SYNERGETIC AUDIO CONCEPTS

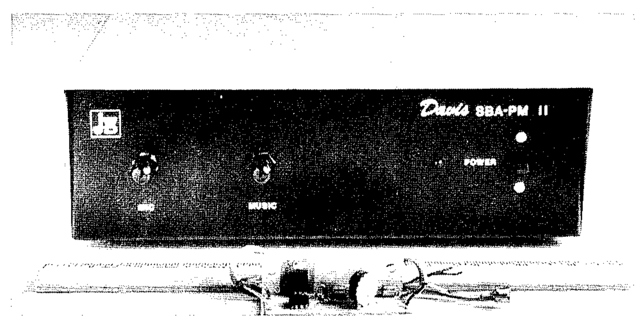
SYN AUD CON

newsletter

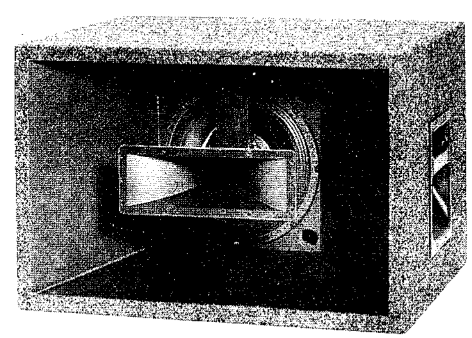
Volume 17, Number 2
Winter, 1990

J. W. Davis & Company

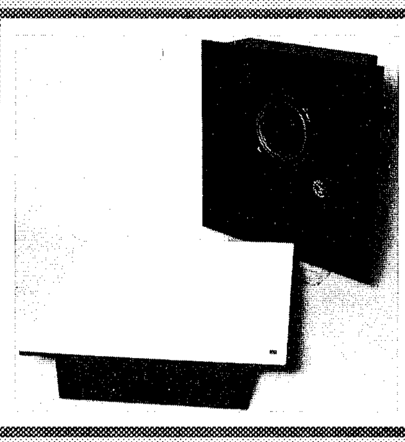
Bessel Array



SBA



Pataxial 70



Ceiling Speaker

SYNERGETIC SYN AUD CON AUDIO CONCEPTS

EXCHANGE OF IDEAS

I met a man with a dollar
We exchanged dollars
I still had a dollar

I met a man with an idea
We exchanged ideas
Now we each had two ideas

Synergetic: Working together; co-operating, co-operative.

Synergism: Co-operative action of discrete agencies such that the total effect is greater than the sum of the two effects taken independently.

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Carolyn Davis

Design & Layout: Dashia Alfonso

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J. W. Davis & Co.

Our long standing friendship with Harvey and Jo Earp of Dallas, TX, owners of J. W. Davis & Co., is one that we treasure. Texas, its history, its people, its legends, and its beauty have had a life long interest for us.

Texas often suffers from the caricature that non-Texans love to put forth. They lose contact with the real article which personifies the true meaning of the words "gentleman, good as his word, he'll do to ride the river with," and a host of other sayings that describe hard working, intellectually honest, loyal-to-the-fault men and women of extraordinary grace, hospitality and virtue.

What does all this have to do with the audio company, J. W. Davis? It is our firm belief that companies reflect the philosophy of those in charge. Let me say that when the kind of Texans I'm talking about have a company—he or she is in charge. J. W. Davis sells a very broad range of products as a distributor and as an original manufacturer. Because of their early recognition of the abilities of Dick Heyser, Dr. Patronis, and other innovators of the highest order, you will find the Pataxial, Bessel Array, SBA system, and a cleverly engineered ceiling speaker shown on the front cover (a truly wide angle, wide range ceiling system) in their product catalog.

We have stated repeatedly in this forum that "first rate men hire first rate men -- second rate men hire third rate men." Chuck Griffith and Jack Tucker are full proof of Harvey and Jo's first rate standing.

