500 Hz, the Studio's power handling essentially kept up with the highest power systems I have tested! Between 100 and 200 Hz, the limit of the speaker system was reached at about the same point that my test amplifier's limit was reached! This was due to the low impedance of the system through this range.

The upper curve in Fig. 11 shows the maximum peak sound pressure levels the

system can generate, at a distance of 1 meter on axis, for the input levels shown in the lower curve. Also shown is the room gain of a typical listening room at low frequencies, which adds about 3 dB to the response at 80 Hz and 9 dB at 20 Hz.

With room gain, the peak output starts at a very strong 106 dB at 20 Hz, rises rapidly to 112 dB at 25 Hz, and after a slight hesitation rises into the very loud mid-120s region, where this level of output matches the peak SPLs of live music (with an appropriately high-powered amplifier however). With room gain, the system's maximum output exceeds 110 dB above 24 Hz and 120 dB above 90 Hz, *very* respectable low-frequency limits! The high maximum output of the Studio Monitor at low frequencies ranks it with the best speakers I have tested, which include such strong competitors as the B & W 801, PSB Stratus Gold, JBL L7, Legacy Convergence, and Velodyne and Hsu subwoofers! A stereo pair of speakers can be expected to reach even higher low-frequency levels with bass material common to both channels.

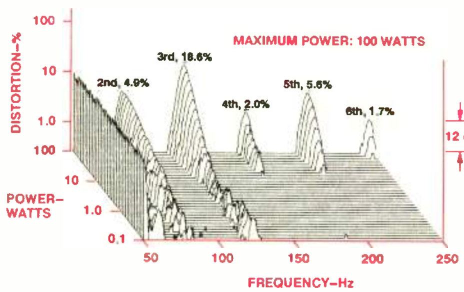

Fig. 9—Harmonic distortion products for E_1 (41.2 Hz).

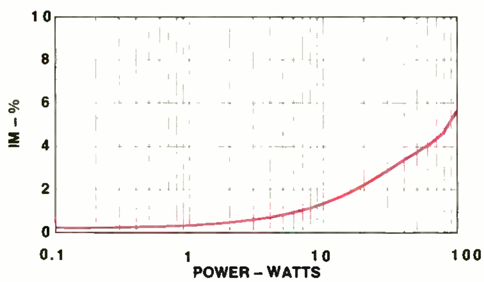

Fig. 10—IM distortion for 440 Hz (A_4) and 41.2 Hz (E_1) mixed in equal proportion.

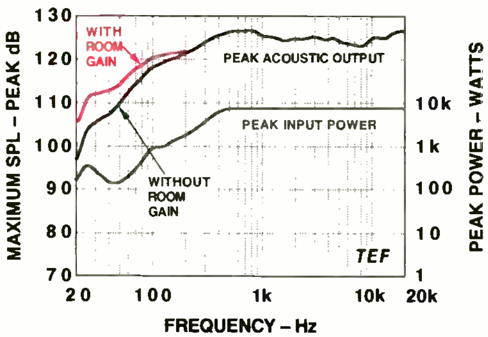

Fig. 11—Maximum peak input power and sound output.

Use and Listening Tests

My review systems were supplied in a good-looking natural oak finish. The systems' cabinetry, workmanship, and fit were tops. However, I can't say I like the metallic front panel in combination with the rest of the system. The systems are supplied with removable, adjustable spiked feet, which I used part of the time. Moving the systems without the spiked feet attached was straightforward, because their weight is less than 100 lbs.

The supplied 8½ × 11-inch owners manual is well written and four pages long. The actual manual is twice this size due to Canada's mandatory French language translation. A warning note on the front of the manual was quite useful to me; it warned that if the systems are transported or stored below 50° F, they must be allowed to warm up to room temperature before using (due to stiffening surrounds on the midrange and woofer drivers and thickening of the Ferrofluid used in the tweeter). This caused me to think twice before testing the systems outdoors in 39° weather (the warmest recent winter day here in Indiana)!

One complete page of the manual is devoted to bi- and tri-wiring and to passive bi- and tri-amping, with a well-written description of the horizontal and vertical bi- and tri-amping configurations. Paradigm suggests aiming the systems toward the listening position in order to optimize high-frequency response and coverage, with a location well away from any reflecting surfaces.

For listening, I placed the systems in my regular listening positions 8 feet apart and 10 feet from my listening sofa, with a spacing of about 5 feet from the rear wall. My equipment line-up includes the new Krell KRC preamplifier and KSA-250 power amplifier along with the Rotel and Onkyo CD players. Other equipment includes the B & W 801 Series II speakers (I am arranging to replace these loudspeakers with the new Series III versions), and Straight Wire cabling.

On first listening, I was surprised how very close the Studios sounded to my reference B & W systems. This similarity extended through the whole frequency range

I CAN ONLY SHOW DISTORTION FOR ONE OF MY USUAL THREE TONES: IT WAS UNMEASURABLE FOR THE OTHER TWO.

and even included essentially the same sensitivity; no level matching was required! The systems exhibited an open, spacious, clean sound, with excellent soundstaging and powerful bass capability.

On an excellent new acoustic jazz CD I picked up at the recent winter Consumer Electronics Show, *The Immigrant's Dilemma* by Todd Garfinkle (M · A Recordings MO17A, an audiophile direct-to-DAT recording done with two B & K 4006 microphones), the systems exhibited a vivid realism and extended, smooth response with a detailed and expressive high end. The acoustic bass lines were reproduced particularly well with fine control and extension.

On wide-range symphonic material with chorus and soloists, heavy with percussion, such as the new Dorian Discovery release of

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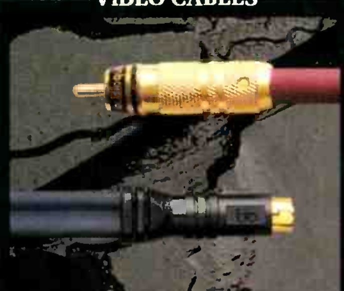

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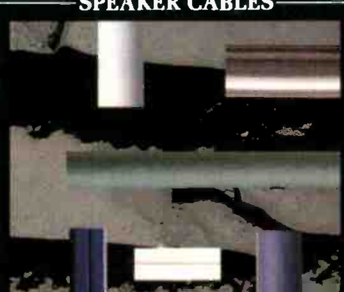

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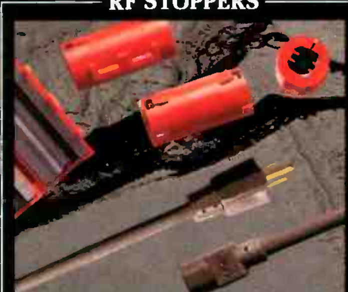

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Venezuelan Antonio Estevez's *La Cantata Criolla* (DIS-80101), the systems demonstrated an excellent soundstage, with good width and depth, coupled with first-rate recovery of recorded ambience.

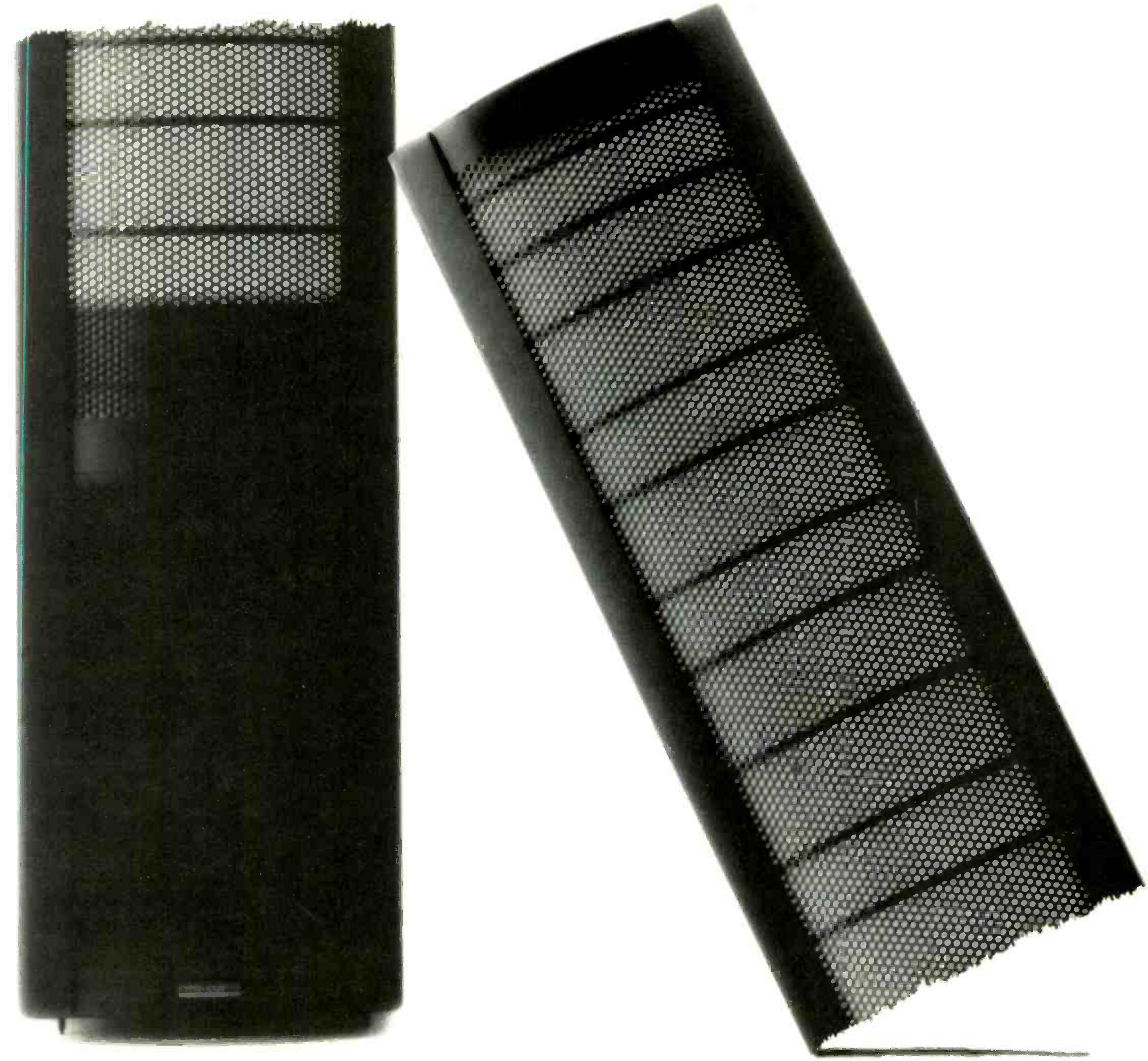
On most program material, the Paradigm systems were so similar to my reference systems that if I directed my attention elsewhere (thus removing directional cues to source identification) by facing to the side, or standing up behind my listening couch and facing to the rear, I virtually could not tell the difference when switching from one system to the other! One source where I could tell the difference, however, was on Clair Marlo's solo singing on *Let It Go* (Sheffield Lab CD-29), where she sounded slightly more open and crisp on the reference systems.

On pink noise, when sitting down, there were minimal tonal differences when compared to my references. Evenness of vertical coverage on pink noise was good on the stand-up, sit-down test, but not as uniform as my references. The Studios exhibited some upper-midrange suckout when I was standing.

