THE BAS SPEAKER

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Letter from the Editor

So far, only two of you have responded to my request for information on your systems and criteria for selecting speakers. We need more participation from members! This is your society. If you do not contribute, there will be no society.

Speaking of contribution, Al has contributed in a major way for this issue—his review of the Carver Amazing speaker, Platinum Edition Mk III. It's not just a review but a detailed exploration of why planar speakers sound different from typical boxed dynamic speakers. Al and I will continue the work and carry out more rigorous tests and comparisons and will report the results in later issues. These will include outdoor dispersion measurements, bass-distortion measurements, comparison with non-line-source full-range planars, effects of absolute phase on perceived sound stage, etc. Stay tuned! Al is also getting an FFT system, which will allow more measurements to be made.

I wish to thank David Moran, Mark Fishman, and Bob Zunner for having served as president, corresponding and membership secretary respectively. They did a splendid job at their posts. I also welcome the old-timers who replace them: Brad Meyer as president, Al Foster as corresponding secretary, and David Weinberg as membership secretary.

Tube Amplifiers

Two things stood out at the New York Stereophile Show: Stacy and tube amplifiers. Tube amplifiers are the in thing for the high end. There are tube power amplifiers with up to 1000W a channel (VTL, for example) and costing up to $20,000. VTL has a tube amplifier which uses Western Electric 300Bs, each tube costing over $200 (only 30W!).

This has sparked my interest in tube amplifiers, and consequently, I have purchased several Dynaco ST-70s, a Marantz 8b (a pristine unit for $200!), a Scott 340B ($20), and a Sherwood 5500II, and will report the results of some measurements I have made on these units. Your views on tube amplifiers will be much welcomed. I am experimenting with ways of extending tube, capacitor and transformer life on these amplifiers and will report my findings to you. I am in the process of building a 175 W/ch tube unit using Dynaco ST-70 output transformers. This should work very well when used above 100Hz—ideal for driving satellite speakers in subwoofer/satellite systems.

September 1989 BAS Meeting

This meeting was held at the General Cinema movie theater at the Shopper's World mall in Framingham, Massachusetts, and brought together the Boston Audio Society (BAS) and the Boston sections of the Audio Engineering Society (AES), the Acoustical Society of America (ASA), and the Society of Motion Picture and Television Engineers (SMPTE). There was therefore no Open Forum portion of the meeting.

Meeting Feature: The HPS-4000 Theater Surround System by John Allen

Charles Atkinson, the director of Quality Planning for General Cinema, was pleased to welcome us to this, the first New England installation of John Allen's HPS-4000 system, and brought out Leo Beranek to introduce John F. Allen.

Dr. Beranek, after dedicating the meeting to Ted Schultz, who had recently passed away, told us that John either was or ought to be familiar to many of us. John had been involved with the pioneering uses of digital audio at WGBH and WGBX in Boston, and had installed and operated New England's largest stereo sound-reinforcement system, at the Hatch Shell on the Esplanade in 1976. During the period that he was responsible for the sound during Pops (and other) concerts at the Shell, many of us thought it was about the finest outdoor sound we have heard in terms of clarity and natural balance. That it has deteriorated markedly since his departure only adds to his achievement.

In 1980, John formed High Performance Stereo to develop the Allen Sound Array and provide a complete package of equipment for high-quality theater sound. The HPS-4000 system includes loudspeakers designed and manufactured to provide efficient, wide-range, balanced sound everywhere in a movie theater. As with the system he used at the Hatch Shell, the goal was that the system should be capable of more than the most demanding source material, so that it would never draw attention to itself.

John, in taking the lectern to applause, told us that he had to thank his mother for the flowers which were beautifully arranged at the front of the theater.

The day's program comprised 5 film excerpts. We would hear "movie sound, not perfect sound," said John. In fact, the first piece was not the best mix or sound at all, but it created a specific atmosphere through the clever use of the surround channel, despite the dialog "spit" (sibilance). This was a Dolby A–encoded source, thanks to Warner Bros.: the fourth reel of *Batman*.

Of particular note, in addition to the sibilance of the dialog track (which was quite annoying even on this extremely good print), was the spaciousness created by the sound of the air conditioning in the museum scene. This is almost entirely surround information.

John pointed out that the surround speakers must match the main system as well as the theater characteristics, in order to achieve both seamless blending and good dispersion. To tune a sound array, he uses a reference sound source. His choice is the film *Top Gun,* because of its blend of bass, wideband noise, dialog, and music.

So the second excerpt was the first reel of *Top Gun,* again a 35mm Dolby A print, with thanks to Paramount Pictures. This is a three-year-old film, and John had to hunt for a playable print. Fortunately, the noise-reduction process was able to clean up some of the sonic damage at the splices in the print that was available.

John particularly drew our attention to the directional as well as the ambient use of the surround channel. Although there is only one surround channel in a Dolby-surround film, it is still possible to create the illusion of a source on one wall or moving through the theater. This requires a well-balanced playback system, however; if the surround speakers do not match the front speakers, the illusion will not "gel."

I felt that the bass end in *Top Gun* was a bit shy of reality. I had been fortunate to have had a recent experience of standing on the roof of my workplace, on Hanscom Air Force Base, when the Thunderbirds were practicing, and it was the kind of experience that makes one realize how far all recording or playback systems are from truth. Of course, when the real afterburners kicked in, it was all I could do to breathe; in *Top Gun,* dialog intelligibility was also a factor, so the slight lack of bass was probably a necessity of the mix.

John held up what he called his "company flag," a folded black cloth which represented the air-coupling area of various speaker types. The piston area of a 15" direct radiator is about 1.5 square feet, for example. A 70mm film will have five such woofers, so the bass radiators behind the screen will have five times the area.

A single HPS woofer has a radiating area of 10.25 square feet.

Each of the three main speaker systems in an HPS installation is a four-way system, entirely horn-loaded. It is only 4' deep, so it can be installed in extremely tight spaces. The sub-midrange uses a conical horn, while the midrange (four drivers) has an exponential horn. The tweeters, two per channel, are also horn-loaded. These speakers were developed for HPS.

Many of those attending had been to one or more of John's earlier presentations at the late Wellesley Playhouse, where he had installed the prototypes of the HPS surround system. Experiments in that theater led directly to the currently available HPS loudspeakers. That original sound system has now been installed in Elk Grove, Illinois. While there are two theaters in Taunton in which John has installed three-way systems behind the screen, the Shopper's World General Cinema is the first New England installation of the four-way models.

The screen itself (necessary for showing the movies) has an insertion loss of about 3dB from 7kHz on up. Across its width, behind it, are three of the four-way systems—left, center (dialog) and right—with an additional woofer between the left and center and also between the center and right. The system can produce 500 acoustic watts, approximately as much power as seven symphony orchestras, and clips at 140dB SPL.

The speakers used for the surround coverage add very important dynamics, and should have a frequency response as similar as possible to that of the main channels. The HPS-4000 surrounds are a three-way system, with a 12" sealed direct-radiator woofer, and two horn-loaded drivers, midrange and tweeter, each capable of handling more than 600W without damage.

John's placement calculations are designed to make it difficult for the audience to localize the surround speakers as a sound source. In this theater, for example, there were three on each side wall and six across the back wall. The goal was to cover the entire audience with sound that varies by less than ±1/2dB everywhere.

There is a physical size constraint on the surround speakers, since they usually hang from the walls. However, the twelve 12" woofers have the same radiating area and power output as one of the front woofers, so there is equal sonic capacity in each channel of the system.

The third excerpt was the fifth reel of *Indiana Jones: the Last Crusade.* This was loud but exceptionally clear. The explosions had more low bass than was evident in *Top Gun,* showing that the sound system was capable of producing it. Despite the extra bass and the levels of the music and sound effects, the dialog was always clear and unstrained. A well-balanced mix.

The accompanying John Williams music for this scene, by the way, is called "Scherzo for Motorcycle and Orchestra."

John pointed out that we were hearing a Dolby Stereo optical print, not a discrete magnetic soundtrack. "This is as clean and clear as you will ever get from this technology," he told us, emphasizing the 10–15dB of noise reduction from the Dolby A encoding and the quality of the mixing and printing.

Dolby A is a four-sliding-band noise-reduction system. A new system from Dolby, called SR ("Spectral Recording"), is equivalent to a ten-band system, with two of the frequency bands fixed and the rest sliding in response to the signal levels. Dolby SR offers 16–24dB of noise reduction, and when applied to an optical soundtrack allows 100% modulation at 12kHz. Subjectively this seems to allow an extra octave of high end. SR also permits 9dB greater bass dynamics.

The newest wave of movies includes some that have been released in SR prints only. This technology produces sound quality similar to that achievable on 70mm magnetic, but with the costs of 35mm optical. John told us that it is sometimes sufficiently compatible with the older Dolby A playback that studios may not be maintaining a double inventory of optical prints. In fact, Paramount ran some compatibility listening tests using the theater with his speakers in Elk Grove. When Dolby Labs subsequently set up an SR theater in Chicago, Paramount said they preferred the sound they had heard on his system.

For our fourth excerpt, to demonstrate Dolby SR, John had chosen the last reel of *Licence to Kill*, a James Bond film starring Timothy Dalton. Thanks are due to MGM/UA for the print.

This reel featured the destruction of a cocaine factory, with lots of shooting and very effective-feeling explosions. Some gasoline tankers are also destroyed during a chase scene. Like the *Indiana Jones* extract, it had a big racket of sound effects, and a very clean mix. Dialog—what there was—was always very audible, and the music was balanced well with the explosions.

What was most interesting about this example, however, was how delicate and open the sound could become. The final scene is at an outdoor party with background music. Quite the opposite effect from the exploding factory! But the same qualities of clarity and atmosphere were used to great advantage in this relatively quiet portion of the soundtrack.

At this point, before the final excerpt of the day, John took a moment to name and thank a few of the people who had helped organize and/or make the meeting possible: Atkinson from General Cinema, of course; Leo Beranek, Dolby Labs, WGBH; David Moran for the BAS; Joel Cohen for the AES; from General Cinema, John Norton, technical help, and Joe DiCarlo, District Manager; and, finally, the local theater management and the projectionists.

"We started with Mozart and Percy Faith," said John, "so we're going to end with rock and roll." First, however, we would see his one-minute trailer for the HPS-4000 system. One minute of film like this can cost $38,000 to produce. The 70mm version has transients approaching 120dB SPL in the 30–60Hz octave. We would hear it twice, first in Dolby A and then in Dolby SR. Both prints have 100% permissible modulation.

The final excerpt was from a concert film, *U2: Rattle and Hum*. U2 play what I call unremittingly loud rock. The sound for this film was recorded in live concert, and all the voices had an unpleasant edge to them. Perhaps this is what deaf rock engineers like? However, the crowd noise at the beginning—done with the surrounds—was quite realistic.