When Syn-Aud-Con accepts a sponsor it is with the belief that they are men and women with whom we want to be associated. We have worked with J. W. Davis since 1979. We are pleased to realize that they to want to be associated with us. Lots of Synergy comes out of that kind of mental environment.

The Year of the Bessel Array

The Bessel array has been shown by Syn-Aud-Con since 1983. The N. V. Philips people had been kind enough to allow us to use the concept experimentally after they had shown it at the AES meeting in Eindhoven, the Netherlands. I feel sure that in a few years, when we make a list of products and concepts that Syn-Aud-Con helped promote and made the audio public aware of, the Bessel Array will take it's place along side LEDE, Signal Alignment, TEF, PZM, to name a few accomplishments.

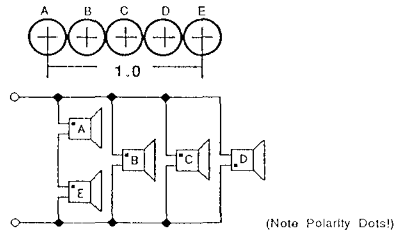
Don Keele presented an exhaustive computer study of Bessel arrays at the last AES meeting in New York. The paper entitled, "Effective Performance of Bessel Arrays", is 61 pages. Don Keele makes the statement,

TABLE 8. COMPARISON OF ARRAY TYPES

ARRAY TYPE =	Single Source	2 Sources Equal Level (L=0.25)	2 Sources Equal Level (L=1.0)	5 Sources Equal Level & Spacing	5 Source Bessel	7(6) Source Bessel	9(7) Source Bessel
Configuration (to scale) =	o	oo	o o	ooooo	ooooo	ooo ooo	ooo o ooo
Number Units =	1	2	2	5	5	6	7
Overall Length (c-c) =	0	0.25	1.0	1.0	1.0	1.5	2.0
Impedance =	1.000	0.500	0.500	0.200	0.286	0.222	0.182
Voltage Sensitivity =	1	2	2	5	2	2	2
Efficiency =	1.000	2.000	2.000	5.000	1.143	0.889	0.727
Maximum Input Power =	1.0	2.0	2.0	5.0	3.5	4.5	5.5
Max. Output Power =	1.0	4.0	4.0	25.0	4.0	4.0	4.0
Maximum Sound Pressure Level =	1.0 (0 dB)	2.0 (+6 dB)	2.0 (+6 dB)	5.0 (+14 dB)	2.0 (+6 dB)	2.0 (+6 dB)	2.0 (+6 dB)
Maximum Upper Frequency = (Distance = 20, P-P Ripple = 4 dB)	Infinity	1.10	0.28	0.40	11.00	5.55	1.30
Efficiency-Bandwidth Product = (Distance = 20, P-P Ripple = 4 dB)	Infinity	2.20	0.56	2.00	12.57	4.93	0.95
Power Bandwidth Product = (Distance = 20, P-P Ripple = 4 dB)	Infinity	4.4	1.1	10.0	44.0	22.2	5.2
Power-Bandwidth Product per Unit = (Distance = 20, P-P Ripple = 4 dB)	Infinity	2.20	0.56	2.00	8.80	3.70	0.74

TABLE 5
ARRAY TYPE: 5 SOURCE BESSEL

Configuration:



Number Units (N):	5	
Overall Length (c-c):	1.0	
Strengths:	0.5 : 1 : 1 : -1 : 0.5	
Impedance (Z_{In}):	2/7 = 0.286	(-5.4 dB)
Voltage Sensitivity:	2	(+6.0 dB)
Efficiency(η_o):	8/7 = 1.143	(+0.6 dB)
Maximum Input Power (P_{In}):	7/2 = 3.5	(+5.4 dB)
Maximum Acoustic Output Power (P_{out}):	4	(+6.0 dB)
Maximum Sound Pressure Level:	2	(+6.0 dB)

Maximum Upper Frequency (F_{max}):