On band-limited, third-octave pink noise, the Studios did extremely well on all the low-frequency bands. As compared to the B & W systems, the 20- and 25-Hz bands were the only ones with slight differences, mainly in the higher frequency sound the port generates when the air velocity is high. The B & W port produced a swishing sound, while the Studios had a slight tonality to the air rush sounds, which may be due to organ-pipe resonances in the port. The B & W sounded slightly cleaner on these two bands when generating the same fundamental sound level.

The systems can get down and boogie when required! This was demonstrated with the bass guitar and kick drum on the "We Will Rock You," and "Fat Bottomed Girls" tracks on Queen's *Greatest Hits* CD (Hollywood HR-61265-2). Fairly clean levels of 95 to 98 dB SPL, A-weighted and 103 to 105 dB with C weighting could be generated. Cathedral pipe organ was also reproduced on a satisfyingly big scale with room-shaking bass from the pedal notes.

Does the Studio Monitor meet its goal of keeping up with the big-guy, high-end systems at only half the price? You bet! Check them out for yourself. *D. B. Keele, Jr.*



[T]HE NEW AERIUS SPEAKER FROM MARTIN LOGAN LTD. SO MUCH [T]ECHNOLOGY WE HAD TO CUT IT IN HALF TO FIT IT ON THIS PAGE

Sometimes it's not what you see, but what you don't [s]ee. That's true of the new Aerius Speaker from Martin [L]ogan. What you do see is a speaker. Sleek. Elegant.

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EQUIPMENT **PROFILE**

DENON TU-680NAB "SUPERRADIO"

For some years now, I have bemoaned the fact that the AM circuitry in most "high-fidelity" tuners and receivers does not take advantage of the signal quality that AM stations are capable of transmitting. As readers of *Audio*'s tuner reports know, AM frequency response typically rolls off at around 2.5 kHz or, in exceptional cases, at 4 or 5 kHz. Yet AM broadcasters can transmit signals whose response extends far beyond this limit.

To show how good AM could be, the National Association of Broadcasters (NAB) commissioned a "SuperRadio" tuner from Denon, originally made for NAB members but now available to audio enthusiasts. The project resulted from the improved AM broadcasting and reception standards developed by the National Radio Standards Committee (a joint effort of the Electronic Industries Association and the NAB). The NAB has also set up a certification standard, called AMAX (AM at its maximum) for high-fidelity tuners. To get

THE DENON TU-680NAB IS BOTH A BYPRODUCT AND A JUSTIFICATION OF TODAY'S IMPROVED AM BROADCAST STANDARDS.

AMAX certification, a tuner must have frequency response from at least 50 Hz to 7.5 kHz, with correct NRSC de-emphasis; it must also have automatic noise blanking to reduce impulse noise, manually or automatically selectable audio bandwidth, connections for an external AM antenna, and the capacity to pick up all stations on the newly expanded AM band (now 540 to 1,700 kHz). If stereo is included, an AMAX tuner must be able to decode the Motorola-developed C-QUAM system. According to Denon, the TU-680NAB is the first tuner to incorporate all of the AMAX requirements, and the NAB is offering it directly to its member stations.

Both the FM and AM sections of the TU-680NAB have selectable bandwidth but not in quite the same way. The FM section has selectable wide or narrow *i.f.* bandwidth, with the narrow setting used for increased selectivity in areas where stations are closely spaced on the dial. The AM section has selectable *audio* bandwidth; the "Wide" setting has a rated bandwidth of 7.5 kHz, while the "Narrow" setting varies automatically with signal strength, narrowing as far as 3 kHz when conditions call for it. The AM section also incorporates a noise-blanking circuit that significantly reduces interference from such sources as fluorescent lights and electric motors. According to Denon, this circuit detects and suppresses impulse spikes, filling in with a portion of the preceding signal. The button that actuates noise blanking in AM mode also switches in the multiplex filter for FM. Confusingly, Denon has labelled this button "NR/NB," implying that the multiplex filter is some sort of noise reducer; actually, the only connection to "NR" is that the filter enables a tape deck's Dolby noise-reduction circuits to work properly when taping a signal from this tuner.

Up to 30 channels of either AM or FM can be stored in memory for instant recall. A remote control, capable of handling virtually all the tuner's functions, is supplied. The remote control also has a "Preset Scan" button that is not found on the tuner's front panel. Supplied accessories include the usual stereo interconnect cable, FM ribbon antenna, and snap-on AM loop antenna. Separate connections are provided for an external AM antenna, so the loop need not be disconnected when an outdoor antenna is used. (According to Denon, disconnecting the loop antenna from this or most other AM tuners will change the resonance of some front-end circuits, preventing proper operation even when an external antenna is substituted for the loop.) The tuner's AM frequency band extends from 520 to 1,710 kHz, covering the expansion of the AM band recently authorized by the FCC.

A NOISE-BLANKING CIRCUIT SIGNIFICANTLY REDUCES AM ELECTRICAL INTERFERENCE.

Control Layout

The "Power" switch and remote-control sensor are at the far left of the panel. Just to their right is a display that shows the current tuning frequency, preset number, radio band, tuning mode ("Auto" or "Manual"), reception mode ("Mono" or "Stereo"), and which of the mixed AM/FM preset banks is in use. The display also shows the presence of a signal, even if it's too weak to be indicated by the signal-strength section of the small secondary display further to the right. This secondary display also indicates the current bandwidth and if the noise blanker and multiplex filter are on.

The right half of the panel is dedicated to pushbuttons, including "Memory" for storing station frequencies and others for auto/manual tuning, "Bandwidth," "NR/NB," AM/FM "Band" selection, and "Tuning (Down/Up)." Below this row are 10 numbered buttons and an "Enter" button, used in entering and recalling preset stations.

The rear panel of the TU-680NAB is equipped with a bracket for the AM loop antenna. Terminals are provided for this AM antenna and for an external or outdoor antenna, as is an F-connector for a 75-ohm coaxial FM antenna lead and the usual left and right phono jacks for audio output.

Although Denon and the NAB emphasize the AM performance of this component, I was equally interested in finding out just how good its FM circuitry is. After all,

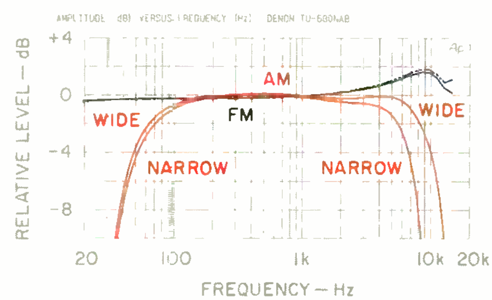

Fig. 1—Frequency response.

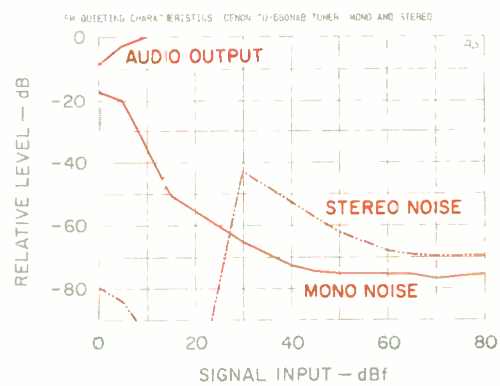

Fig. 2—FM quieting characteristics; see text.

to be dubbed a "SuperRadio" implies that its performance is super in all respects. Accordingly, I tested FM performance before tackling the AM section.

FM Measurements

Figure 1 shows frequency response. Despite a rise of almost 2 dB at 10 kHz, overall

SPECS

FM Section

Usable Sensitivity: 11.3 dBf.

50-dB Quieting Sensitivity: Mono, 15.3 dBf; stereo, 37.2 dBf.

Frequency Response: 20 Hz to 15 kHz, +0.5, –1 dB.

S/N: Mono, 88 dB; stereo, 82 dB.

THD at 1 kHz: Mono, 0.06%; stereo, 0.1%.

Capture Ratio: 1.3 dB.

Image Rejection: 80 dB.

I.f. Rejection: 100 dB.

Alternate-Channel Selectivity: Wide, 50 dB; narrow, 75 dB.

Separation: 50 dB at 1 kHz.

AM Suppression: 60 dB.

AM Section

Frequency Response: 50 Hz to 7.5 kHz, +1.5, –3 dB.

Channel Separation: 32 dB at 1 kHz, 50% modulation.

THD for 50% Modulation at 1 kHz: Mono, 0.3%; stereo 0.5%.

S/N: Mono, 53 dB.

General Specifications

Power Requirements: 120 V, 60 Hz a.c., 12 watts.

Dimensions: 17 1/16 in. W × 2 15/16 in. H × 11 5/16 in. D (43.4 cm × 7.4 cm × 28.7 cm).

Weight: 6.8 lbs. (3.1 kg).

Price: $650.

Company Address: 222 New Rd., Parsippany, N.J. 07054.

For literature, circle No. 92

FM response extends out to 15 kHz. We'll get to AM performance later, but note how well the AM section's frequency response, superimposed for comparison, stands up to that of the FM section.

Figure 2 shows FM quieting characteristics for both mono and stereo, as a function of incoming signal strength. In mono, 50-dB quieting is achieved with input signals of only 15.3 dBf, exactly as claimed by Denon. To measure this, I had to press the "Auto Mute/Manu" button, which controls muting, automatic or manual tuning, and mono switching. Stereo reception is only possible when this button is set to "Auto Mute." Stereo muting occurs somewhere below 30 dBf, by which time S/N is already well above 40 dB. This is typical of sets that combine the muting and mono/stereo switching functions in a single control; such sets can only receive stereo signals whose signal strength exceeds the muting threshold. In the TU-680NAB, this threshold has been set at just about the right level.

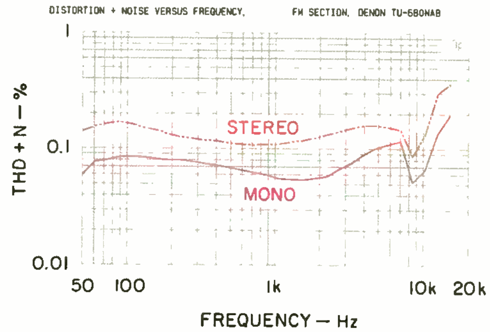

Fig. 3—THD + N vs. FM modulating frequency.

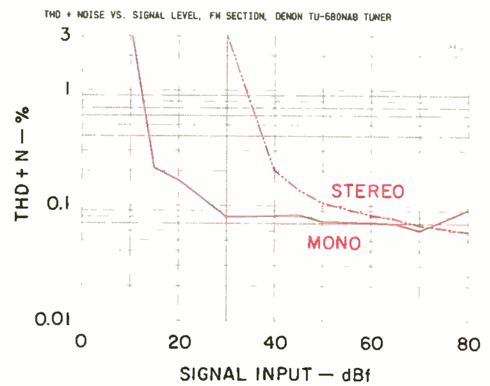

Fig. 4—THD + N vs. FM signal strength.

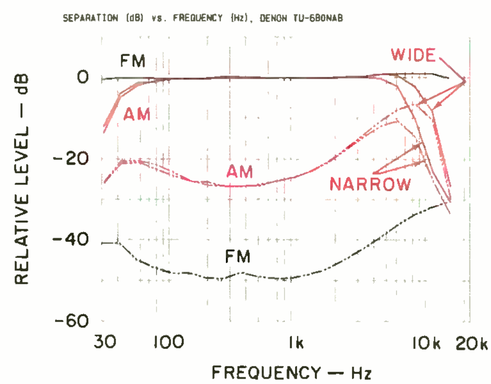

Fig. 5—Frequency response and channel separation.