In response to comments about the volume, John told us that he had this played 3dB *below* the mix level. "Modern films are too loud for approximately one percent of the audience." He felt that if a theater manager gets 4 complaints per show, then the volume's about right. (In other words, if you want it turned down, get six friends to complain about the volume.)

Harry Ellis Dickson asked why films are so loud today. "Is there no beauty in softness?" John said that playback levels are determined by what makes the dialog most intelligible. Mixes in general do not use the dynamics well; most effects are mixed in at high levels. *Indiana Jones* was clearer than *Batman*, and *Licence to Kill* was probably best because of Dolby SR. Also it was a very good print.

Most theaters are dead, in order to enhance intelligibility of dialog. The HPS-4000 system is so clean and balanced, said John, that it can take advantage of the benefits of a live environment. It is the expectation of a dead room that leads to boosting the extreme frequencies in the mix.

Don Puluse (Berklee) commented that we have a responsibility to be aware of volume problems. "There is a generation of rock musicians growing up deaf," he said. The U2 film reached peaks of 110–115dB. Of course, it was close to that level all the time, which makes the problem of hearing fatigue and stress much worse. However, at Great Woods there have been live concerts by rock groups which were even louder.

In the future, John told us, there will be films with digital optical soundtracks. This has already been demonstrated, though not commercially, by an affiliate of Kodak, using film running at the equivalent speed of 70mm. A comparison of digital film sound with 70mm magnetic technology shows that the digital tracks will have five (instead of four) discrete channels (plus the extra subwoofer channel), and these will be full bandwidth instead of cutting off above 15kHz; signal-to-noise ratio will be increased by 30dB, to 90dB; and separation will increase to 100dB (from 50dB).

The introduction of digital playback will require that theaters upgrade not only the projection systems but also the amps and speakers, or there will be no audible difference. A good sound system can pay for itself at the box office: the Wellesley Playhouse, with no fanfare about the new sound system, grossed 25% more in the first year after installation.

— *Mark P. Fishman (Massachusetts)*

January 1990 BAS Meeting

Elections of BAS Officers

It was again time to nominate new officers for the new volume year. David Moran reached the end of his three-volume-year term, and could not run again for President. Mark Fishman had other commitments for the upcoming year and could not continue in his current Corresponding Secretary post. Bob Zunner similarly declined to continue his current post of Membership Secretary. Ira Leonard was the only one willing to continue in his position (treasurer). After some discussion, Brad Meyer was nominated for President, and Al Foster for Corresponding Secretary. No one volunteered (or was nominated) for the Membership Secretary post.

Open Forum

Someone noted that this is the year his friends who are not interested in CDs bought CD players. This is because they cannot find the music they want on LPs anymore. It is now cheaper to make CDs than LPs, said Ira. This is partly due to fewer returns. Al noted that he had about equal percentage of CDs returned as LPs, the difference being CDs are returned because they did not play, while LPs were returned because they were warped. Mark pointed out that dirty lasers, lenses, and servo tracks can cause mistracking too. Paper slithers and dust attracted to the CD surface by static also cause mistracking.

Al said that test tones, his favorite music, were "100 percent better" on CDs than LPs. This sparked a discussion on relative merits of CDs versus LPs. Brad commented that LPs tend to have more random phase errors and more L–R signals which makes the music more spacious sounding than the original master tapes. Since most audiophile have not heard the original, they assumed the more spacious sound is more accurate.

Mark said that some people questioned the adequacy of the CD medium's bandwidth and dynamic range. Brad replied that he has as yet to be shown that either is inadequate. He thought that for *production* purposes, wider dynamic range is desirable—for mixing together multiple 16 bit tracks with EQ, more dynamic range will be necessary (the Lexicon Opus, for example, uses 50 bit words for EQ processing). However, once past the production stage, most music can fit comfortably within the CD's dynamic-range capability. He found the quietest Telarc CD's noise floor to be 85–88dBA below the highest peaks. Mark agreed, noting that the widest dynamic range he encountered at Symphony Hall is 75dB. However, care should be taken to dither the signal when reducing the bits.

Al noted that he only recently switched to CDs, after having an AR CD player for two years gathering dust, "only after Poh Ser came and showed me how to use the machine." He had quite a few CDs at that point, and he found the changeover dramatic. First, he heard a lot more L–R signals with CDs—"sounds were coming from locations way beyond the speaker boundaries." This is partly due to new techniques used by the pop industry, and the CD's ability to maintain stable and consistent interchannel phase relationships. "Some can hear sounds circle *behind* them" (Al himself cannot hear this). Second, he found CDs much brighter. Mark thought that might be partly due to the spring-back effect of vinyl which softens highs on LP playback.

Meeting Feature: Winter CES

Ira Leonard, Mark Fishman, Brad Meyer, Al Foster and Peter Mitchell formed the reporting panel.

Speakers

Peter thought that most of the exhibit rooms are not ideal for audio—generally L-shaped rooms with lots of reflective surfaces. As may be expected, most set up their speakers in the worst possible way.

Acoustic Energy, a British speaker manufacturer, introduced a full-size model AE-3, which uses a 10″ woofer. Peter thought it sounded "wonderful." Their model AE-1, raved about by the British press, sounded "too thin" to Peter.

Acoustic Research was bought by International Jensen two days before CES. Personnel present at the AR booth were positive about the take-over, but Foster thinks that takeovers are never good. AR had an experimental speaker which is a 4–5 ft. tall cylinder with a flat front for the drivers and a slanted top which slopes from the front towards the rear. It houses two 12″ woofers, one facing down (it has a Q of 1.8 at 35Hz), and the other facing forward (with a Q of 0.6 at 43Hz). By appropriately blending the two woofers, the composite response is equivalent to a system with a Q of 0.8, and –6dB at 23Hz. Mark talked at length to the AR engineers John Buzzotta and George Shultz and noted that AR now manufacture all their woofers in the US. They still import their tweeters.

Al listened to the large Acoustat 66 and was disappointed. Al said that the "listening axis is very narrow," which he disliked. He was disappointed that "a speaker so big has to be so position-sensitive."

AHL, a French Speaker company, showed a full-range cold-plasma speaker. It is about 8′ tall, 5′ wide, and sounded terrible. It was driven by 500W McIntosh mono amplifiers with their needles pinned, but was barely audible. When Al tried his Carver CD, the distortion was gross with a 1kHz tone, and just "tick, tick, tick" with the 24 and 16Hz tones. The exhibitor claimed that the speakers were not getting enough voltage—10,000 instead of 12,000 volts. Cost is a staggering $80,000. Al commented that he "didn't hear anything worth anything."

Allison introduced a new home speaker—the Allison 1A, now called the IC-10. This is similar in shape and size to the original Allison Ones, but uses two 8″ woofers in push-pull instead of two 10″ woofers operated in the normal mode. The IC-10 also allows separate connections to the two faces of the speaker, so the outer panels can be fed an ambience signal, for example. A version with wireless remote is available.

Allison also introduced a line of car and truck speakers, named the "cruise-master" series. The largest truck system is essentially two sets of CD-9 components mounted in one carpeted rectangular box to fit in the back of trucks or hatchback cars. Allison also offers his woofers, convex midrange and tweeters for mounting in cars.

Atlantic Technology, a corporate relative of NAD, showed a 3-piece powered system for $500. The satellites use two 3″ drivers in small boxes. The three amplifiers and two 6″ woofers are housed in one larger box. Brad helped fine-tune this system. Bass is not quite as deep as from the Boston Acoustics sub/sat system, and it may not be quite as smooth, but does come with amplifiers for the same price. An optional carrying case is $100. The company's new $1,200 video surround system has 5 satellites with two 8″ woofers, and Dolby Pro Logic decoding.

Brad listened to the ATC SCM100 amplified monitors which bowled Peter over during the last Chicago Show. Brad thought that they played loudly and cleanly, but was disappointed with the bass, considering the price ($8,000 a pair). It was much smoother than other speakers which can play as loudly.

Avalon has upgraded its speaker—from $11,000 to $13,500 a pair. According to Peter these sounded much like the Snell Cs, at about 6 times the price. A unique feature is a 6"-thick front baffle, but Peter found that the side panels vibrate.

Celestion introduced their new 1000 series speakers. These new speakers employ their new ribbon midrange/tweeter, which handles 900Hz and up. They are rectangular boxes with the inner front edge cut off at an angle; the ribbon is mounted on this angled surface. Thus the ribbons are toed in at 45 degrees with the boxes facing directly forward. The woofers are mounted on the forward-facing panels. Al commented that the ribbon was "very good, very flat," but the woofer section had a "box sound." Peter concurred that Celestion needs to work further on it. He measured the speaker and found that the ribbon is quite beamy, with a rising response to mid treble on axis, and "has no top octave." As a result, there is severe high-frequency rolloff on the axis of the woofer, a suckout in the crossover range followed by the mid-treble rise on the ribbon axis, and a bigger suckout with good mid treble at about 30 degrees off the woofer axis. Like all Celestion speakers, one has to "slouch" down to listen to them, or use a higher stand. Peter did not think it deserve the "gaga" reviews the British press gave it.

Clements Audio, a Canadian firm, also sells speakers with ribbon tweeters. Al thought they sounded good, but Brad mildly disagreed.

Hail, a British manufacturer, has a deep and narrow speaker weighing 181 lbs. per side. It is very attractive. Costing $9,000 a pair, it has a clear suckout around 2.5kHz at normal U.S. sitting position, but sounds much smoother if you slouch down.

JBL introduced two new speakers, both large floor-standing models with 12" woofers. One has a constant-directivity horn for mids and highs, while the other uses their titanium dome midrange and tweeter. Brad and Peter liked the latter (the XLP series) very much, but thought the former was "peaky, colored, and nasty." They commented that JBL was well known for making excellent drivers but poor systems. Mark noted that JBL also introduced an 18" woofer with force-cooled voice coil, rated at 1,000W, for cars. List price is $479 each.

Museatex, the original owner of Sumo, is making a smaller version of the Sumo full-range speaker that Peter liked so much.

NHT [acquired in mid-summer of 1990 by International Jensen] introduced a new speaker, the model 100, which Peter liked. It's a 10" three-way.

The Olson Nightingales, at $1,600 a pair, sounded "absolutely wonderful in the mids and highs" to Peter, and in fact measured dead flat in this range. It featured ribbon tweeters and time alignment. Unfortunately, bass is "soggy and thick"—Peter thought the enclosure needed better bracing, and told them so. Al noted with amusement that Peter always tells manufacturers exactly what he thought, and gives free consulting. Al himself always says something complimentary even when the product stinks. Peter replied that any manufacturer who puts up with his equipment and lets him play test signals that drive everyone else out of the room deserves a little free advice.