Distance ->		5	10	20
Ripple (dB):	3	2.05	4.00	8.00
	4	3.00	6.00	11.00
	6	4.50	8.80	18.00

Efficiency-Bandwidth Product (η_o x F_{max}):

Distance ->		5	10	20
Ripple (dB):	3	2.34	4.57	9.14
	4	3.43	6.86	12.57
	6	5.14	10.06	20.57

Power-Bandwidth Product (P_{out} x F_{max}):

Distance ->		5	10	20
Ripple (dB):	3	8.20	16.00	32.00
	4	12.00	24.00	44.00
	6	18.00	35.20	72.00

Power-Bandwidth Product per Unit (P_{out} x F_{max} / N):

Distance ->		5	10	20
Ripple (dB):	3	1.64	3.20	6.40
	4	2.40	4.80	8.80
	6	3.60	7.04	14.40

"When compared to the other analyzed arrays, the five source Bessel line array is the clear winner, considering 1) polar response, 2) off-axis frequency response, 3) bandwidth of operation, 4), efficiency-bandwidth product, 5) power bandwidth product, and 6) power bandwidth product per unit."

Table 5 and Figure 32 illustrate just 2 of the 32 figures and 15 tables in this paper. AES members can get the complete 61 page preprint from AES for $4.00. (Quite a bargain when one considers that a 4 page preprint costs the same amount.)

Where to Buy Bessel Arrays

J. W. Davis in Dallas is licensed to Philips to make and sell Bessel arrays as well as the licensed wiring. J. W.'s phone number is 800-527-5705.

POLAR PEAK-TO-PEAK RIPPLE
VS
FREQUENCY COMPARISON
OF ALL ANALYZED ARRAYS
(Distance = 20 Units)

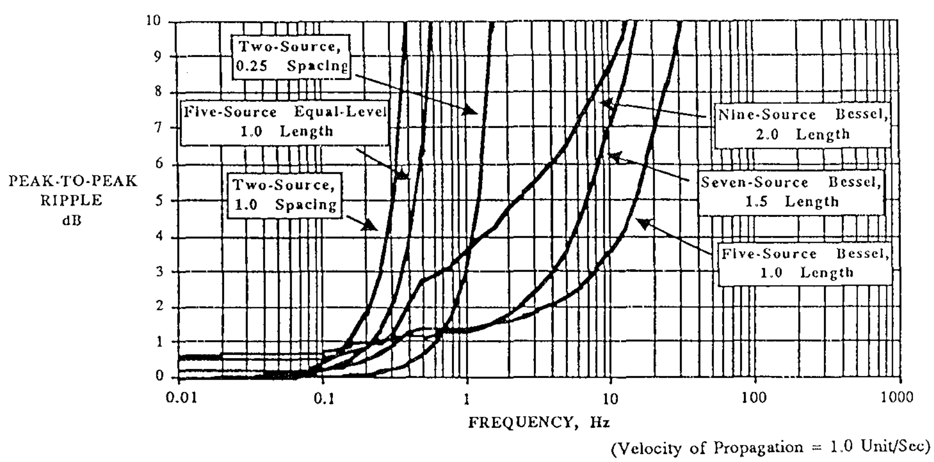


Figure 32. Comparison of polar magnitude peak-to-peak ripple vs frequency for all the analyzed arrays, at a working distance of 20 units. The superiority of the five-source Bessel is again, quite clear.

"Arrayability" of Loudspeakers

"Measurement and Estimation of Large Loudspeaker Array Performance" by Mark R. Gander and John M. Eargle, Preprint 2839.

"Design Considerations of a High Level Coaxial Point Source" by William Gelow, Renkus-Heinz, Preprint 2847.

"Large Arrays: Measured Free-Field Polar Patterns Compared to a Theoretical Model of a Curved Surface Source" by John Meyer and Felicity Seidel, Preprint 28533.

There were three papers at the Fall AES in New York on the general subject of Arrayability of Loudspeakers.