Figure 3 is a plot of THD + N versus modulating frequency. In mono, THD + N at 1 kHz is a very low 0.057%, increasing to 0.085% at 100 Hz and a bit over 0.1% at 6 kHz. For stereo reception, THD + N measures just over 0.1% at mid-frequencies, increasing to 0.17% at 100 Hz and to 0.16% at 6 kHz. Figure 4 shows how distortion of a 1-kHz modulating signal varies with signal strength. For a 65-dBf signal, THD + N is 0.07% in mono and 0.08% in stereo.

Figure 5 shows frequency response and channel separation for FM, with the AM section's response and separation overlaid for comparison. In the FM mode, separation is excellent, reaching nearly 50 dB at 1 kHz and maintaining that level at 100 Hz. At 10 kHz, the separation remains greater than 30 dB.

A further test of stereo FM performance involved a spectrum analysis of the modulated (left-channel) and unmodulated (right-channel) outputs of the tuner for a 5 kHz left-only signal modulating my FM signal generator (Fig. 6). The top curve shows the reference output level of the 5-kHz signal (peaking at 0 dB) as well as harmonic components at 10 and 15 kHz and at 5-kHz intervals out to the end of the sweep. Even the greatest of these harmonic components (that at 10 kHz) is down about 70 dB below reference level, equivalent to a second-harmonic distortion level of only 0.03%. Note, too, that the 19-kHz pilot carrier has been suppressed by 80 dB, while the sidebands of the suppressed 38-kHz subcarrier, at 33 and 43 kHz, are attenuated by almost 60 and 65 dB, respectively. As for the output of the unmodulated channel, 5-kHz crosstalk is down some 40 dB relative to the reference level. Other harmonic components and subcarrier components are also adequately attenuated.

EVEN IN NARROW-BAND MODE, THE AM SECTION'S FIDELITY WAS BETTER THAN I'VE HEARD FROM AM IN MANY YEARS.

Alternate-channel selectivity measured 60 dB in the wideband mode, increasing to 77 dB when the narrow mode was selected. Image rejection exceeded the published spec; it was 85 dB, as against 80 dB claimed. AM suppression was exactly 60 dB, as claimed, while capture ratio measured 1.2 dB. I.f. rejection was in excess of the 100 dB claimed.

AM Measurements

What a pleasure it was to finally come across a tuner whose frequency response in AM extends well beyond 5 kHz. In fact, as was shown in Fig. 1, response in the wide-band AM mode extends way out to 9.2 kHz before the attenuation reaches 3 dB! (In other tuner reports, I usually use a more permissive 6-dB criterion for AM frequency response.) Even when I used the narrow mode, frequency response of this remarkable AM section extended beyond 6 kHz for a 10-mV signal. At the bass end of the spectrum, the –3 dB point was reached at approximately 50 Hz.

Figure 7 shows how THD + N varies with frequency for the AM section, with modulation levels of 90%. At 1 kHz, the THD + N measures 1.2% in the wide mode and increases slightly, to 1.4%, in the narrow mode. Note that the published specs for AM distortion were given for 50% modulation. At that modulation level, the claimed THD figures of 0.3% in mono and 0.5% in stereo were met or surpassed.

Harmonic distortion itself, without the noise component, was just under 1%, as measured by spectum analysis of a 1-kHz

TO MY EARS AND OTHERS', THE AM ACTUALLY SOUNDED BETTER THAN AN FM SIMULCAST!

signal at 90% modulation. Ultimate S/N, with strong signals applied, was 55 dB for monaural operations, as against 53 dB claimed.

As shown in Fig. 5, channel separation in AM is just over 24 dB at 1 kHz, regardless of the audio bandwidth setting, and it is more than adequate. At 100 Hz, separation is approximately 23 dB for either bandwidth setting. At 6 kHz, it decreases to just over 8 dB for either mode at the 10-mV r.f. signal level I use.

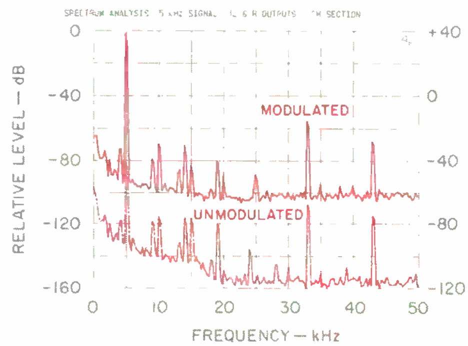

Fig. 6—Spectrum analysis, showing FM stereo crosstalk and distortion products. Use right-hand scale for bottom curve.

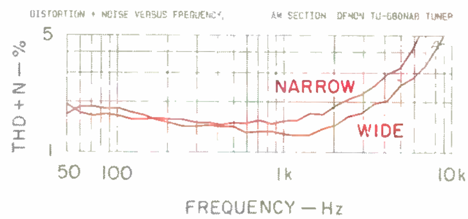

Fig. 7—THD + N vs. AM modulating frequency, with monophonic input signals.

Use and Listening Tests

I hooked up an ordinary indoor dipole antenna to the FM antenna terminal and oriented the dipole towards the west, in the direction of most of the transmitter antennas in my metropolitan area. Under these conditions, I was able to receive no fewer than 53 acceptable signals in mono, nearly a half dozen more than I've usually gotten with typical "hi-fi" tuners and receivers I have tested in the last several years. Switching to the automatic tuning mode (thereby activating stereo circuitry), I logged some 43 acceptably noise-free stereo signals on the FM band.

Orienting the supplied AM loopstick for best reception, I then switched to the AM band and logged 26 acceptable signals. There was little difference in the signal count when I switched from automatic to manual tuning mode. A few of the stations exhibited less interference when I switched to the narrow-band mode, but even then, audio fidelity was better than I have heard from an AM tuner in many years. (Back in the 1940s and 1950s, AM receivers—then in the majority—sounded a lot better than most AM tuner sections do today. The Denon TU-680NAB is a happy exception to this unhappy trend.) Perhaps the most startling revelation occurred when I tuned to a classical music station on the FM band that also simulcasts on AM. This enabled me to switch back and forth between them while listening to the same program. I know you may find this hard to believe, but to my ears (and to those of several visitors in my lab when these tests were going on), the audio quality of the AM transmission actually seemed better than that of the FM band!

Denon deserves to be congratulated for its effort. The TU-680NAB "SuperRadio" may very well inspire other equipment manufacturers to follow a similar course in designing tuners and receivers.

Leonard Feldman

AURICLE

SOUNDSTREAM DAC·1 D/A CONVERTER

Soundstream's DAC•1, a stand-alone digital-to-analog converter, resulted from a collaboration between Soundstream and Krell Digital engineers. At $695, it's far less expensive than Krell's own products and is one of the least expensive stand-alone converters available. Like other such devices, its raisons d'être are the superior performance that can come from isolating the converter, electrically and physically, from the CD player proper and the convenience of routing all digital sources through the same converter.

THE DAC·1 SELECTS AMONG ITS THREE INPUTS AUTOMATICALLY, WITH NO CONTROLS NEEDED.

Company Address: 120 Blue Ravine, Folsom, Cal. 95630.
For literature, circle No. 93

The DAC•1 is trivially simple to use. It has no controls, even though it accommodates three digital sources (one via a Toslink optical jack and two via 75-ohm coaxial cable), because it automatically selects between them. You can permanently connect three sources and select the one you want by powering it up. If more than one source is powered at a time, the DAC•1 gives highest priority to the optical input, next priority to coax 1, and lowest priority to coax 2.

The unit is powered by an external 12-V d.c. supply, which should be placed well away from audio signal lines to minimize hum and noise. The supply cable plugs into a phone jack, and you can leave the system on permanently (if you don't mind the converter's green power light glowing constantly) or plug it into a switched outlet on your preamp. Inside, a 100-kHz switching circuit converts the 12 V d.c. into three separately regulated power sources, each with an e.m.i./r.f.i. filter. One feeds the digital circuitry, a second the analog control section, and the third the analog output section. This helps isolate the sections to reduce noise. One set of gold-plated pin-jack analog outputs is provided.

The simple chassis, black-painted steel with white lettering, is 17 inches wide, just under 2 inches tall, and just over 7 inches deep (including the jacks). The circuitry occupies less than half this space. Everything except the power jack and LED is mounted on a single board, 7⅛ inches × 4¾ inches, at the right rear of the enclosure. Construction quality is good. Large components are affixed with silicone adhesive, small components are neatly mounted and well soldered, the board is designed with plated-through holes and protected with a solder mask, and metal-film resistors are used throughout.

The DAC•1 is based on the Yamaha YM3623B DIFRC (Digital Interface Format Receiver Chip), a Burr-Brown DF1700P dual-channel digital interpolation filter, and a Burr-Brown PCM67P dual-channel 18-bit D/A converter—all recent-vintage devices. Each of these chips is socketed; this raises an interesting possibility, as we shall see later.

The Yamaha DIFRC feeds the digital filter directly and generates the system clock from a crystal oscillator. The Burr-Brown filter is a three-stage device with 20-bit internal arithmetic. Each stage oversamples by a factor of 2. The first stage has 153 taps, the second 29 taps, and the third 17 taps. Total oversampling rate is eight times, and the filter affords a stop-band rejection greater than 110 dB, with a passband ripple within ±0.00005 dB.

The DF1700P filter offers selectable 16-, 18-, or 20-bit output data formats; Soundstream chose the middle road in handing off to the PCM67 converter. The PCM67 is a hybrid 18-bit chip that aims to combine the low-noise performance of a traditional R-2R ladder converter with the excellent low-level linearity

1 Refined topology with no ICs in signal path. 2 Hand-matched J-FET pairs for balanced differential drive. 3 More precise drive circuit board layout. 4 Gold switches select balanced differential/unbalanced direct. 5 Temperature stable gold-tip Holco feedback resistors. 6 Roederstein Resista series metal film resistors. 7 Faster tracking, wider range DC servo circuits. 8 Higher speed premium grade DC servo ICs. 9 Silver-clad internal wiring with improved shielding. 10 Sturdier premium gold RCA jacks. 11 Improved heat sink thermal

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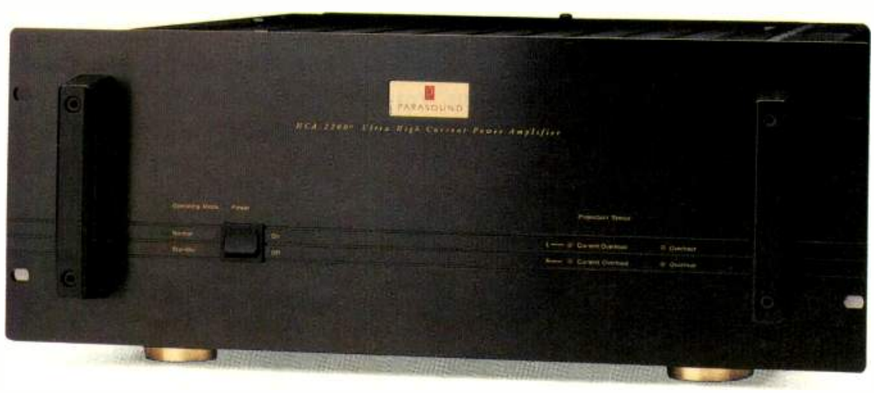

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(low distortion) of a one-bit converter. Internally, the 10 most significant bits are converted by a laser-trimmed R-2R ladder; the eight lower bits are converted by a one-bit converter that uses a first-order noise shaper.