Pinnacle, a company run by two brothers and their mother, showed their PN8 plus ($400 a pair) which sounded "amazingly good" to Peter.

Snell has updated their B and C speakers. Ira thought that the new B's top is not quite as alive as the former version, and it has less deep-bass extension. The new C-III, on the other hand, was excellent. It has a new front tweeter and a modified crossover. Snell has its final prototypes checked out by the Floyd Toole group at NRC in Canada. They had a program which helped customers determine optimum speaker and listener locations for their rooms. They were proud that RCA chose to use their speakers for monitoring their new series of CDs (movie music).

Soundlab was at the show, and Al said they were "sounding good as usual."

The Shahinian Diapason is a multi-directional speaker which seems to be able to give pinpoint imaging and to reproduce symphonic music with the proper weight and scale, said Peter. Brad thought that its treble balance is off—a suckout in the 2kHz range followed by a peak in the 5–6kHz range.

Soundwave Fidelity produces speakers with a pentagonal top, one apex facing forward. Drivers are mounted on the two front faces. Their second largest, the Soliloquy, at $2,400 a pair, is 38" high, 12" wide and 16" deep. Peter thought it was "extremely accurate, spectacularly smooth, bringing out massive details." Peter tried both pop and classical and both sounded great.

The new Spica TC-30 costs $400 a pair. It is the company's first plain rectangular speaker, and it sounded extremely neutral to Peter.

The other speaker Peter liked a lot is the Swan, another expensive system—about $7,000 to $8,000. Peter felt that the more he listened to it, the more he liked it.

Last but not least, Westlake has a whole series of studio monitors, the larger ones using all JBL drivers, and costing up to $50,000. DMP use Westlakes for their monitoring. Their room was very absorptive, with only one seat! Al thought the people seemed very knowledgeable.

Turntable and Tonearm

Finial had two of their laser turntables working at the show—one at the ADC booth, the other at their own. Cost in the US is $32,000, with "white glove" on-site installation and two-year maintenance. They are considering making a version which will play 16" shellac masters.

Bob Graham introduced his Graham model 1 tonearm. Al described it as the Decca arm without the tilt problem. It accepts the SME headshell. It's beautifully made, and can be yours for $1,776. Bob came up with the design 10 years ago, but was not able to sell any because McIntosh bought the rights to it and only recently released them.

DATs

Sony, Technics, and Pioneer are bringing in DAT machines (with the SCMS circuit) this July. They are not waiting for the Congress to pass the copy protection laws. They are expected to list for $800 and up.

Cassette Decks and Dolby S

Pioneer introduced a cassette deck that can hold up to six cassettes, and can be programmed to record on all of them, with full synchronization to a companion CD player. Steve Owades commented that the manufacturers seem to be trying their best to prove that RIAA is right in worrying about copying.

Dolby S will be available shortly in Denon and Pioneer decks. The Dolby S chips are made by Sony, but due to Sony's commitment to digital, Sony will hold off on Dolby S decks themselves. Dolby has laid strict frequency-response and azimuth tolerances on decks to be licensed for Dolby S. The panel members commented that Dolby S sounded OK even without any noise reduction in the playback.

Laserdisc Players

Ira said that Panasonic will be selling "multi-disc" (i.e., multi-format) players—disc players which will play video discs and CDs. These are capable of playing both sides of a video disc without manually turning over the disc. The laser will move from one side of the disc to the other. Ira thought that it took less time to change sides than Pioneer machines. Resolution is 425 lines. They use MASH decoders, have S video connectors, optical digital outputs, and a digital time-base corrector for the top machine (with an FM time-base corrector for the cheaper model). When playing CDs, its video output displays the playback level.

Headphones

AKG showed a new headphone costing $850. Its unique features include a three-point cranium mount (nothing touches the ears), and drivers with adjustable angles—straight into the ear for normal headphone sound, swiveled out in front of the ears for a more spacious sound (but unfortunately no bass). Brad found the driver height adjustment is critical for high notes. They are fascinating and very good in many ways but still need more work.

Peter had a pair of Beyer DT-990 Pros on loan and the more he listened to them the more he liked them. "Not as good as the Stax Signature, of course, but good." The main drawback is their low sensitivity. Price is $275 list. [See review in Vol 17 No 5.—Ed]

Miscellaneous Items

Isosonics, an M.I.T. group, showed a black box which digitally transfers CDs to VHS tape. It will record in the six-hour mode, at 16 bits, but will not be PCM-F1–compatible. It does not have A to D converters, which means it cannot be used to do live recordings. Some members voted it the "pie in the sky" award, with pay per recording digital video sharing the same award. This latter scheme allows two-hour movies to be taped in 20 minutes; the tape supposedly will self-erase 10 minutes after the second play (shades of *Mission Impossible*).

THAT showed a recordable CD system (CDR). This is a record-once system, based on color dyes. The recording laser changes the surface color. The colors will fade after about 50 hours' exposure to sunlight. System price: $40,000, plus about $10 a CD. Given that for $1,000 you can get 1,000 CDs including mastering using the usual method, the new system is useful only for very small quantity production. THAT also showed a new cassette tape with a metal coating called nano dynamic techtoid metal formulation.

Clarity Audio Systems sell the Ultron Supercharger power cord for $750 apiece—guaranteed to improve the sound of your CD player! It uses extra virgin solder, and super-pure copper. Al thought he could hear a difference but attributed it to the power of suggestion.

The meeting drew to a close with comments about Las Vegas's rapid growth, and how gamblers are drawn to the newest and biggest hotels, leaving the older ones empty.

— *Poh Ser Hsu (Massachusetts)*

A Review of the Amazing Loudspeaker, Platinum Edition

by Alvin Foster

[Alvin Foster is Corresponding Secretary of the Boston Audio Society. He is the producer of the Carver Sonic Holography test record and CD. The speakers were supplied for review by the manufacturer.—Pub]

I received for review a pair of Carver's Amazing Loudspeakers, Platinum Edition. In this Mark III version, they rank as one of the best loudspeakers I have had the pleasure to listen to and measure. They deliver a wide soundstage, superb bass response, an excellent sense of depth, and lots of ambience.

For over three months I have conducted a series of measurements and comparative tests. Two of the tests are new and have to my knowledge never appeared in any literature on listening room or audio measurements. I undertook the tests in an attempt to explain the audible differences between the large, ribbon design [dipole line sources—Ed] and boxed dynamic speakers.

I have isolated five sound characteristics which I feel differentiate dipole-line-source speakers (represented by the Carver) from the typical boxed dynamic speaker (represented by AR):

1. The boxed dynamic speaker has a "box" sound which may be characterized as a low-Q-resonance sound.

2. At high levels, dynamic speakers tend to "shout" at you, and sound louder.

3. Boxed dynamic speakers have a sound which can be characterized as containing an "echo" surrounding the major instrument, particularly audible on the voice. Some have characterized it as a "megaphone" sound.

4. The soundfield from a typical boxed dynamic speaker seems to emanate from a smaller source than the much larger, dipole speaker.

5. The boxed dynamic speaker lacks the clarity and detail of the large ribbon design.

Before going into details of my observations and tests, I will outline my first experiences with the Carvers: unpacking, how the speaker works, Sonic Holography, and setup.

Unpacking

Each speaker comes packed in a box that is 5'11" long, 3'4" wide and 9.5" deep, weighing 110 pounds. It requires two people to handle safely, but once unpacked a speaker can be easily moved on a carpeted floor by one person, using a rocking side-to-side motion. Each box is marked with the words "left" or "right" and a serial number, and also contains a stand.

Setup

Setting up or positioning the Carvers in my room to sound "right" was slightly more difficult with than dynamic, direct-firing speakers. The difficulty was partly due to the size of the speaker (30"×66"×10"). Because of the bidirectional radiation pattern, more care is needed to minimize front-wall reflections, and because the speakers are so tall, the top-to-bottom or tiltback angle must be factored into the setup. The width of the speaker forces you also to consider the toe-in angle; for best imaging, the speakers have to be angled inward so that the axes of the ribbons cross just in front of you.

A tape measure is essential for setting up the speaker. Although the Carver manual suggests measuring only from the center of the ribbon to the center of your listening chair, I found it easier and more reliable to measure from the four corners of the speaker, which ensures accurate toe-in and tilt as well.

The latest, but I am sure not the final, setup has the speakers 9'4" from my listening chair to the inside edge of the Carvers; the outside edge is 9'2" from the chair. The best result in my room was obtained with a toe-in of 10.5".

Because my room is only 10' wide, placing the speakers in the normal fashion (i.e., ribbons closest to each other) resulted in only 2–3' of separation—not satisfactory for stereo imaging. Poh Ser Hsu suggested swapping the left and right speakers so the ribbons are closer to the side walls. This gave 7' of separation between the ribbons.

I followed the manual's instruction for adjusting the tiltback angle to nine degrees. In my room, decreasing the tiltback angle will result in slightly more high-frequency and a little less midrange energy at the listening position.

The tiltback angle also affects the amount of ambience. Greater ambience can be achieved if the panel is tilted away from the listening chair, beyond 9 degrees. However, because I have a low ceiling, I decided that reducing ceiling bounce (reflections off the ceiling) was more important.

The Mark III version of the Amazing is fitted with 3 wirewound pots. Each has a range of about ±5dB. The top rheostat adjusts mainly frequencies above 8kHz; the middle one affects the range between 3 to 8kHz; the bottom level control (new with the Mark III) adjusts frequencies below 200Hz. The flattest frequency response in my room is obtained by setting all 3 level controls to a 3:00 o'clock position (about 25% from full on).

Sonic Holography

The need to purchase the optional Carver Electronic Control Center (ECC) for equalization is reduced now because the Mark III has added a third control, the bass level pad. [In the case of the Carver, a pad can be used for the bass without seriously affecting bass damping—there is practically no electrical damping to begin with.—Ed] The ECC box, however, also contains Carver's latest thinking on how this feature should work and sound. It is superior to the older version in my C-4000 preamplifier, which I considered excellent. I use Holography on about 20% of my records. When there is a good "fit" between the recording and the unit, you are transformed by a listening experience that relegates the stereo world to the dark ages. When the match is right, the extra expense ($295) is your ticket to listening through to the actual performance—you are there.

Sonic Holography overcomes the limitations of stereo. In stereo both ears receive two sound arrivals, one from each speaker. Your ear-brain neural processor gets confused, some feel. In most cases, one gets a relatively flat, two-dimensional sonic image between the speakers. [One exception is tracks 4 and 10 on Talking Head's *True Stories*, where some instruments circle all the way around you when played through an ordinary system with two speakers.—Ed]

Holography cancels the extra set of sound arrivals of conventional stereo. A listener can actually pinpoint the location of individual artists and instruments far beyond the normal limits of stereo.

How the Speaker Works

Planar radiators can be either electrostatic or electromagnetic in their operation. Carver based the Amazing Loudspeaker on a driver that he calls a "direct-drive, large-area, full-range ribbon." It is a type of electromagnetic driver whose "voice coil" consists of a long foil conductor suspended vertically in a magnetic field. The foil is sandwiched between two layers of magnets located front and back. "Direct drive" refers to the absence of any matching transformer to couple the (normally) very low impedance of the ribbon to the driving amplifier. The ribbon in the loudspeaker crosses over at about 125Hz. To obtain a sensitivity rating of 88dB (2.83V @ 1m) for a ribbon which goes down to 125Hz, the Amazing needed, according to Carver, the highest gap flux of any commercial ribbon driver in the world.

At frequencies where the wavelength is long compared with the baffle, cancellation occurs. Net output radiating into a hemispherical space will exhibit a 6dB-per-octave roll-off starting at around 100Hz in the case of the Carver. To overcome this cancellation, the Carver utilizes four 12", high-Q drivers. By making the woofers' Q much higher (2.5 instead of 0.3) and by placing their resonance at the desired lower frequency limit of the system, bass response could be made to rise at 6dB per octave with decreasing frequency [within an octave or so above the woofer resonance.—Ed]. When the woofers' response [with some help from the crossover—Ed] is combined with the falling panel response of 6dB per octave below 100Hz, the result is a flat system response down to the woofer's resonance frequency. A sharp cutoff at 18dB per octave occurs below that point.

The first paper to document this behavior is an article by R.J. Newman appearing in the *Journal of the Audio Engineering Society (AESJ)* of Jan./Feb. 1980, titled "Dipole Radiator Systems." It concluded that "the modest first-order rolloff rate would be most receptive to the addition of low-frequency equalization to the system concept. An appropriately applied electrical boost of 6dB would, for instance, lower the first-order rolloff frequency to 50Hz, with the slope taking hold at lower frequencies if the boost were to be sustained."

Since at low frequencies a substantial amount of driver excursion is used up in front-to-back cancellation rather than supplying useful output, the dipole system requires greater available excursion for a given output than most other common system types. Carver uses four extremely long-throw woofers to achieve high output.

According to Carver, the Amazing has a critically damped system Q of 0.5 which ensures that the quality of the low-frequency output is tight without a trace of resonance boom or semi-one-note bass.

First Listening Impressions

The Carver manual warns the new owner not to pay much attention to how the speakers sound right out of the box, at least not for the first 20 hours. This is impossible. Most people start to form opinions about their new acquisition within minutes after it is plugged in. One of the reasons offered in the manual is that the resonance frequency of the woofer and ribbon is initially too high, above the design parameter of the crossover, etc. After "exercising" or playing the speakers loudly for about three months the resonance of the woofer and ribbon will fall, and the speaker will sound as intended. According to Bob Carver the ribbon "ages" without being played, so time alone is required. However, like other dynamic bass drivers, the woofer needs the exercise.

The woofer resonance of the review pair after about one month was 28Hz. After three months it had fallen to 24Hz (see Figure 1). The ribbon took on a more wrinkled appearance. The sound, as promised, did improve.

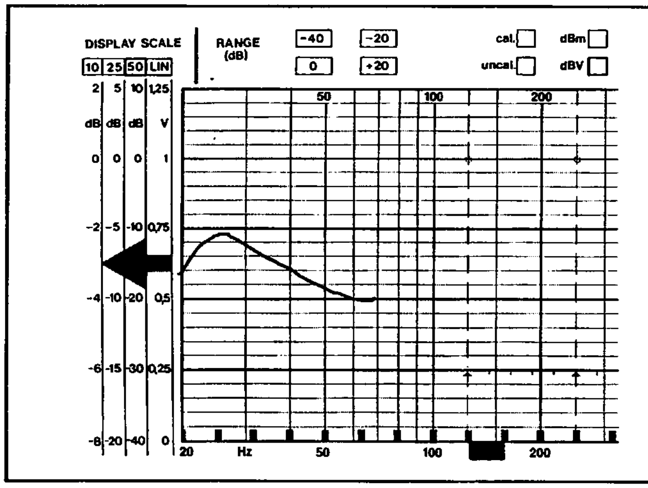

Figure 1: Woofer resonance of Carver loudspeaker

After listening for years to box speaker systems, I thought the Carvers sounded strange, borderding on the peculiar. The stereo sound stage was very large and instruments were wider than what I was accustomed to. The acoustic radiation from a large-area speaker like the Carver produces a sonic image that seems to float in air. It does not appear to come from a specific point of origin. The dipole radiators emit sound in a figure-eight pattern, equally from their front and rear surfaces. Very little sound goes to the sides, floor or ceiling. The rear radiation, however, bounces off the front wall before coming back to the listener. The resulting directional scattering and time delay of approximately 20 milliseconds in my room add additional airiness and a sense of depth to the sound. (In my room the front wall is 11'6" from the rear of the Carvers.) Like other true planar speakers, the sound intensity hardly changed at all throughout the listening room, even when I stood quite close to the speakers themselves.

After weeks of moving the speakers for the ideal placement, I began to take notice of the items which drew my attention to planar speakers and caused me to think them peculiar. One was the large increase in detail, clarity or what some call transparency. The sound was never congested. It was much better than I had heard before on my dynamic speakers. This took a while to get used to, and it launched me into trying to explain what could be the cause.

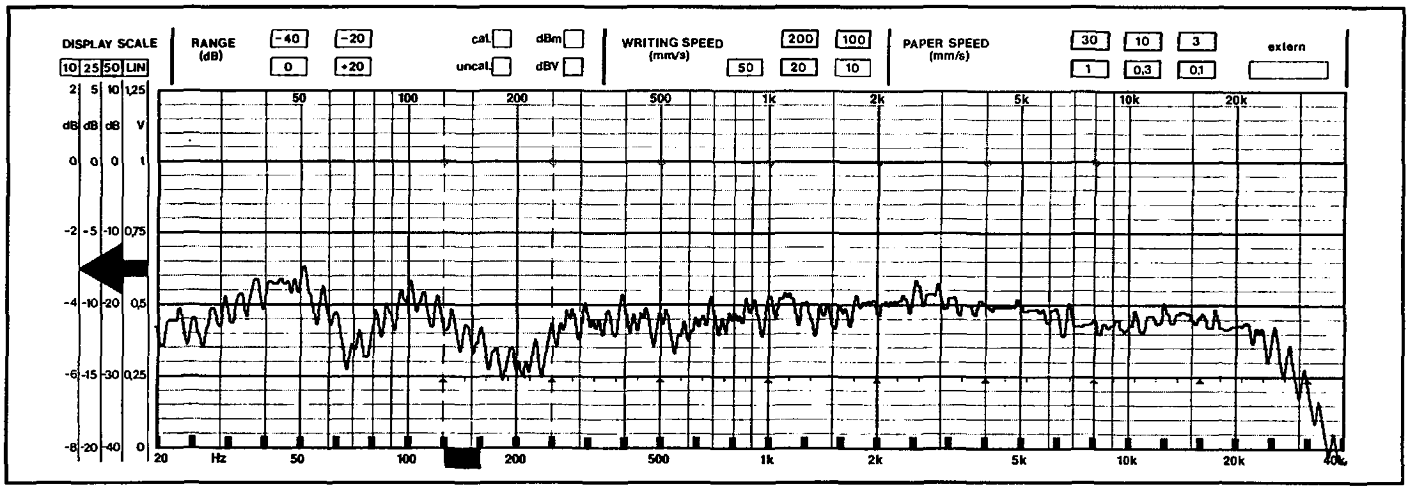

Figure 2: AR 98LS frequency response

Transparency, Clarity, and Detail—A New Test

The type of detail revealed by the Carvers is shared by other planar loudspeakers. Edward M. Long in his December 1989 *Audio* review of the Apogee Duetta Signature described it as having lots of "clarity, detail, and transparency."

The detail revealed by the Carvers, after breakin, is stunning. It is similar to what I have experienced with other planar speakers. The speaker I have admired most is the Sound Lab A1, a large full-range electrostatic, whose detail and transparency was unmatched until the Carvers.

By my use of such overused terms as clarity and transparency, the reader is left with a sense of not knowing what I am trying to describe. Not being content with just realizing the difference for myself, I had to find a way to measure or quantify what I was hearing. I figured that if the "right" test signal was applied the greater detail that I claim is present in the Carvers would be audible to a listening panel. The panel, without prompting, should be able to determine which speaker had it and which one did not.

Before I came up with the test, I tried desperately to get different listening panels to understand what I meant by the term transparency. Instead, most of the panels I assembled were distracted by the vast frequency-response differences between the dynamic speaker I used for the comparison (an AR 98LS) and the Carvers. The panels heard differences, and some attributed what I described as transparency to merely differences in frequency response. The test I am about to describe eliminated the confusion. My listening panels could no longer relegate all the differences I heard to a frequency-response phenomenon. It is appropriate to note at this point that the Carvers were kept in the position described in the "Setup" section (9 degree tilt, inside edge 9′4″ from the listening chair, etc.) in most of the comparison tests described below.

The Buzz Test—Carver vs AR

The first listening panel to hear my new test consisted of an experienced audiophile and a musician. The test signal consist of a 1kHz tone burst with 33 percent duty cycle (2 cycles on, 4 off). The (mono) signal was fed through an amplifier and into one of the Carvers. The second speaker chosen for this experiment was an AR 98LS. It is a very well-designed, wide-dispersion loudspeaker. The speaker appears in the 1985 *Stereo Review Buyer's Guide*, where it is described as a bookshelf or floor-standing 4-way acoustic-suspension speaker in a vertical array. It features a 12″ woofer, an 8″ lower-midrange driver in a sub-enclosure, a 1.5″ dome upper-midrange and 3/4″ dome tweeter. The last two are combined in a single-magnet structure/driver. The speakers measure 29.5″×15.5″×10″. They sold for $1,100 a pair.

The AR 98LS Speaker was chosen because the speaker sounds very good, and it stands among the best of the acoustic-suspension designs. Acoustic Research, during their Boston Audio Society presentation, was especially pleased with the combination upper-midrange/tweeter design. My measurements confirm that the speaker has a usable output to 30kHz. The speakers have extremely flat on-axis frequency response, one of the best that I have ever measured, +2/−1dB 250Hz to 22kHz (see Figure 2).

The purpose of the repetitive tone burst was to determine which speaker would reproduce the buzz over the widest possible on/off gate settings. The on/off gate rate, and to some extent the input frequency, was varied until the listening panel could no longer hear the buzz-like sound with either speaker, or until the tone burst sounded continuous. At the other extreme, the on/off gate rate was adjusted until the buzz was very obvious and audible.