This approach doesn't eliminate the "major carry error" (low-level nonlinearity) of a ladder converter completely. So, to reduce the audibility of the error, Burr-Brown offsets the data by nine bits to raise the level at which the nonlinearity occurs (thereby making the fixed error a lower percentage of the signal) and compensates for the offset (when it is used) by injecting an offset current equal to the weight of bit 9.

This hybrid approach reduces some of the problems with one-bit DACs. Since high-level signals are not converted by the one-bit system, the clock rate needn't be so high; in fact, the one-bit portion of the PCM67 chip operates directly from the system clock, eliminating the need for a second oscillator and possible jitter problems. Also, "out-of-band noise" is lower in amplitude than with a full one-bit system, so a simpler first-order noise shaper will move it into the ultrasonic region.

Problems (if any) with a hybrid approach are likely to occur at the point where the two DACs are married. Indeed, the DAC•1's THD + N levels shifted abruptly as signals fell from –40 to –50 dB. In the left channel, THD + N dropped by 4.3 dB (from –89.3 to –93.6 dB below maximum signal level), while in the right channel the drop was even larger, 11.4 dB (from –83.3 to –94.7 dB). Although this is not exactly where I would have expected to see the problem with a nine-bit shift, it's reasonably close and I have no other explanation for the observed data. Furthermore, my measurements also showed a slight rise in nonlinearity (+0.055 dB on the left channel, +0.092 dB on the right) at the –40 dB level. Comparing spectral analyses of 1-kHz tones at –40 and –60 dB suggested to me that the increased "THD + N" at –40 dB was more noise than distortion, although there was a small difference in second harmonic content as well.

It must be stated that the test data meets Burr-Brown's specifications for the PCM67P chip. It also should be stated that the PCM67P comes in three grades, of which Soundstream chose the least expensive. The PCM67P-J is specified at 6 dB less THD + N, and the PCM67P-K exhibits 10 dB less THD + N. Since Soundstream has socketed the chip, the adventurous soul *could* give a go at upgrading. The chips are interchangeable and do not use external MSB adjustment, so a simple swap is all that's needed. Since that may void the warranty and may not do a whole lot of good, I'm not necessarily suggesting it, but it's an interesting thought!

Aside from its THD + N shift and the slight companion increase in nonlinearity between –40 and –50 dB, the DAC•1 acquitted itself quite well in bench tests. Response was truly "ruler flat" (within +0, –0.08 dB from 10 Hz to 20 kHz on either channel), and interchannel phase error was no more than 0.065° from 5 Hz to 20 kHz. Obviously, Soundstream and Krell paid attention to the output filter (which, by the way, is built around Signetics NE5534AN op-amps and is followed by a discrete Class-A output stage).

THE DAC•1'S SIMPLICITY, FLEXIBILITY, PRICE, AND IMAGING MAKE IT WELL WORTH AUDITIONING.

THD + N versus frequency (at 0-dB level) was less than 0.0060% on the left channel and less than 0.0085% on the right from 20 Hz to 20 kHz. Linearity error on the left channel, without dither, was less than 0.07 dB at –60 dB and reached 2.53 dB at –90 dB. With dither, the error was less than 1 dB at –80 dB and 1.64 dB at –90 dB. Right-channel performance was even better: Less than 0.016 dB at –60 dB and 1.87 dB at –90 dB without dither, topping out at 1.00 dB at –90 dB with dither. Channel separation was 73.2 dB at 16 kHz, improved to 84.2 dB by 4 kHz, and maxed out at about 92 dB at 1 kHz and below.

At 1.99 V, output level was typical, and the channels balanced within 0.03 dB. Output impedance (125 ohms) is low, so there should be little problem driving relatively long interconnects. When fed a digital absolute-zero signal, A-weighted noise was –100.7 dB relative to maximum output; with a signal, quantization noise was –90.2 dB. The EIAJ dynamic range was 93.4 dB on the left channel, 94.3 dB on the right.

I exercised the Soundstream DAC•1 at 48 kHz, using a DAT source and live recordings. Performance was at least equivalent to—arguably, a slight improvement over—the DAT recorder's internal converter. (The DAT machine, of first-generation vintage, uses a 16-bit ladder DAC.) Most of the serious listening was done with 44.1-kHz sampling, using CDs, under single-blind conditions. (I didn't know which converter was being used, but my companion, who was doing the switching, did.) The comparison was against a high-quality CD player with a one-bit MASH converter. Levels were matched to ensure a valid comparison.

Although the differences were subtle, I (and my companion, when we switched roles) could identify the converters with sufficient reliability to convince me that we *were* hearing differences. Most of these related to imaging, which was a bit deeper and broader on the DAC•1 than on the player. This can be pleasant on orchestral works (and, perhaps, with LaserDiscs, where the Dolby Pro-Logic surround circuit might derive more spatial information to work with) but can be less advantageous on a solo recording.

In particular, on the Kubelek recording of Chopin's Third Ballade (Dorian DOR-90102), I found the DAC•1's imaging more nebulous and less precise than that of the CD player. The same was true of Elly Ameling's voice on *An Die Musik* (Philips 410037-2) and Gidon Kremer's violin on a Brahms concerto (Deutsche Grammophon 410029-2). On the other hand, with a full orchestral work like Mahler's Symphony No. 2, "Resurrection" (Telarc CD-80082), the depth given the rear brass was much appreciated. The only audible artifact I could attribute to the glitch in converter response around –40 dB came about 19 minutes into the final movement of the Mahler, where the soft flute was somewhat more "hairy" with the DAC•1 than with the one-bit MASH.

Soundstream's DAC•1 has enough going for it in simplicity, flexibility, and price to make it worth auditioning by anyone interested in a stand-alone converter. For large-scale works, the depth of imaging alone is worth a listen. *Edward J. Foster*

LIRPA INFLATABLE AUDIO REVIEWER

Dimensional Illustration: James Nazz

Not content with stretching the limits of physics, credulity, and the law, Prof. I. Lirpa now turns his attention to The True Meaning of Stereo with the Lirpa Inflatable Audio Reviewer, which is an integrated computer hardware and software system using artificial intelligence to provide Important Audio Critic opinions and disinformation in your home. Based on personal experience, Prof. Lirpa observed that inviting audiophile friends over to your house to audition the equipment that precipitated your divorce can become a high-impact contact sport when these friends can't hear the Obvious Improvement. Deeply convinced that no price is too high to pay to be told that you spent the rest of your money wisely, Lirpa decided to end these messy disagreements. His new system assures you that you bought the very best stuff money could buy, when such assurance is warranted.

Company Address: Lirpa Labs, Main & Elm Sts., New York, N.Y. 10101.
For literature, try going to a library; to order direct, call the Lirpa Inflatable Audio Reviewer hotline, (800) 555-LIAR.

The result of six years of nearly consistent research, the Lirpa Inflatable Audio Reviewer was introduced in January at the Winter CES during a blockbuster party at the Little Chapel of Las Vegas. Regrettably (but predictably) the initial reactions of the invited Important Audio Critics were unreasonably hostile and violent. Indeed, fragmentary and confused reports of the unfortunate ensuing melee made it into the local newspaper, under the headline: "Transvestite Marriage Interrupted by Prison Escapees."

After the police restored order and the promised open bar was opened, a warm glow of acceptance and camaraderie developed. Indeed, as soon as the Important Audio Critics realized that Lirpa's machine could do all of their tedious evaluating, rating, measuring, and writing, they began to look at it with new respect and stopped spitting at it. Quite a few rounds later, a consensus developed that the Lirpa Inflatable Audio Reviewer would free up Important Time of Important Audio Critics for attending trade show parties, reselling review equipment, and making personal appearances on late-night cable access programs. At that moment, every critic requested a no-cost loaner for an extended evaluation. By 4 a.m., the Important Audio Critics had accepted the Lirpa Inflatable Audio Reviewer as one of their own. They drunkenly carped to it about editors, argued with it about the contents of reviews it hadn't written, speculated about the personal habits of absent reviewers, and offered to get it extremely drunk at the next CES.

The basic operating premise of the Lirpa Inflatable Audio Reviewer is that the reviewer and the reviewing process introduce distortion and deviation from the Expected Typical Rational Outcome. In simple electrical terms, negative and positive reviewer biases are fed back through the review to the consumer. By measuring and tabulating reviewer distortion on known signals and sources, Prof. Lirpa realized that a paradigm representing individual reviewer distortion could be applied to any other new, unknown system. Through careful analysis of the distortion products of a large population of reviewers, an Archetypical Jungian Reviewer Pattern was established. Once the base distortion and

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deviation parameters were uncovered, Lirpa grasped that it would be a simple matter to listen to a device, distort the results, and submit a review for publication.

Yet reviewer emulation is not a job for the queasy. The fundamental software element of the Lirpa Inflatable Audio Reviewer, the Lirpa Important Audio Reviewer Emulation Module, represents the first serious attempt to analyze, quantify, and predict the listening habits of Important Audio Critics. Critics were divided by type into Objective Accuracy Mavens, Objective Effect Disciples, Subjective Accuracy Enthusiasts, and Subjective Effect Mystics. Within each group, selected Important Audio Critics were further divided into subcategories: Moses, Job, Hamlet, Clytemnestra, King Lear, Don Quixote, Candide, Captain Queeg, Sam Spade, Joseph K., Walter Mitty, and Willy Loman.

The database to quantify deviation from the Expected Typical Rational Outcome was secretly gathered under the guise of inviting Important Audio Critics to a party featuring free food and liquor. A preliminary hearing test was performed by loudly announcing, "The bar is open." Those Important Audio Critics who heard the announcement and responded were monitored by sensors hidden in the cushions of their bar stools. Trained abnormal psychologists observed Important Audio Critic behavior through a one-way mirror to analyze personality traits. A modified background music system reproduced the usual demo-record material—tedious and musically trite audiophile sludge—while the hidden sensors detected physiological changes and the onset of stereonucleosis.

In those few cases where musical taste was considered important and likely to be mentioned in a review, the selected critics were plied with beer until a recording of street musicians playing "My Way" was perceived as having significant musical content. A few critics were tested with such variables as the effect of weightlessness, submersion, and digestion on hearing acuteness, attitude, and footnote density.

Because analysis of the data showed that the underlying event distribution of the modelled sample was random and irrational, applying the individual results to a coherent model would be similar to applying computer modelling of basic chaos theory to trading in stock futures. It follows, then, that buying audio equipment based on a review is like buying an unknown stock based on a tip from a convicted junk bond manipulator in the Federal Witness Protection Program.

The technology for the Inflatable Audio Reviewer derives from the NeXT Cube/NeXT Dimension computer platform, an Aachen Head "dummy head" microphone modified by Prof. Lirpa, and a Lirpa Labs artificial intelligence expert system computer program with custom databases and an easy-to-use user environment that is environmentally friendly.

Analog audio pickup is through the aforementioned Lirpa-modified Aachen Head stereo "dummy head" microphone. It pneumatically adjusts head size to match varying reviewer confidence levels, which turns it into a "smart head" microphone.