Listeners were seated one at a time in my listening chair, about 10′ from the speakers, while the tone bursts were fed alternately into an AR or a Carver. The AR occupied the position between the Carvers (about midway between the side walls), on an 18″ stand. [As far as early reflections are concerned, being in such close proximity to the two large Carvers, the ARs are effectively "against a wall."—Ed] The contour switch, mounted on the rear of the AR, was set in the shelf position. (This position yielded the flattest response in my room.) The sound pressure level (SPL) was adjusted until the panel claimed the difference in level was no longer obvious. Adjusting the level was partially subjective because the sound of the tone burst was not identical with the two speakers. My spectrum analysis of the speakers' output confirmed their differences in reproducing the tone. The frequency response of the initially pure tone, after it passes through the tone-burst generator, looks more like a triangle or pyramid, with maximum energy centered at the frequency of the sine wave, and tapering off fairly linearly at both ends. An SPL meter was also used to verify and match the levels for some of the tests. It closely matched the panel's subjective level settings. The panel was also asked to move their heads around in an effort to minimize the effects of directivity differences. As an additional precaution, the tone controls on the Carver C-4000 preamp were set for maximum cut, including the 3dB trim control which adds additional bass deemphasis below 1kHz.

I hypothesized that the ability to detect or hear a repetitive tone burst over a speaker positioned in a typical listening room would correlate well with the subjective impression of a speaker's ability to transmit detail, clarity, and transparency. The tone burst, in some respects, resembles music. It is repetitive, contains harmonics, and, most important, can be varied all the way from a continuous tone to a "buzz" or "spike" sound. The latter contains extremely long intervals between pulses.

Results: The Carver was clearly superior to the AR at reproducing the buzz sound. It did not mask the buzzy quality of the test tones. The AR, whenever the repetition rate became too high, masks the buzzy quality of the test tone. The results remained consistent even when we moved our heads around at our listening chair or the bass and treble controls were reduced to a minimum via the preamp tone controls. Varying the input frequency from 500Hz to 5kHz and altering the on/off rate produced the same results; the Carver was superior.

I decided to examine the near-field response of both speakers. I placed a B & K microphone on a stand and as close as possible to each speaker. I then fed the output of the microphone preamp to the input of an oscilloscope. As suspected, the near-field response trace on the scope was better with the Carver—the output more closely resembled the input. I then decided to examine their far-field response at the listening chair. The quality of both tone bursts had deteriorated; however, the tone burst of the AR had become much worse.

Given the superior performance of the Carver in the near field, it was no surprise that it also looked better in the far field. The next experiment proved that a speaker could have a poor near-field response and still exhibit a superior far-field tone burst.

Horn Driver Results

I decided to compare the tone burst of a horn driver [a Motorola KSN 1025, 2"×6" piezo horn—Ed] to the AR in the near and far field at 5kHz. The higher frequency was used primarily because the lower limit of the horn is 2kHz. The piezo horn sat on top of the AR, the AR and Carver being set up as described above. In the near field, the AR produced a superior tone burst. The horn unit is very critical of microphone positioning, and at best yielded only a fair representation of a tone burst. However, in the far-field the results reversed; with both drivers, the quality of the tone burst, as portrayed on the scope, had deteriorated. However, the horn driver now produced a much better representation of the tone burst than AR's dome tweeter!

The horn driver was then compared with the Carver in the far field. Again, the Carver was superior. However, the microphone had to be aimed more precisely at the Carver during this comparison to produce a clear winner. The horn driver remained good only if the axes of the microphone and driver were exactly matched. The Carver required only that the microphone be aimed directly at the speaker before its performance in the far field clearly exceeded that of the horn driver. [Since the Carver is a line source, the microphone is effectively much closer to being "on axis" over a wider range of positions compared with the horn.—Ed] In the previous comparison with the AR there was no need to reposition the microphone. At almost any position the Carver's far-field response on the scope was superior to the ARs.

The results suggest that:

(1) room reflections play a significant role in the reproduction of impulsive sounds at the listening chair;

(2) the anechoic transient response of a good driver may be only marginally related to how it sounds in a real room; and

(3) the type of driver and the resulting dispersion pattern have a bearing on how much of the original sound reaches the listening chair.

My results, although requiring further tests, support what my ears were telling me for years, i.e., that large, planar drivers are better at delivering transients to the listening chair than typically-mounted dynamic drivers, and that horn-loaded drivers can also be very good.

Additional Support Findings

(1) Although the cause eluded me, I came to the conclusion years ago that the typical dynamic speaker failed to reproduce the "click" or "tick" sound of the early transient. I knew it was there because I heard it reproduced on the Sound Lab A1 and the corner-loaded Klipschorn. They were able to reproduce from a disc or record the pure, pristine sound of a metal instrument being struck. The cymbals on some dynamic drivers always sounded dull and nonmetallic, and the attack transients were missing. With triangles you could hear only the ring, not the energy of the two objects clashing. The sound is dull and two-dimensional; it has height

and width but no "darts" or "arrows" assaulting your ears.

Without the early attacks all metal instruments were denied believability to my ears. Increasing the treble tone control or the energy in the 12–16kHz area with a graphic equalizer sometimes helped, but neither could replace the clarity of a good planar driver or horn unit. The Carvers do an excellent job of reproducing the attack of the metal cymbal being struck. Listen to the sound of the cymbals in "Corner Pocket" on Sheffield Lab's *Creme de la Creme*, CD-CRM. On a good speaker the striking of the cymbals seemingly shoots darts into your ears. Another good example is the New Wave music of Michael Jones, *Seascapes*, Narada Music, ND-61004. The piano, when reproduced properly, has the sound of a taut wire being struck. The pluck or strike of the strings by the hammers can be clearly heard with the Carvers or Sound Lab A1.

(2) My experience with reducing the rear-wave, high-frequency energy of the Carver supports my theory that the early impulse sound is sometimes masked by listening-room reflections. The reflected, rear-wave sound of the Carver is very pleasant; however, I felt the high frequencies emitted from the rear interfered slightly with the reproduction of the attack sound on cymbals, etc. After owning the Carvers for only a month, two months before I came up with the test to measure room masking, I purchased some sound-absorbing material. I used it to reduce the high frequency, rear wave reflection of the Carvers. Edward Long, in his review of the Apogee Duetta, also concluded that rear absorptive panels increased their "precision and clarity."

The foam material I used is called "eggcrate." It is a mattress cushion or pad whose surface looks like an egg carton. The 1"-high egg-shaped ridges are designed to increase air circulation between your body and the mattress while you sleep. According to tests by a friend, it also is a good, cheap substitute for the much-better-known absorber, Sonex. I purchased two 60×80" pads, one for each speaker. I rolled the 2"-thick foam into a 12"-deep tube or roll, with string to keep it from unraveling. The 80"-high absorber was then centered behind the ribbon, held in place with staples and string. The foam was placed as close to the ribbon as possible without touching.

My absorption measurements were made by placing the microphone 12.5" directly in front of the ribbon to obtain a reference level. I then measured back behind the foam, and noted the difference in level. A sinewave generator supplied the tones: at 15kHz there is a 20dB reduction; at 10kHz it drops to 16dB; at 5kHz it is down to 12dB. As one might expect, at 100Hz and below, difference in level is not measurable. This reduction is enough to preserve the pristine attack of an instrument being struck or plucked while only slightly reducing the ambiance you get in spades with the bidirectional radiator.

How important is it to preserve the early-attack transients when, in the end, it is the frequency response and dispersion of the loudspeaker that count most? Unfortunately, if you don't have narrow dispersion you are missing half of what it takes to get good sound in the listening room. Audiophiles base their buying decisions on how something sounds and accept the given limitations of real-world speaker design; this is the best science can deliver. In my case I was not too pleased with the frequency response of the Amazing Mark II. It was not until I received the Mark III version that I became thoroughly satisfied with the speaker's frequency response. Like most audiophiles, I would have lived with the Carvers because I enjoyed the extra detail, etc.; however, the new crossover gave me almost everything I wanted. I contend that if you can have it all, why not ask for the preservation of the early-attack transients also? And by comparison the speakers are a bargain at $2,195.00 per pair. The new crossover brought true magic to the sound of the Carvers. The frequency response was now about right. The current version not only retains the feature I like most about large panel drivers—their dispersion—but rewards the listener with good power handling and a flat frequency response to boot: 63Hz to 16kHz +1/–2dB (see Figure 3).

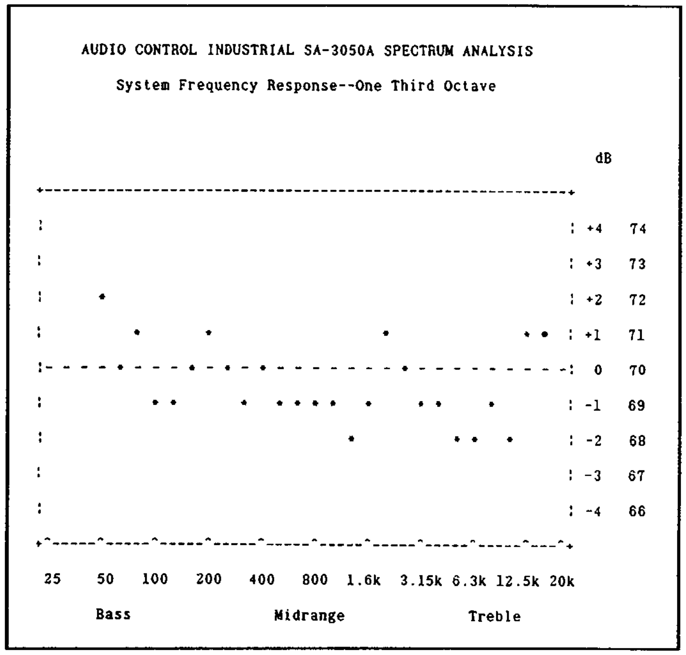

Figure 3: Frequency response of the Carver Amazing Loudspeaker Mark III

Perceived Soundstage

One of the first things I noticed with the Carvers was the width and height of the sound stage. It has a wide sound stage, just right for a large orchestra but perhaps too wide for a combo. However, I grew to appreciate the soundstage and decided it was just right for all orchestra sizes; one size fits all.

I hypothesized that the speaker's width and height greatly influence the resulting soundstage size—large speakers sound big, little ones sound small. I borrowed my son's Fried Betas to represent the small, mini speaker design. The Beta is manufactured by Irving Fried of Philadelphia. The 1985 *Stereo Review Buyers Guide* describes them as a "full-range speaker of mini-monitor proportions with polypropylene cones and linear crossovers." It features a 6.5" woofer, a composite tweeter with a 2" cone and a 5/8" dome, a phase-compensated, slow-slope crossover, and a pressure-release bass-loading free-flow filter system [bass reflex?—Ed]. It measures 13.5"×8"×8" and sells for $290/pr. The AR 98LS was again used to represent the large, wide dispersion, bookshelf-type speaker.