A 17-inch fine-pitch color monitor, a 400-dpi printer, and a modem linked to the user's bank account are standard. The modem monitors the bank balance to determine the precise time for a Full System Upgrade. The principal use of the color monitor is to display the Capsule Review Feature, which shows a thumb-up or thumb-down icon.

Applying chaos theory to an audio review metamodel required that Lirpa Labs integrate the Expected Typical Rational Outcome and the individual Important Reviewer Results into the Archetypical Jungian Reviewer Pattern paradigm. These link a custom financial trading and analysis software package, measured data from the Aachen Head microphone, predicted data from the Expected Typical Rational Outcome database, and calculated reviewer distortion from the Important Reviewer Results deviation database. Other software utilities of the Lirpa Important Audio Reviewer Emulation Module include a screech recognition program, the Expected Typical Rational Outcome database, and the Important Reviewer Results deviation database resident in one of the internal hard drives.

THE QUICK BROWN FOX JUMPED OVER THE LAZY RED DOGS . . . . TESTING, TESTING, 1, 2, 3.

Another major software component is Critic in a Bag. This utility package has a timer function to determine when to throw everything out into the street, a link between descriptor and price point to tell you that a product sounds better when it costs more, four levels of buzz-word generation to impress both the casual reader and the magazine editor, interactive critic confidence subroutines to operate the pneumatic head pump, a personal assets analyzer to time the next system trade-up, and a random psychosis subroutine to tell consumers that everything they own is wrong.

The Archetypical Audio Test Signal is also resident in the computer and is the only signal used to review equipment. Dr. Lirpa, reasoning that Important Audio Critics do not want to waste time by listening to complete musical selections, simply combined the best parts of every standard test and demo disc into one very large noise. The resulting Archetypical Audio Test Signal was described by the Vermont Department of Fish and Wildlife as "a threat to migratory waterfowl."

This reporter was fortunate to have a hands-on, up-close, and actual in-person audition of the new Lirpa system. Anticipation ran high as I unpacked the Lirpa Inflatable Audio Reviewer, because unlike with lesser brands, there often is no relationship between what Lirpa promises and what is eventually delivered. There can also be some risk when first plugging in a new Lirpa product. Accordingly, after I received the Lirpa Inflatable Audio Reviewer, I alerted the local fire and police departments before beginning to assemble it in my listening room.

The instruction manual is about what you'd expect for a Lirpa product: A comprehensive no-refund, no-warranty statement—and nothing else. However, after consulting with the subcomponent manufacturers, I was able to assemble the Lirpa Inflatable Audio Reviewer in a few months. I then turned it on and waited for the traditional Lirpa Labs smoke and flames. No smoke. No flames. No neighborhood electrical outage. As I slowly got up from behind the sofa to wave off the police and fire trucks, it was apparent that the Inflatable Audio Reviewer represents a new pinnacle of reliability from Lirpa. It did not catch fire or explode when plugged in. All I heard was whirring and clicking as the system initialized itself. Incredible. While adjusting to this new order in the audiophile universe, I was startled by a reedy and nasal "harrumph" that emerged from the Lirpa Inflatable Audio Reviewer. I was amazed. A Lirpa Labs product that worked!

As I stared open-mouthed, I realized with a start that the Lirpa Inflatable Audio Reviewer was talking to me: "I can't listen

SO, HOW MANY LETTERS GO ON ONE LINE BEFORE HEY ARE CUT OFF BY THE DGES OF THE BLACK BOXES

to any of this stuff unless I'm sitting in the best seat." A few clicks and whirrs later, "And I don't like the electrical outlet I'm connected to and want to know if the wiring is oxygen-free copper back to the substation." Then, after a small computer-generated belch, "Where did you find those clothes? Are you tone deaf *and* color blind? Loud colors interfere with listening. Too much coloration. Any fool knows that you must wear neutral colors. Change them. Damn, I'm dealing with an amateur."

I quickly realized that the Lirpa Inflatable Audio Reviewer really does sound like an Important Audio Critic. It continued, "While you change your clothes, let me tell you how lucky you are to have me here.

Since your validity as a person is based on your choice of audio accessories, I am now the basis of your entire value system. Fortunately for you, using me is simplicity itself. You ask, 'Well, what do you think?' I then instantly generate The Archetypical Audio Test Signal, think for a second, and give my opinion. And you believe it without question."

The Lirpa Inflatable Audio Reviewer droned on. "Before we start, let me tell you that you need to know about some vital new Lirpa Labs products that have yet to be built and that you don't have here. Yet." The Capsule Review Feature display switched over to show a heavily retouched photo of Prof. I. Lirpa superimposed over an American flag waving in a wheat field. "Okay, so none of these products has progressed beyond the deposit-taking stage. And none has been designed, let alone actually exists, but I just happen to have with me some literature from the manufacturer and some reviews that I wrote myself. These reviews are accurate simulations and predictions of what unbiased and journalistically responsible manufacturer-written reviews would be like, and I expect you to believe them without question."

The printer started churning out Lirpa press releases and reviews on the Lirpa Listening Room Spike System, Lirpa Audio Floss, Lirpa Quantum Affect Modulators, and Lirpa AudioCare Correcting Fluid. (I stared at the growing pile of Lirpa literature and thought that, somewhere along the way, I had lost control of this process.) Shocked into silence by this amazingly accurate example of CriticSpeak, I watched the adjustable pneumatic head grow larger and then heard it say, "All right. Pay attention. Look, I need complete silence if I'm going to concentrate, so just tell me exactly what kind of junk we have here and then shut up."

As I began to tell the Lirpa Inflatable Audio Reviewer that it was listening to my state-of-the-art system, it interrupted and said, "The stuff you have is okay, but I'm not really too hot about it. Let me give it a blast, though." With that, the head swelled and a truly disgusting noise emerged from the system, followed by a loud splat from a Canada goose that flew into my listening room's picture window at full speed. The Lirpa system muttered, "Sounded like a Canada goose. Damn birds." The head enlarged alarmingly, the video screen displayed a big thumbs down, and then: "Don't quote me on this, but I don't like your junk and I'm not going to waste my valuable time reviewing any of it."

I asked the Lirpa to review just one piece of my system, the ******** ****** D/A, which is generally considered the absolute state of the art. After a pause and several electronic burps and harrumphs, it replied, "You want me to review *that*? Well, all right." The tone was unmistakably surply and sulky, just like that of a real reviewer. "I'll review it."

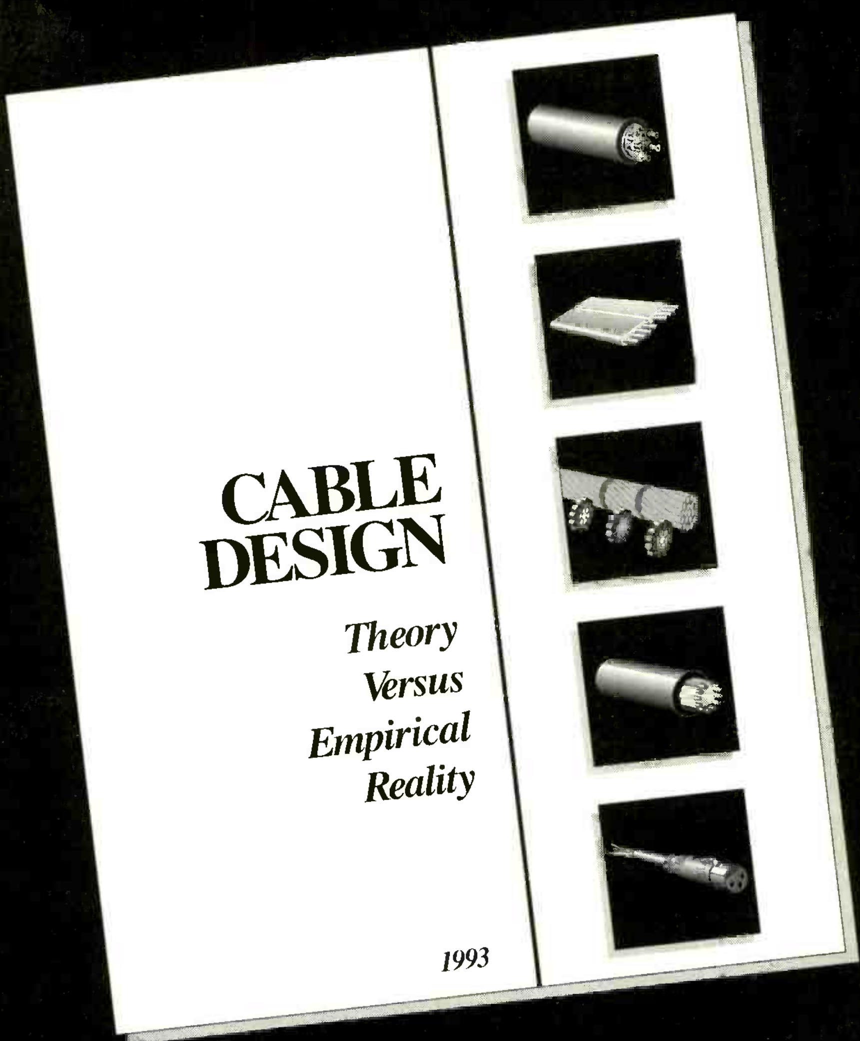
I then hastily gathered a group of friends to serve on a Lirpa Inflatable Audio Reviewer observing panel. Everyone cringed, expecting a further onslaught of birds splattered against the picture window. But instead the Lirpa's pneumatic head enlarged dangerously and said, "I don't have to listen to this rotten D/A converter, a non-Lirpa Labs product, to review it. My mind is already made up. I hate it. It's the wrong shape, in the wrong place, and owned by the wrong person. You."

The panel inquired if that was the entire review. The Lirpa's head deflated and asked, "What do you mean? You don't trust me? You want to edit the life out of my copy? You can't do that. I'm the only one around here who knows anything. You don't know anything about audio. You have no right to have an opinion. You're acting like typical editors. You're nothing but cloth-eared philistines. Audiophiles need me, you pathetic imbeciles."

After 8½ minutes with the Lirpa Inflatable Audio Reviewer, the panel had an overpowering urge to strangle it. We had heard enough. We pulled the plug, because after 8½ minutes any rational person wants to strangle a real Important Audio Critic. And it had sounded *exactly* like an Important Audio Critic to us.

Are you thinking about owning a Lirpa Inflatable Audio Reviewer? Do you really need the security of an authority figure to validate your existence? Are you tired of waiting for the Summer 1984 issue of your favorite underground audiophile publication? Have you missed the point of this article? If so, then the Lirpa Inflatable Audio Reviewer may be for you. However, there is a downside: You'll have piles of dead migratory waterfowl and will lack friends. On the upside, you'll enjoy the benefits of reflected status and authority. Somebody once said that you have to be crazy to be an audiophile. Well, by paying $122,800 and buying the Lirpa Inflatable Audio Reviewer, you can now scientifically prove this.

Otto "Bob" Otto



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SYMPHONIES NOS. 83, 84, AND 85

Schubert: Rosamunde; Symphony No. 5
Orchestra Anima Eterna, Jos van Immerseel
CHANNEL CLASSICS CCS 4292, CD; 52:20

Haydn: "Paris" Symphonies Nos. 83, 84, and 85
The Amsterdam Baroque Orchestra, Ton Koopman
ERATO 2292-45807-2, CD; 67:21

Like a great quiet wave, like a slow tide, our conversion of past music to what is mostly now called "period" instruments majestically invades era after era, as more and more first-class professional performers "see the light" (or perhaps a better living from their art) and learn how to play old and ancient instruments, formerly despised, and play them as well, perhaps, as the original players. Here is a case in point, and not even given special status; there are 39 performers, all on instruments as close as possible to those Franz Schubert used for this familiar music, *Rosamunde* (the overture and two of the incidental pieces) and the Fifth Symphony. The time is 1816 to 1823, the period of Beethoven's ascendance.

For those accustomed to the big modern orchestras (and the supermarket ensembles that sometimes get to Schubert!), the sound may be at first a bit unsettling: A darker effect, emphasizing the winds, with the strings somewhat obscured in their familiar melodies but making their impact by that slightly edgy, steely tone so characteristic of the old unaltered violin. It's a matter of getting used to it, for this is as close as we get to Schubert's sound.

Somehow, the performance is very Dutch (modern, of course). Quite heavy, somber, in the loud and baleful-sounding segments, new in Schubert's day, yet light and easy in the fast parts. Pure coincidence! But it works. There is no sense of rush or of concert-tour jet lag; these people have taken their time to feel Schubert in a new way—and it shows, or sounds.

I was particularly interested in a comment of the conductor, Jos van Immerseel: "Intonation [is] based on the principles of natural tuning, with coloring in the sharp and flat . . . as practiced in Schubert's time." Yes! All the instruments are free to raise or lower a pitch by a tiny amount, abandoning the tempered scale for a truer overtone blend—and you can hear it in the purity and impact of Schubert's marvelous changes of key. Anyone who listens with a keen ear can.

This new wave of instrumental authenticity seems strongest in Holland (and England) as here is yet another Dutch orchestra to parallel the Orchestra Anima Eterna and its Schubert. The latter is appropriately larger, as of the post-Napoleon period when Europe was bursting every seam in expansion, from iron and

Photographs: Robert Lewis

steel to music. Haydn's "Paris" Symphonies were composed 35 years earlier, before the French Revolution, and the appropriate orchestra is smaller, though in Paris itself the normal size was very large. These symphonies exploited the expertise of the French groups and not necessarily the size, which was easily adjustable. Nineteen players are listed here, all with period instruments. As the notes say, Haydn probably tried the works out first with his small home orchestra, then sent them off to Paris.

This is spendid Haydn—for today! Perhaps a bit too high-tension, even for that saintly but actually somewhat high-strung composer. The playing is wonderfully fleet, light, accurate, and beautifully phrased. If you want a decisive bit of evidence that "old" instruments really can be played, here it is. The balance, as is clearly the "consensus" on many recordings, puts the winds more forward and the early-type violins (often called baroque, though Haydn is far beyond that) somewhat in the background. These violins are wiry-sounding, not full-bodied as the later (and present-day) modified violins. Right or wrong, this was the only fiddle sound known for most of the baroque and classic literature.

Edward Tatnall Canby

The instruments on this Schubert CD are free to raise or lower a pitch for a truer overtone blend.

The Celestial Frog Trio
Arturo Toscanini, Glenn Gould, Christopher Faye
LIRPA CD-040193
CD; DUH; forever

Illustration: Rick Tulka

I'm just trying to get out of this alive. And rich. Otherwise you would never be reading about it.

It all started when I purchased a Compact Disc player that permitted me to enter at any point on a disc and also exit at any point. I discovered that the entrance and exit points could be separated by only one note. I then found that I could also program this player to repeat that one note as many times as I wished.

As I have spent a great deal of time listening to music waiting for a few great moments, it became obvious to me that the only logical way to enjoy music was to find the one best note that had ever been written in the history of all music and then repeat it endlessly.

Why surround myself with mediocrity?

I hired some musicians to help me search for the best note ever composed. Our operating assumption was that this note was someplace in the Chorale Finale of Beethoven's Ninth—or possibly in the Roy Rogers-Dale Evan's rendition of "San Antonio Rose."

Over the years, I spent so much time and money trying to find this note that I almost went bankrupt. The musicians I hired turned out to be useless. I don't think they ever understood that the continuous playing of one note was the only scientific way to enjoy music.

The only way to recoup my loses was to get a new group of experts who were not musicians, find the note, record it repeatedly for an entire Compact Disc, and then market that disc internationally. Such a disc would sell itself. By definition it would be the best disc that could ever be created.

I hired consultants in assorted disciplines from all over the world. They were a colorful group. I will never forget their gala party. I hired an ocarina octet from the Orkney Islands who played medleys of the tunes requested by the various Antartic arachnologists, Estonian esophagologists, Venezuelan vulcanologists, etc. The party cost plenty, but it was worth it. It provided the real breakthrough. An Albanian amphibiologist gave me some startling information. He explained that he had made an extensive study of the master tapes of the individual recordings of Arturo Toscanini and Glenn Gould. He singled out each of these great musicians for the same reason: Both found it necessary to sing along with their performances. Their record companies went to considerable trouble to filter the singing out of the recordings.

So my amphibiologist consultant gained access to the master tapes, since these tapes provided him with the pure, unfiltered songs of these two musical geniuses. He analyzed these tapes with sophisticated equipment. It was here that his training as an amphibiologist paid off. His professional conclusion was that both Toscanini and Gould's singing was identical to the croaking of frogs. What a discovery! In their supreme musical judgment, Toscanini and Gould decided *frog croaking* would improve even their sublime creations.

Needless to say, my consultant's presentation to the biennial World Symposium of Amphibiologists along with a paper entitled *Let's Fire all the Musicians and Hire Some Frogs* created quite a sensation.

And now for the final element in the scheme that will either make me wealthy or make me dead: Using the same technology that permits Nat King Cole and his daughter Natalie to sing duets on records that they never sang in real life, I am going to have a CD made of Toscanini and Gould croaking together. After this is completed, I will then find their best single note and create the best CD ever.

So how will that make me rich? Everyone will want to buy this disc. So why might this make me dead? The record companies will never again be able to sell anything else. I am too dangerous for them to let me live.

This article is my insurance policy. I hope its publication will make it too dangerous for them not to let me live.

However, if you can't get my disc within six months, they probably got me. In the meantime, I'm practicing croaking like a frog. Perhaps if they do get me, I can be in a celestial frog trio with Arturo and Glenn.

Christopher Faye

Vivaldi's Favorites, Vol. 1
Philharmonia Virtuosi, Richard Kapp
ESS.A.Y. CD 1022, CD; 60:07

Note the apostrophe! A genial sales play on words—these are hardly public "favorites," for the simple reason that practically nobody has ever heard them. (Maybe they were indeed Vivaldi's—who knows?) Not to worry a bit. The six concertos feature an absolutely bizarre collection of solo instruments—or the necessary substitutes—including a viola d'amore, pairs of horns, mandolins, and theorbos, and what at first glance seems to be a pair of salmon (salmò) and two English violets (violettes inglese). Also a recorder, the wooden flute type, not an Ampex, played here by a 16-year-old genius who merely duplicates the incredible pyrotechnics of some equal genius who played the notes more than two centuries ago for Vivaldi himself. All in all, a lot of musical fun, in spite of the substitutions. No salmon.

Richard Kapp's vibrant and skillful small orchestra makes a good go-between, basically a "standard" group of modern instruments but with a slant towards the "period" sparked by Kapp's keen interests. He writes his own liner notes, persuasively—"period" purists, who can be a bit stiff-necked, will surely forgive him most of the modern substitutes, if perhaps not the big fat pair of horns that bumble through a concerto for two horns like a pair of walruses in serenade. (Skilled players of the more agile and lighter valveless horn are available these days.)

The sound is excellent and the recording technique interesting—the music was recorded during the group's concert series, with "retakes" only where necessary. Evidently they were able to edit the sounds-with-audience right into those in an empty hall, not often feasible. We are not aware of any audience, original or retake.

Edward Tatnall Canby

Olivier Messiaen: Organ Works
Olivier Messiaen, organ
EMI CLASSICS CZS 7 67400 2

In 1956 the great French composer/organist Olivier Messiaen, who died last year, recorded all of his then-published organ music on the organ of St. Trinity in Paris, an instrument that had inspired him. Aside from later works such as "Meditations on the Trinity" and "Livre du St. Sacrament," this four-CD set is the definitive Messiaen for organ. While mono, the recordings by the noted French sound engineer André Charlin are well balanced so that the rolling reverberation of Messiaen's sometimes overwhelming complexities does not obscure the primary notes, as can happen in mono recordings of pipe organ.

The spiritually psychedelic nature of much of this music comes from many influences, the primary one being Messiaen's mystical Catholicism. Others include Debussy, Gregorian chant, Indian and Russian music, and in the composer's words, "everything which is stained glass and rainbows."

John Sunier

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Billy Childs' first piano trio outing features works by John Coltrane, Bill Evans, Cedar Walton, and his own compositions.

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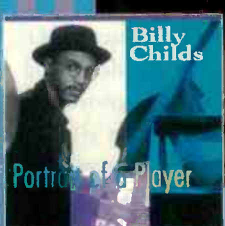

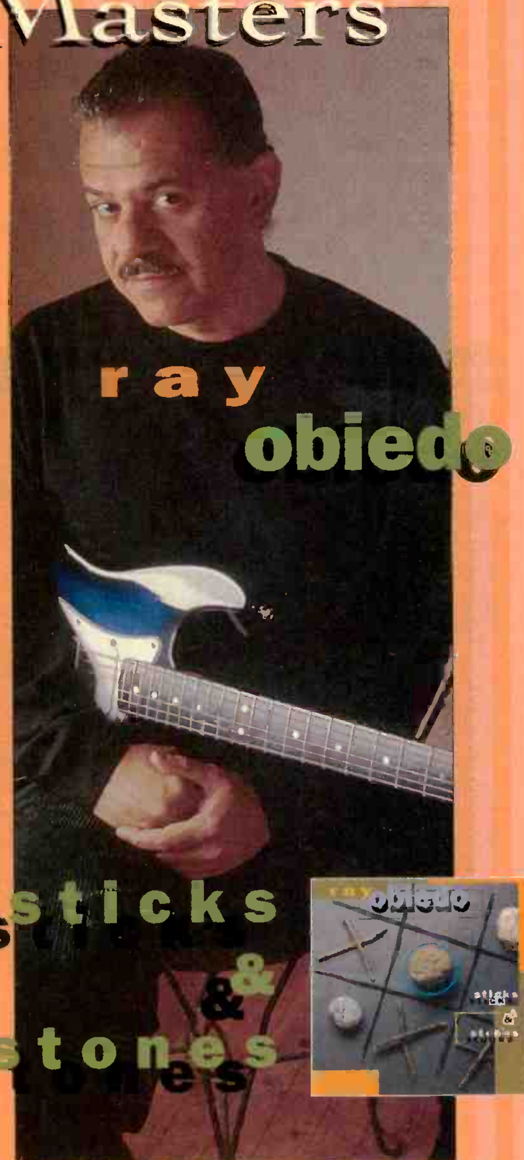

Latin, jazz, pop, and r&b accents fuse this new album by guitarist, composer, and arranger Ray Obiedo. Contributions from a seasoned cast of players including Kenny Kirkland, Andy Narell, Louis Conte, Dave Garibaldi, and many others.