I connected the Carvers and the alternate pair of speakers to separate amplifiers. A make-before-break switch was used to switch the output of the preamplifier between the two amplifiers. As a further measure against prejudice and to increase the objectivity of our observations, I hung a sheet between the speakers and the listening chair, about 2' in front of the speakers, 6' from the listening chair. No one seated in the listening chair (except Superman) could see the speakers.

For the signal source I used mainly music and pink noise. With each source, I varied the preamp's tone controls, and sometimes introduced the Carver's ECC. Typically, I permitted the source to go through unaltered to the speakers. The tone controls etc. were occasionally inserted in the chain in an effort to get the speakers to have a similar tone/frequency response. Not surprisingly, I was unable to make any pair of speakers sound like another. The tone shifted whenever an alternate speaker was connected. The inability to make the speakers sound alike compromised my experiment.

The AR and Fried were placed about 1" in front of the Carvers, which remained in their optimal position throughout the tests. The AR and Fried were moved around them to determine if their soundstage varied with location.

Soundstage Height

The Fried speakers were placed on 18" stands, bringing them to a height of 31". The preamp fed both amplifiers a mono or stereo signal, either pink noise or music. The Fried speakers were moved to different locations in front of the Carvers and the A/B switch was used copiously. Most panel members indicated that the Fried's soundstage height was low. The Carver's soundstage was higher, and the AR's the highest. On the stands the AR's tops were 47" from the floor, yet it presented a higher soundstage than the 66"-high Carvers! The tests indicate that soundstage height of either the AR or Fried was determined, for most people, primarily by the location of the midrange and tweeter. However, the soundstage height of the Carvers would vary. It changed with the height of the seated listener. If the listener stood, the soundstage was higher. The output from the 66"-long ribbon had, otherwise, no effect on the height of the soundstage.

The height of the Carver's soundstage remains at ear level because of the Haas effect. The term Haas effect, or fusion zone, has been coined to describe the findings of Helmut Haas. He found that the ear seems to "clamp" onto the first arrival so persistently that the "echo" or delayed signal had to be 10dB louder before it could overpower the "clamping" effect. The timbre change, when one stands in front of the speaker, is most likely also the result of this distance. According to Sean Olive and F.E. Toole, in their article "The Detection of Reflections in Typical Rooms" (*AESJ*, July/August 1989), delayed sounds coming from the same lateral position tend to introduce a timbre change while delayed sounds from a different lateral position "are more likely to introduce left/right image shifts."

Because the top of the ribbon is angled away from the listener, about 10" with the recommended setup, a slight delay of 1ms is introduced. The delay probably accounts for my finding that increasing the tiltback angle of the Carvers increased one's perception of greater ambience. [Perhaps a likelier explanation is the change in room interaction—more ceiling bounce with the larger tilt angle, especially considering that Al has a very reflective ceiling.—Ed]

Soundstage Width

The stereo soundstage width of all the speakers varied directly with how far apart the speakers were spaced. If they were placed on the outside edge of the Carvers, their soundstage was wider. The converse is also true: if they were placed nearer to the center, their soundstage was narrower. [In my experiments with my Acoustats and my dynamic speakers, I noted that the soundstage tends to extend *beyond* the left and right edges of the Acoustats, but not with the dynamic speakers. I cannot explain why, especially since my room is nearly anechoic (all walls are covered with "eggcrate"!). This is true even when I used the "left," "right" voice identification on test CDs.—Ed]

Localization cues above 7kHz are important to the ears for lateral and height information/feedback. All three speakers seemed to be able to present wide soundstages.

Summary: Soundstage width is more a function of separation between the two speakers, and not the type of speaker. With regard to soundstage height, point-source speakers have the soundstage at the level of the tweeter, irrespective of the listener's position, while in the case of the Carvers, soundstage height moves up and down with the listener.

Width of Mono Image/ Solo Instruments

Attempts to determine which pair of speakers have the narrowest mono image produced mixed results. The Carvers and the ARs are equally good, while the Fried more often came in second place. [I subsequently went to Al's place and noted that mono imaging was not particularly good, and suggested that more toe-in is necessary. After this, the mono image on the Carvers is among the best I have heard.—Ed]

The mono-imaging difference, if any, between the AR and Carver could not be determined because of the following setup limitations:

(1) The frequency-response difference clouded the results;

(2) My listening room did not permit enough space between two pairs of large loudspeakers; and

(3) I couldn't eliminate the amplitude difference between the drivers.

Sometimes the panel selected a winner only because it was louder. Too often when the input level to the chosen speaker was balanced better, the results changed.

To my ears the Carvers deliver the most narrow mono, as they should with relatively little vertical output (ceiling or floor bounce) and a narrow horizontal dispersion (little sidewall bounce).

Speaker Matching Test

To obtain a good narrow mono image, it is also necessary that the left and right speakers have good phase and frequency-response matching.

A test to measure the matching of the two speakers was once used by Peter Walker to demonstrate an attribute of the then-new Quad 63 Electrostatic Loudspeakers. The demonstration took place in a large hotel room at a Chicago CES. He fed pulses to a pair of Quads, then reversed the input plug on one speaker so one speaker was 180 degrees out of phase with the other. With a microphone connected to an oscilloscope, he found a null position in the exact center of the two speakers which caused the pulse to disappear from the scope.

The null generated between the speakers attests to their close matching. To pass the test both speakers must have nearly identical phase and frequency responses.

For the test to be fair to wide-dispersion loudspeakers, it should be conducted in an anechoic chamber to eliminate room reflections. Lacking such facilities, I decided to see how the Carver and AR would perform in my listening room, with the knowledge that the results may not be conclusive.

Results: The Carvers produced a clear null, with no visible spike once the null position was found. The AR was able to produce a spike about one half its original size. Perhaps in an anechoic chamber the ARs would have performed as well as the Carvers.

The Box and the Echo Sound

I have combined the box and echo sound because I believe they both describe the same fault of some boxed dynamic speakers. The human voice is the most obvious victim of the box sound. There are many causes of voice colorations. I will concentrate on colorations resulting from modal problems in the speaker's box. I am suggesting that some box speakers supply colorations in the form of unnatural and monotonously repeated overemphasis of certain frequencies in the voice spectrum. Prominent isolated modes are frequently the cause of such colorations.

For a male voice, the frequencies which color the voice most in a room are found between 100 and 175Hz, and for a female voice 200 to 300Hz. C.L.S. Gilford's article in IEEE Vol 106 (reprinted in the *New Audio Cyclopedia*) entitled "The Acoustic Design of Talks Studios and Listening Rooms" says, "Colorations disappear above 300Hz because of the greater modal density."

What Is the Box Sound?

My own listening room has been occupied almost totally by dynamic speakers. My last speaker, the AR 9, dominated my listening room for almost nine years. During that time I never heard, nor understood, the comments from of non-box-speaker owners. Owners of the Quad, KLH 9, etc., tried at various times to acquaint or introduce me to the virtues of a boxless speaker. I couldn't hear the effects they talked about, and I maintained then that if their comments were true, why can't the effect they're describing be measured?

The Carvers taught me that the difference is subtle, and it can be measured. Not all box speakers have the problem, and its importance varies with the listener. For my ears it is not as important as a good frequency response nor would I sacrifice good bass or realistic playback levels to get it. However, this is the price that some boxless owners have had to pay. The Carvers have changed all that. You can get excellent bass, ear-shattering playback levels and the absence of box sound in one package.

The voice of Tracy Chapman (*Tracy Chapman*, Elektra CD 960774-2) is deep enough to excite box colorations. However, Sade's voice on *Diamond Life* (Portrait Records CD RK 39581) is too high to expose box sound. Male singers and announcers will elicit low frequency colorations as well.

What I'm talking about sounds like a low-Q resonance; it rings at frequencies significantly different from the one that initiated the response, thus imparting a monotonic coloration to a range of exciting frequencies. It makes the voice sound deeper, tubby, more resonant and congested. It also introduces an echo or "megaphone" type sound into the voice. Some have described it as a bottom-of-the-barrel sound. It makes the singer sound farther away, not in the same room as the rest of the orchestra. It is independent of volume or loudness. It is most aggravating at moderate listening levels, less offensive at higher playback levels. In a conversation with Roy Allison he agreed with my description of how it may sound. He added, "An easy way to notice it is to listen to double basses or cellos. The sound will disappear in some ranges."

The Search For The Cause

To find the colorations or excessively vibrating modes in rooms, the *New Audio Cyclopedia* suggests using the BBC approach—amplify only a narrow band of frequencies, and move the peak through the desired portion of the audible spectrum. in this way, marginal colorations can be made to stand out dramatically.

Ideally, to apply this technique to speakers, the driver output should be completely isolated from the enclosure output. For a normal boxed configuration with drivers mounted on the front baffle, this means mounting the box in a concrete wall, with the back and sides on one side of the wall, and the front on the other. A spectrum analyzer or an accelerometer should then be used to look at the output of the back and sides, without the contribution of the front. Even this ideal technique does not get at all the potential coloration-producing modes—it ignores the contribution of the speaker's front panel, which can be the worst offender because all the drivers are typically mounted directly on it.

Testing Box Colorations

I tried two ways of determining the extent of box colorations: measurement of the acoustic output of the back and sides of the enclosure, and a spectrum analysis of the speaker output. If there are significant low-Q modes, the spectrum analysis should consistently pick up energy at these frequencies when the speaker is fed a wide range of frequencies.

Measuring Back and Side Output—A New Test

Lacking the ability to build two totally isolated rooms, I chose an easier, simpler approach. I decided to place the AR and Fried loudspeakers face down on my hide-a-bed sofa. The sofa has 5″-thick foam pillows on top of a foam mattress. The folded mattress, beneath the pillows, is at least 15″ thick with lots of air space.

I used my spectrum analyzer to measure each speaker's frequency response and sound pressure level (SPL) when it was firing directly into the calibrated microphone. I then flipped the speaker onto its face permitting it to aim directly into the sofa bed. The frequency response was again measured along with the SPL. The location of the microphone, one meter on axis, did not change relative to the speaker's front or back.

Generally, the reliability or repeatability of the test is poor. Each time I conducted the test I obtained different results. The isolation was inadequate between the front-firing speakers and my rear-speaker measurement. Small movements of the inverted speaker produced widely different results. Nevertheless, the results are worth reporting.

To my surprise, the SPL was not reduced by much. The back side of the AR was down by only 12dB. The frequency response had lots of energy in the voice-sensitive coloration area of 100 to 300Hz. The largest peak was at 80Hz; the next highest was 315Hz.

I then decided to feel around on the box in an effort to detect any modes of excessive vibration. There were plenty, especially around the input terminal lugs. The vibration was concentrated most around the lower part of the box, nearest the woofer, and at the top panel of the box, which vibrated as much as the bottom section.

The Fried loudspeaker's SPL dropped by 28dB when the rear radiating surfaces was measured by the microphone. The area vibrating most was the 4″-square area which corresponds to the rear of the woofer and the input terminal lugs. Moving my hand around the surface of the cabinet did not reveal as many vibrating sections as the AR, most likely due to the fact that the Fried has only a 6.5″ woofer. The Fried had two vibration peaks, at 315 and 160Hz.

Spectrum Analysis Approach

My next attempt to uncover the roots of box colorations took place on my test bench. I fed frequencies from 50 to 500Hz alternately into one Fried or one AR loudspeaker. The B & K microphone was connected to the wave analyzer, which was set to detect output in the 100 to 300Hz band. Tests were carried out at two SPLs, 85 and 95dB. At no time with either the AR or Fried were unrelated vibration modes found at levels above –40dB.

These results are more repeatable than the first. Until I can have a concrete wall to totally separate the front from the back and sides, the second test will have to do. Some root causes of the box sound may actually have been exposed by my tests, but the results will have to wait for better controls or until the variable being tested can be better isolated.

Summary: Vibration modes in the critical frequency bands are below –40dB. It is doubtful that vibration modes below –40dB account for my listening observations. Vibrating box panels may be undesirable, but unless the panels "speak" almost as loudly as the drivers or generate unrelated harmonics their contribution to the box sound can be ignored.

The "Wall Dip"

After conducting the distortion and the vibration tests for box colorations, it occurred to me that Roy Allison, of Allison Acoustics, did his pioneering work in the mid-'70s on the influence of room boundaries on loudspeaker power output. His summary said, "It has been shown that the low-frequency power output of contemporary loudspeaker systems, when they are used in real rooms, is affected adversely and significantly by reflected impedance from the boundaries."

For years I have kept his room/speaker interference charts on my wall. They plainly illustrate that the dip or suckout that I had observed around 200Hz in my measurement of the AR (see Figure 2) was due to the path-length difference between the direct sound and the floor reflection. The distance from the woofer to the floor and then back to the woofer totaled 36″. This distance corresponds to a half-wavelength of 188Hz. As a result the output of the AR dipped by about 4dB precisely at 188Hz, just as Allison predicted.

The ARs have a switch on the rear of the speaker. In the "floor" position, it reduces the bass output, thus allowing the AR to be floor-mounted without sounding bass-heavy. On the floor, with the switch in the "floor" position, the box sound diminished enough to support my conclusion that it was primarily an artifact of speaker placement and room boundaries. To verify my results I used my 1/3-octave equalizer to introduce a 200Hz dip into the output of the Carvers. The echo or bottom-of-the-barrel portion of the box sound, which I had associated exclusively with box speakers, was now being accurately reproduced by the Carvers! Multiple echoes now surround the voice, pushing it from front stage.

The tubby sound was still present in the ARs. However, I found that if I stood up, while the speakers were on the floor, it got worse. If I moved my head closer to the floor, beneath my normal seating position, the tubby sound was reduced! The tonal or timbre change is a clear artifact of floor reflections; it changed as a result of my head's distance to the floor.

Repeating the experiment with the Carvers produced similar results with one major exception: The timbre change was much less noticeable, indicating that the vertical dispersion pattern of the Carvers created much less floor bounce, permitting a greater vertical listening window and no tubby sound.

Results: The reproduced voice is very sensitive to colorations. The frequency band between 100 and 300Hz must be carefully handled to avoid tampering with nature's most musical instrument. Too many box speakers give the end user the opportunity to introduce colorations in that range. Judicious placement [i.e., staggered distances to the three nearest boundaries—DRM] of most speakers will avoid the suckout that Allison's research revealed. The megaphone sound can be avoided. Singers do not have to sound as if they are singing inside of a barrel. Tubby, congested sound is more difficult to deal with, given the typical dispersion pattern of most dynamic loudspeakers.

Direct-Sound Theory and Transients

A research paper from Finland by Salmi and Wickström discusses at great length the problem of the floor bounce and speakers that are designed primarily to be flat in an anechoic chamber. The authors suggest that too many speaker designers use a "Direct Sound Theory" approach to design. Proponents of this theory subscribe to the precedence effect, which says that sounds from a different direction following the first (direct) sound give the impression that the sound came from the direction of the first one. Direct Sound Theory advocates believe "that the ear has a kind of weighting filter with respect to time, which attenuates all information that arrives after the first signal arrival. This is however not true." If music signals are examined under short time intervals (1–2ms, the typical delay of the floor reflection), floor reflections constantly alter the direct sound. The reflected signals from the floor are very different in character than the direct signal. In general the higher frequency components in the spectrum suffer greater attenuation at each reflection than do the lower frequencies components but this is not inevitable. When the reflection reaches the listener it will imprint its own character.

Salmi and Wickström continue, "Another problem with the 'Direct Sound Theory' is that the importance of the first signal arrival uncovered by Haas had only to do with sound source localization and tells us nothing about whether reflected signals alter the audible frequency response or not.

"To summarize, we conclude that early reflections color the sound because the resulting frequency response will be uneven regardless of the spectrum of the reflected signal. Late reflections (in the order of 10ms or more) mainly add to the acoustic intensity at the listeners ears, and therefore only introduce coloration when their spectrums are distorted compared to the direct sound."

David Moran summed it up nicely in the *Speaker*, vol. 17 no. 6. If the ear is captured by the initial arrival of sound (according to the precedence effect), the effect must be a continuum. "Otherwise we would have none of this floaty, broad-stage imaging at all; everything would come from its earliest-arrival source, the speaker." Wall surfaces would not alter the imaging. "With a given speaker pair, a tile room would deliver the same sound stage and localization as an anechoic chamber."

Salmi and Wickström joined a host of audio researchers who point out that early reflections modify the sound reaching the listener. James Kates, (formally with Acoustic Research) writing in *AESJ* ("Loudspeaker Cabinet Reflections Effects," May 1979) describes how covering the front of a loudspeaker cabinet with a layer of sound-absorptive material will suppress potentially audible reflections from the cabinet edges.

The Ideal Loudspeaker Radiation Pattern

What is the ideal radiation pattern? To answer this question, I first turned to another paper by Kates, "Optimum Loudspeaker Directional Patterns" (*AESJ*, Nov. 1980). He defines what the human auditory system requires for optimum localization and clarity. He maintains that low frequencies are localized by comparing the phases of the signals at the two ears, and high frequencies by comparing their intensities. The results of our ear's analysis, he maintains, dictate that loudspeakers should be more directional than conventional design practice. He adds that the listener-to-speaker distance should be 1.5 to 2 times the separation between the speakers for good localization.

"Combined with the increase in directionality is a requirement that the loudspeakers be angled in toward the listening area so that the respective maxima of the directional patterns are aimed at the diametrically opposite ends of the listener locus. An ideal spherical source has traditionally been the goal of many loudspeaker designers. We have shown, however, that a consideration of auditory perception leads to a different design goal. Loudspeakers that are directional over a wide frequency range are required to give the best localization performance."

Benjamin Bauer, several years ago, also realized that localization could be improved by using a loudspeaker having a controlled directional pattern and by angling the loudspeakers in toward the listening area. He proposed a dipole as a workable solution.

According to Daniel Queen ("The Effect of Loudspeaker Radiation Patterns on Stereo Imaging and Clarity," *AESJ*, May 1979), increasing a speaker's directionality increases clarity at the listening chair. "It can be shown that the broadband virtual image created by a 2-channel sound reproduction system is highly dependent for its clarity on the directional characteristics of the loudspeaker."

James Moir, writing in the October 1979 issue of *Wireless World*, states that, "One distortion, using the word in its widest sense, that has not received its due share of attention is the effect on sound quality of the variation in the speaker polar diagram with frequency."

A typical single-cone loudspeaker in a box will radiate in all directions at low audio frequencies. As the frequency is increased, the angle of radiation decreases, becoming more "beamy" (i.e., there is less off-axis output). Moir stated that "At first thought it would appear that the reduction in the off-axis output at high frequencies would be of little consequence to a listener seated on the axis, but experience shows that the effects on the sound quality are indeed obvious to a moderately experienced listener. A loudspeaker having a good (flat) axial frequency response but a poor off-axis response sounds 'hard and tiring' to a listener seated on the axis, while the stereo image tends to jump about with changes in the spectral content of the program." The effect of the polar sound distribution is rarely discussed in audiophile literature other "than a comment that cymbals sound better when you sit in front of the speaker."

In a recent discussion I had with Roy Allison, he pointed out that dipoles have extremely narrow vertical dispersion from the midrange up. Dynamic speakers are nondirectional at low frequencies, and directional at some higher frequencies. To prevent excess brightness on axis, you have to let the power response at the upper end of the woofer fall. The power response falls off even though the on-axis remains flat. Moran says that he can hear such changes, calling the result in the midrange a "honk" type of sound.

According to Moir, "The sound field in a room does not become increasingly diffuse with the passage of time as is generally thought, but instead becomes increasingly ordered, with the sound energy concentrated in well defined spatial patterns even at the lower frequencies. The primary components of the reverberant sound energy are concentrated along the three axes of the room in the frequency bands for which the room length, width, and height are one half wavelength and at the harmonics of these frequencies. Thus reverberation is not the decay of a diffuse sound field but the decay of a well defined pattern of sound distribution over the whole of the room volume. The sound field becomes less diffuse and more ordered as the decay proceeds, with the sound energy concentrated in the narrow frequency bands that constitute the modes of oscillation characteristic of the room."

A loudspeaker with wide dispersion will potentially excite all room modes. The spectrum of the reverberant sound energy will then be shaped by the room's size and shape. A narrow-dispersion speaker, on the other hand, sends much less energy towards the walls, floor and ceiling, greatly reducing the effects of room acoustics. Hence the sound of a narrow-dispersion speaker will be very different from that of a wide-dispersion speaker, even when both speakers have flat on-axis response. "Dipole radiators such as the electrostatic speaker or a cone type loudspeaker in a flat baffle will sound rather dry in some rooms, particularly those with a short reverberation time. A dipole radiator has no radiation in the plane of the diaphragm and thus provides the minimum excitation of the height and width room modes," says Moir.

Daniel Queen states that the typical wide-dispersion loudspeaker permits only about 14% of the direct energy to reach the listener. Removing the bounce from the ceiling and floor effectively eliminates most of the offending early reflections which tend to color the sound. Queen's own loudspeaker had a restricted vertical dispersion and a uniform horizontal dispersion.