"Brazilian and Caribbean rhythms boil a handful of the tracks over the brim of plain, down-home cookin' and light funk."—*Jazziz Magazine*

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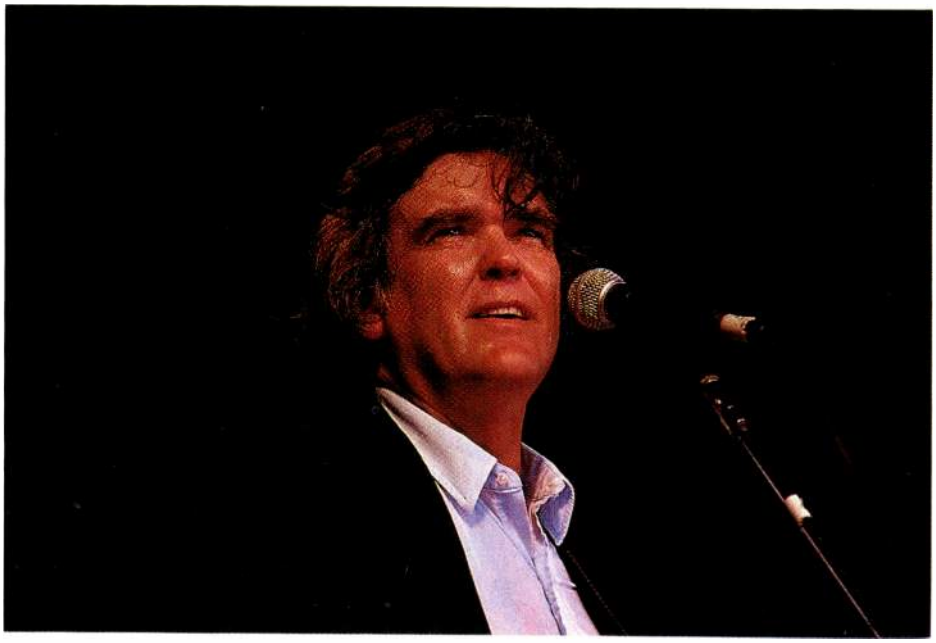
BOATS TO BUILD

GUY CLARK



Photograph: David Gahr

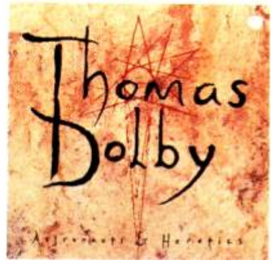
Boats to Build
Guy Clark
ASYLUM AMERICAN
EXPLORER SERIES 61442-2
CD; 32:23
Sound: A, Performance, A+

Guy Clark is one class act. The West Texas-born songsmith has been forging songs as small gems for over 20 years, only occasionally putting out albums. *Boats to Build*, his first since 1988's very elegant *Old Friends* (Sugar Hill SH-1025), is an eloquent document with a whole lot to say about grace and dignity and, for that matter, about the heart of the artistic process. In "Picasso's Mandolin," Guy sings "You can play it straight or play it from left field/You got to play it just the way you feel." And that's the way he does it.

The arrangements on *Boats* are sparse, best showcasing Guy's hand-crafted songs. Having on hand featured pickers the caliber of mandolinist Sam Bush, guitarist Verlon Thompson, and dobro and slide guitar ace Jerry Douglas doesn't hurt one bit either. Likewise with featured vocalists like Emmylou Harris on "I Don't Love You Much Do I," or Rodney Crowell on "Jack of All Trades" (which he co-wrote with Guy), or the erstwhile duo of Bill Lloyd and Radney Foster on the song they co-wrote with Guy, "Picasso's Mandolin."

The recording is most intimate and appropriately so. These are not songs that hit you over the head; with time they deepen as their wisdom unfolds. Similarly the recording, while not flashy, is right on the money with a superb clarity that lets these acoustic instruments and voices shine like the burnished wood of hand-built boats.

But it all comes back to Guy's songs. In "Jack of All Trades" he writes "There ain't no need to do a job if I can't do it right/I may not be gettin' rich but I'm sleepin at night." In Ben Sandmel's excellent liner essay, he quotes Guy as saying how a lot of his songs take a lot of time, patience, and tinkering before they are completed. But when they are, they glide effortlessly and naturally. This is the essence of Guy Clark's art—an essence *Boats to Build* beautifully captures. *Michael Tearson*



Thomas Dolby
Astronauts & Heretics
GIANT 24478-2

"She Blinded Me with Science" made Thomas Dolby a momentary darling of '80s New Wave. Some of his quaint electronics live on, and that's one of this album's problems: It's hard to reconcile such artificiality with Michael Doucet's Cajun fiddle on "I Love You Goodbye" or with Eddi Reader's guest vocals on "Cruel." Dolby does aspire to honest songwriting, but sometimes it sounds borrowed—from sweeping Bruce Hornsby here, from popcrafty Squeeze there. Highlights are surprising: "Eastern Bloc," an appealingly faithful sequel to "Europa and the Pirate Twins," and "Neon Sisters," an ode to a drug casualty that is the album's best sustained mood. This is certainly an improvement over the muddled *Aliens Ate My Buick*, yet Dolby's newfound logic has him stuck between high-tech and low-key approaches.

Ken Richardson

Cuba Classics 3
Various Artists
LUAKA BOP/WARNER BROS. 9 45107-2

What's happening on the Cuban music scene isn't all salsa and rhumbas, as you can discover on this unevenly recorded but still exciting collection. Instead, groove to an exotic blend of rhythmic a cappella scat, funky electric jazz, African juju revival, reggae meets steel drums, progressive salsa, a poet singing a gentle ballad, and speed/thrash metal! All, with the exception of the metal, contain sensuous, distinctively Cuban syncopation. If you like homogeneity, forget this. If you like to explore, here's your chance for a rare peek behind the sugar-cane curtain. *Michael Wright*

The Monterey International Pop Festival
Various Artists
RHINO R70596

Nowhere was the transition of pop music into rock art more evident than 1967's Monterey International Pop Festival, where the top-40 pop of The Association and The Mamas and The Papas stood on the same stage as raging revolutionaries such as Jimi Hendrix and The Jefferson Airplane. You can hear it all in this wildly uneven, lavishly packaged whiff of patchouli.

The visionary performances are already legendary: Hendrix, Otis Redding, and The Who, all brought a taut, seasoned sense of theater and dynamics largely absent from more self-indulgent performances by The Byrds and Eric Burdon.

Missing in action are performances by The Grateful Dead and Quicksilver Messenger Service, whose extended jamming was a more important signifier of the era than Lou Rawls' "sock-it-to-me" soul. Ironically, it's the revolutionary performance of Hendrix and the timeless music of Ravi Shankar that linger on after the incense has wafted into the atmosphere. *John Diliberto*

Spilt Milk
Jellyfish
CHARISMA V2-86459

On their 1990 debut, *Bellybutton*, Jellyfish was entrenched in a late-'60s powerpop sound along with the apropos kitsch. On *Spilt Milk*, their follow-up, they're even more rooted in a '70s powerpop sound, also with the apropos kitsch. This time, kitsch is less in the form of clothing (Mylar belts, crushed velour, platform heels) and more in the way of vintage instrumentation and production reminiscent of what Roy Thomas Baker did to beef up the Queen albums. Not much synthesier here, but plenty of real cellos, harpsichords, an occasional string section, and lush, layered vocals that manage to work on the strength of the songs. One can only wonder which band Jellyfish will sound like three albums from now. *Jon & Sally Tiven*

Queen of Soul
Aretha Franklin
RHINO ATLANTIC R2 71063

Aretha's recordings for Atlantic were a revelation of major proportions and it's the work that her career and legend are based on. With *Queen of Soul*, Rhino/Atlantic has done a fine job of compiling, on four CDs, some highlights of Aretha's Atlantic tenure. There are no surprises here; *Queen of Soul* is essentially an end-to-end compilation, albeit one covering one of the finest singers

to grace the planet. The accompanying book deserves mention. Annotation by a host of those involved in making these recordings (Jerry Wexler, Tom Dowd, Ahmet Ertegun, and Arif Mardin) as well as appreciators (Dave Marsh and Thulani Davis) offer some very lively anecdotes and insights that work well with the music. As far as the sonic aspects of the remasterings, the warmth and punch of the rhythm section really come through here. We can only hope that Rhino will offer some legendary outtakes of this material in the future. *Jon & Sally Tiven*

The Rising Sons
Featuring Taj Mahal and Ry Cooder
COLUMBIA/LEGACY CK 52828

These 22 cuts are the entire recorded output of a legendary L.A. band that, for various reasons, just never got off the ground. As the vehicle for the first recordings of both Taj Mahal and Ry Cooder, The Rising Sons have a legitimate historic cachet. The songs Taj and Ry sang were mostly blues, while those of fellow Son Jesse Lee Kinkaid skewed toward pop. This disparity—Cooder and Mahal's country blues and Kinkaid's pop—created a perplexing marketing problem for Columbia, which eventually threw in the towel. A lot here is raggedy and raw, but there is enough right to make this a very welcome release from the Columbia vaults. Marc Kirkeby's notes relate the history that gives these tracks context. *Michael Tearson*

The Pahinui Brothers
The Pahinui Brothers
PRIVATE MUSIC 82098-2

The Pahinui Brothers—Cyril, James ("Bla"), and Martin—are sons of the late and great Hawaiian slack-key guitarist Gabby Pahinui. Their album is a mix of traditional songs and standards of Hawaiian lore (no, nothing like Don Ho) plus some savvy covers that include "Come Go with Me," Steve Earle's "My Old Friend the Blues," and a marvelous Hawaiian/reggae hybrid of John Lennon's "Jealous Guy." Featured players are Ry Cooder (who produced a terrific Gabby album in the '70s), David Lindley, and Jim Keltner, with cameos by Van Dyke Parks and Dwight Yoakam. This dreamy music is beautifully, even lovingly, performed and will put a sunny smile on your face. *Michael Tearson*

Thelonious Monster
Beautiful Mess
CAPITOL CDP 80227

It's been five years since Thelonious Monster's *Next Saturday Afternoon*, a truly beautiful mess of satiric ranting and Traffic/tuba instrumentals. The band seems antiseptic today, mere hissin' vinegar. Guitars that jangle are the usual '90s stuff—and back in the old days, pairing vocalist Bob Forrest with Tom Waits would have been considered redundant. Saving graces: "Body and Soul?" and "Bus with No Driver," two pleas for understanding (of all things), and "Song for a Politically Correct Girl from the Valley," a nasty, lethal thing (now that's more like it). *Ken Richardson*

The Wallflowers
The Wallflowers
VIRGIN V2-86293

Jakob Dylan and band have made an impressive, rough-edged debut, incorporating many styles that would not be inappropriate on a record by Jakob's father, Bob. Fortunately, Jakob doesn't try to sing like Dad, although at times he sounds too much like Ron Wood. Still, his vocals are appealing in an unconventional way. The songs are quite good albeit a little self-conscious, as he seems more intent on conveying everything he knows than directly telling a story or otherwise addressing his audience. In a season of post-industrial teen angst, The Wallflowers stand head and shoulders above most new young bands. They'll make Bob proud. *Jon & Sally Tiven*

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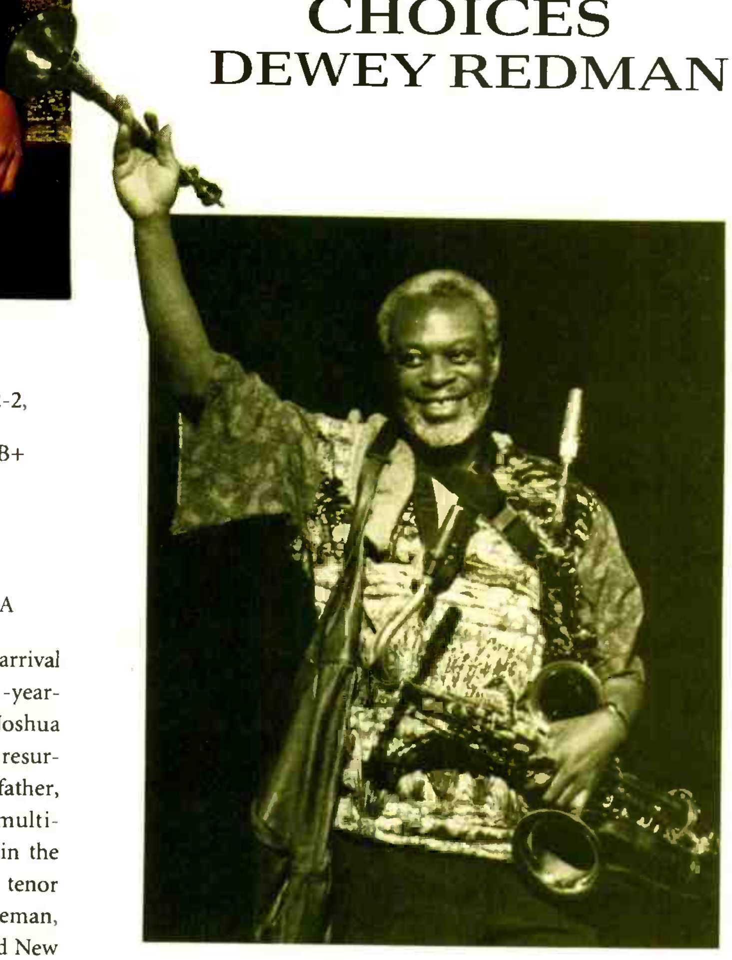


Joshua Redman
Joshua Redman
WARNER BROS. 945242-2,
CD; 64:32
Sound: A, Performance: B+

Choices
Dewey Redman
ENJA CD 7073-2,
CD; 55:29
Sound: A, Performance: A

Is it coincidental that the arrival of precociously mature 21-year-old tenor saxophonist Joshua Redman is attended by a resurgence in the career of his father, 61-year-old Dewey, a multi-reedist who kept his alto sax in the closet through his tenures on tenor with Keith Jarrett, Ornette Coleman, and the co-op quartet Old And New Dreams? Even if there's no causal link, the occurrence is truly doubly gratifying.

The elder Redman's tone can be languid or grizzled but it's always focused and now lends him an aspect of *eminence grise*. Though he's been moved by his peers and predecessors, nodding to Ornette, Coltrane, and Lester Young, Dewey, on *Choices*, delivers insights gained from his own experience and easily commands the adept attentions of bassist Cameron Brown and drummer Leon Parker.

Continually probing with his music, Redman has developed an expressive spectrum on tenor sax that has subtly gradiated from tender vulnerability to caustic assertion; he tosses off ironic asides in Humphrey Bogart style to protect his essential romanticism. He plays a double-reed musette as credibly as a Berber shepherd on "O'Besso" and also scat-chants in a made-up tongue. Redman uses his alto to demonstrate an exploratory, freely harmonized, melodic and motivic approach.

Having turned down a law school scholarship to pursue the muse, Joshua Redman fuels fresh enthusiasm with prodigious technique and daring, open feeling on his fine debut as a leader, in trio and quartet settings, with a fine if not yet famous rhythm team. A powerful but self-controlled presence, the younger Redman blows great blasts of notes,

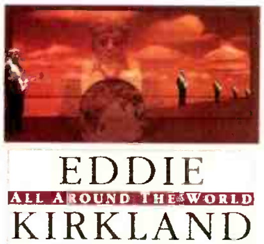
Photograph: David Gahr

well articulated, rhythmically excited lines that climb towards ever higher climaxes, and warm carresses of ideas.

That he has traditions under his fingers is beyond doubt. Joshua has mastered Monk's devilish "Trinkle Tinkle," takes Dizzy Gillespie's "Salt Peanuts" at a furious true-bop tempo, and proves himself ready for "Body and Soul," the graduate exam for tenor men. He's onto some newer things too, boogalooing through James Brown's "I Got You," kidding around "On the Sunny Side of the Street," and burning on his own "Groove X." An end-of-the-century kind of guy, he's still in self-definition, and aware of how much he has to choose from. His debut deserves a "B+" as an "A" is reserved for his greater things to come.

These albums share a clear, close, live-to-two-track recording quality that allows percussive accents to jog the listener.

Howard Mandel



All Around the World
Eddie Kirkland
DELUGE RECORDS DEL D 3001

A true blues professional, proto-grunge guitarist, not-bad harpist, and rip-roaring singer, Eddie Kirkland has led bands in and out of Detroit for more than 20 years with little national recognition and few recordings to show for it. So look for this one. Abetted by a modern studio full of make-good apprentices on riffing horns, extra guitars, swelling organ, drums, and bass, Kirkland (in turban and dark glasses) socks plenty of gusto to traditional boogies and doesn't give a damn about being occasionally out-of-tune. Guest star John Lee Hooker is always welcome but doesn't add much here, since Kirkland himself is in the league of Magic Sam and J. B. Hutto. If he's still singing about indignities suffered in 1961, it's because the rough sob in his voice—"Yeah! I'm in trouble!"—just won't quit. (Deluge Records, P.O. Box 1522, Scarborough, Maine, 04070.)

Howard Mandel

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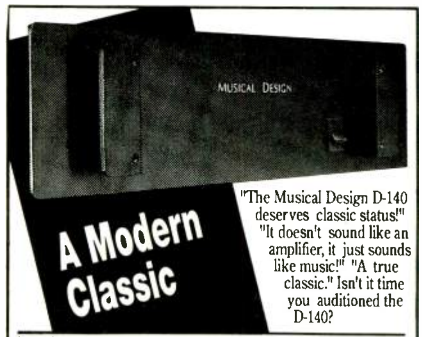

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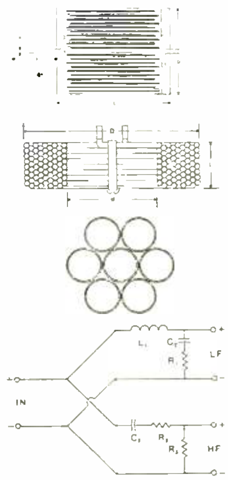

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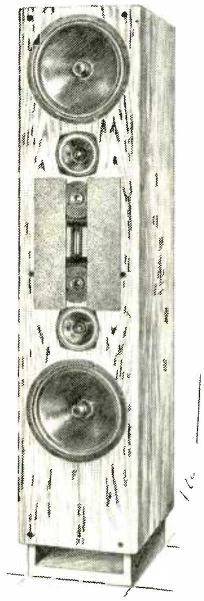

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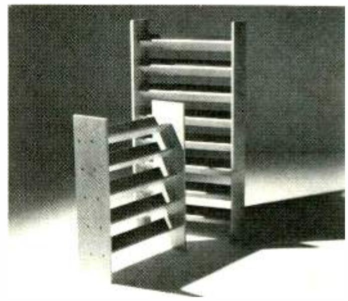

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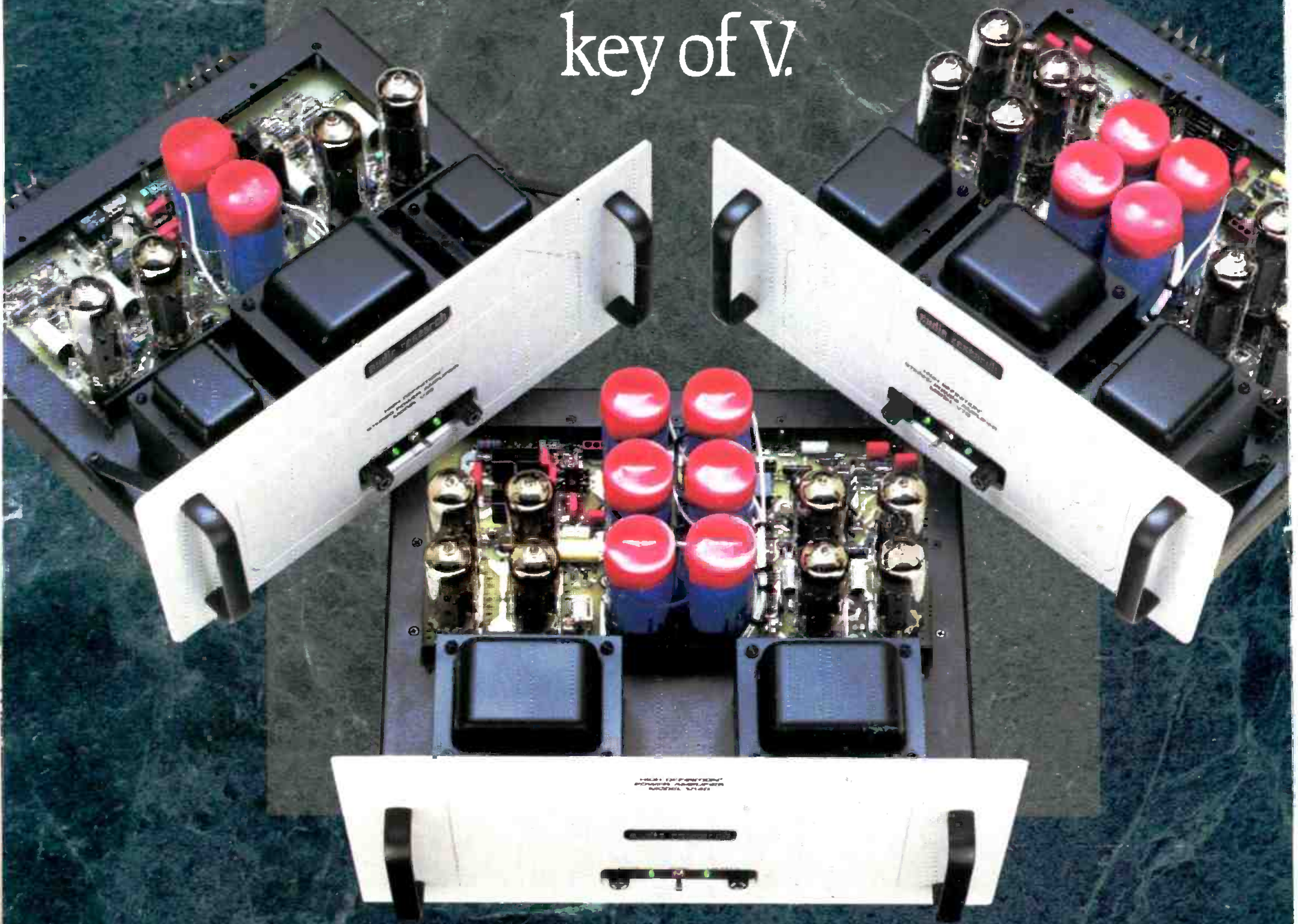

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