Summary: All of the articles I was able to find, only a few of which I mention here, indicate that for optimum imaging a speaker should have a dispersion pattern which is more directional than the typical wide-dispersion type. A controlled-dispersion loudspeaker offers the listener greater clarity and better localization by minimizing potentially coloring room reflections.

Dipole radiators like the Carver offer the listener a better "window" into the recording, and they sound more like good electrostatic headphones. These effects coincide with the findings of my tone-burst tests, i.e., that speakers which excite the fewest room reflections are more likely to deliver to the listener all the information present in the recording.

Boosting the high-frequency energy above 8kHz only marginally enhances the clarity of the dynamic loudspeaker. Listen to the Soul II Soul recording, *Keep On Moving* (Virgin Records CD 791267-2). The recording has a cymbal with lots of energy in the 12kHz area. Boosting the high-frequency output of the dynamic speaker in an attempt to "match" the presence of the line source is only partially successful. The cymbal becomes more forward, similar to the line source; however, the character is now unnatural and harsh.

On voice, the line source sounds, in general, more forward. The lack of high-frequency detail of the dynamic driver overemphasizes the midrange and lower midrange frequencies. It is the high frequencies which permit you to identify which instrument is being played.

Less high-frequency information reduces clarity. Increasing the emphasis on the midrange reduces the transparency of the voice. As a result, on large orchestral recordings, the dynamic loudspeaker sounds as if the orchestra has fewer instruments and less detail.

Attempts to overcome the high-frequency rolloff caused by room absorption were only partially successful because of the added harshness and coloration.

There is a need to expand the definition of a good loudspeaker. The new definition would include a rating for room interaction. The best speakers would have the quality or nature of their output altered least by the room. If a rating for room interaction is included, wide-dispersion loudspeakers would not fare well.

Dynamic Speakers Shout At You

All the listening-panel members stated that the Carvers, when played at high listening levels, did not sound as loud as the ARs. The ARs sounded louder even though the levels were matched, as if they were "shouting," a very unpleasant effect. I decided to examine their comments even though I had no clue as to why the ARs elicited this reaction from the panels. Both the ARs and the Carvers are designed to handle high playback levels.

Setup For Shouting Test

A Technics model SH-8065 1/3-octave equalizer (with thirty-three bands from 16Hz to 25kHz) was used to minimize frequency-response differences between the two speakers under test. The output from the right channel of the amplifier fed a Carver while the left-channel output fed an AR. The AR was placed on the floor. The level controls on the amplifier were used to compensate for the difference in speaker sensitivity. The microphone of my Audio Control SA-3050A, a one-third-octave real-time analyzer, was positioned at the listening chair.

I asked each listener to:

(1) make both speakers sound alike utilizing the graphic equalizer and, if desired, the real-time analyzer, and

(2) adjust the level controls on the amplifier so that both speakers were playing back at the same level, first with pink noise, and then with music.

A curtain was hung between the panel members and the speakers to make this a single-blind test.

Results: All the panel members were frustrated in their attempt to make the two speakers sound the same. Nor could they get the frequency response to match. This finding is no surprise. Dr. Mark Davis and I found that speakers with different dispersion patterns cannot be made to sound alike unless their polar patterns are matched.

To make the job easier, the bass controls on the preamplifier were set at minimum. This was necessary because the Carver had a lot more deep bass, and it sounded different. It lacked the coloration of the floor-bounce reflection (no tubby sound). After the panel members adjusted the speakers for the same loudness using pink noise only, I examined their results with pink noise and the SPL meter. With the pink noise operating exclusively as the signal source, the Carver was louder by 3 to 5dB—only a fair match. However, when music was used to balance the levels, the panel members were able to match the two speakers to within 1dB of each other. In one case the match was perfect. The difference or match was verified by the SPL meter on pink noise. The music source used to equalize the SPL output of the two speakers was Michael Jackson's *Bad* (Epic EK 40400). I chose this recording because it has lots of vocal parts, and the music remains relatively constant in level.

The volume of both speakers was raised to an average of 95dB SPL at the listening position. The listening panels all agreed that the AR sounded louder than the Carver: it seemed to be shouting.

I then examined, with an oscilloscope, the peak voltage being fed to each speaker at the average playback level of 95dB. The AR has a sensitivity of about 88dB (2.83V, 1m) and an impedance of about 4 ohms. The peak voltage at the amplifier measured between 65 and 75 volts. We had been delivering over 500 watts into the AR, and it was being asked to deliver peak SPLs over 115dB. These figures indicate that what the panels described as shouting may have been the sound of stress; the ARs were driven into their nonlinear range. The Carver, on the other hand, just sounded louder. Even at this level, it remained linear.

Sinewave Distortion Tests

The results in Table 1 indicate that the distortion among the speakers at the *average* SPL in the above tests was too low to have contributed to the observed differences. All three speakers measured very well. The Carver was better at all frequencies and levels particularly in the range of the ribbon. The grill cloth vibrated loudly below 100Hz, contributing to the measured distortion. All measurements were made with the microphone one meter from the center of the loudspeaker. The sound-pressure level was set utilizing the SPL feature of the Audio Control. Attempts to measure the speakers at the listening chair were abandon because of the extreme levels required. Measuring at the listening chair would have forced the dynamic units to play about 3–4dB louder (up to a point) because their SPL drops off about twice as fast with distance as the planar speaker.

Salmi and Wickström also conclude that loudspeaker distortion at typical playback levels is not a factor in judging sound quality with modern loudspeakers. They conducted an "Absolute Listening Test," in which a loudspeaker and microphone are inserted in the sound reproducing chain via a switch and can therefore be compared with an absolute reference, a straight wire. (The microphone and speaker were in an anechoic chamber.) "Because all traditional loudspeaker imperfections like harmonic distortion, intermodulation distortion, phase distortion and delayed resonances also are heard by the microphone, their effect upon sound quality should be easy to detect in an absolute listening test.

The fact that the sum effect of these distortions does not significantly color the sound just means that the drivers of today are good enough in converting electrical signals into sound (i.e., good enough from the ear's point of view)."

SPL	Frequency	2nd Harmonic	3rd Harmonic	Comments
Amazing Loudspeaker, Platinum Edition				
95dB	100Hz	53dB	–43dB	Ribbon Only
102	100	UM	–41dB	Ribbon Only
95	30	–35dB	–34dB	
100	1kHz	–63dB	–73dB	
100	100Hz	–48dB	–52dB	
100	50	–44dB	–52dB	
100	30	–35dB	–31dB	
102	100	–45dB	–51dB	
103	50	–41dB	–49dB	
104	100	–44dB	–50dB	
AR 98LS Loudspeaker				
100dB	100Hz	–39dB	–44dB	
100	1kHz	–37dB	–39dB	
103	50Hz	–35dB	–47dB	
Fried Beta Loudspeaker				
85dB	1kHz	–57dB	–63dB	
85	100Hz	–49dB	–45dB	
85	500Hz	–58dB	–54dB	
85	5kHz	–65dB	UM	

UM—below the resolution of the equipment.

Table 1: Distortion Measurements

Although I did not perform a bypass test for the loudspeakers, the low distortion results for all of the speakers reported in Table 1 indicate that they generally put out what is fed to them. At playback levels where "shouting" is not an issue, distortion is not a factor in determining sound quality.

Floyd E. Toole has done extensive research into the audibility of nonlinear distortion and has conducted many tests in this area. His paper, "Loudspeaker Measurements and Their Relationship to Listener Preferences: Part 1," outlines the results of several researchers: "Bose concluded that with most high-fidelity loudspeakers audible nonlinear distortion in music or speech is definitely one of the more minor of their shortcomings." Kantrowitz arrived at a fairly generous 3% as the level of CCIF (intermodulation) distortion above which it became objectionable in high-frequency drivers. The more recent work of Fryer indicated similarly large values for the detection of intermodulation distortion. Noting that typical speakers at typical listening levels produce less than 1% intermodulation distortion, he concluded that "it is not a particularly serious issue for designers."

Summary: The Carvers can play at average levels of 95dB (well above typical listening levels) on music with 15 to 20dB peaks without audible nonlinear distortion. When utilizing a third-octave equalizer, attempts to make a dynamic speaker sound like a dipole line source proved futile. If the bass from the music is reduced, a trained listener can match the SPL outputs of the two speakers within 1dB even though their sound character and dispersion pattern are different. With pink noise as the source, trained listeners can come only within 3 to 5dB of a correct match.

Conclusion

The Carver Amazing Loudspeaker, Platinum Edition Mark III, is my loudspeaker of choice. It can play loudly without strain and the clarity and transparency are unmatched by most commercially available speakers. It is one of the few speakers I know that do not need a subwoofer.

Why do the Carvers sound so great? It is not because of lower distortion, excellent mono imaging, better linearity, or the ability to play loudly without strain; instead, it is because they have:

(1) a dispersion or polar pattern which comes closest to fulfilling the auditory requirements of both the ear and the listening room; and

(2) an incredibly flat frequency response.

What you get with the Carvers is not only the best sounding and least-colored bass I have ever heard, but a clarity and stereo localization matched by only a few speakers. The clarity produced by dipoles puts them in a class by themselves, and among the dipoles, the Carvers excel in what for most speakers of this kind are problem areas: bass output, high playback levels, and long-term durability.

When the recording and Sonic Holography "fit" or match up, nothing in my experience can duplicate the realism that results. I have heard excellent surround-sound processors. They work well, perhaps with a wider range of recordings; however, at their best they are not the equal of Sonic Holography. Listen to the you-are-there feeling of *Sweet Honey In The Rock Live At Carnegie Hall* (Flying Fish CD FF70106), or "Colonel Bogey" on *Grand March* (London, CD 417 329-2). A new Dorian harp recording (*The Enchanted Isles*, Carol Thompson, harps, DOR-90120) is almost unlistenable unless holography is used. The harp is buried in reverberation; the holography seemingly removes the reverb and permits the clean sound of the harp to dominate.

The low distortion of high-quality speakers of today is good enough at regular playback levels. However, directive speakers deliver a better stereo stage. They also deliver, because the amplitude of the reflections is reduced, more of what is on the record. Initially, the clarity, transparency and the impressive sound stage you get with the Carvers may be disarming. After a few weeks you wonder how you were able to live without these virtues.

The Carver's ribbon transducers are an elegant route to low distortion, boxless sound, and an ideal dispersion pattern. Together, the ribbon transducers and the four woofers deliver a wide soundstage, superb bass response, and a overall musicality that must be heard to be believed. You also get a speaker with flat frequency response, and the good looks are thrown in at no extra cost. [In piano black, I think it's one of the most beautiful speakers in the world.—Ed]

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