About three years ago Mick Whelan from Electrotec asked a loudspeaker manufacturer if they thought that a circular array of trapezoidal loudspeakers would create interference patterns.. Mick was glibly told, no problem. He asked what we thought and we told him, definitely a problem. Mick went to work with his TEF and created a wonderful study. We reproduced part of his study in Newsletter 16N2, Page 26. We have included the rest of the study in this Newsletter. It beautifully illustrates why JBL, Renkus-Heinz and Meyer are publicly addressing a problem that anyone who has been using his TEF would be very aware of. Certainly Sound System Engineering is full of references to the problem of "identical or similar devices that share the same frequency range while at the same time sharing a portion of the same coverage area."

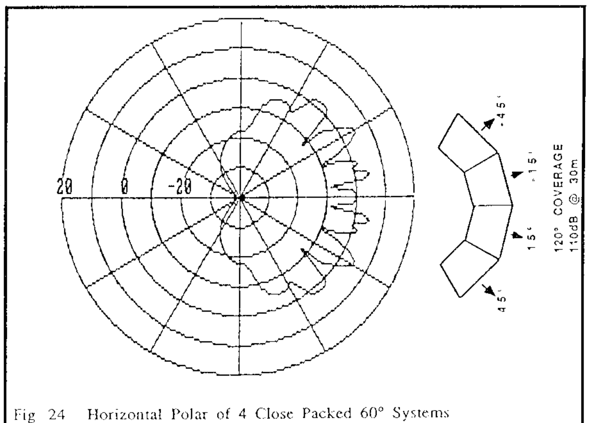


Fig 24 Horizontal Polar of 4 Close Packed 60° Systems
Renkus Heinz

1989 is the year that loudspeaker manufacturers are willing to say, yes, we have a problem!

Bill Gelow, Chief Engineer at Renkus Heinz states, "Although many claims are made about a loudspeaker system's performance in an array, little data is shown to validate it. **The laws of physics dictate that offset sources will cause interference if their sound fields overlap.** (underlining and bolding is in the paper.) Several manufacturers including ourselves, offer trapezoidal cabinets with an overall wedge angle of 25° with a 60° pattern horn. While convenient for physically building arrays and for obtaining enough SPL, they do not optimize the horizontal polar pattern. Figure 24 shows the results of close packing four of these conventional systems with 60° coverage angles, coverage is uneven with several lobes."

He writes in the last paragraph of his paper:

"In the course of our investigation into general array performance, it became clear that arrays with true point source performance are only possible if constructed from individual true point sources, and then only, if the systems are aimed away from each other for minimum overlap."

TEF owners will like the Gelow paper as he uses his TEF abundantly and intelligently.

Mick Whelan was sufficiently impressed with Mark Gander's paper that he has reproduced 100 of them and each person attending the Concert Sound Reinforcement Workshop will receive a copy of the paper.

Meyer essentially duplicates the outdoor measurement approach used by Community in 1975 and there is nothing wrong with that if one doesn't have a TEF. Meyer and Seidel write:

"As criteria for arrayability, we want to say that if the third octave polar plots of a given speaker array are even, within a 6dB tolerance over a specified coverage angle, that speaker system is said to be arrayable. For example from the preceeding data analysis, we would say that UPA loudspeakers are arrayable when configured in a 30 degree wide throw configuration. However, if the third octave polar plots of an array deviate 6dB or more from the on-axis value over the specified coverage angle, that speaker type is said to be non-arrayable in this configuration. We therefore would say that the UPA is non-arrayable in the parallel configuration."

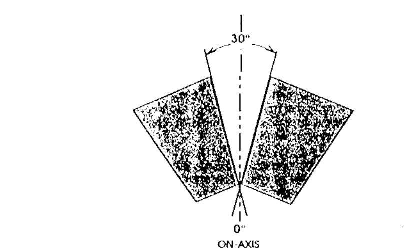


FIGURE 3a UPA 30° Wide Throw Configuration

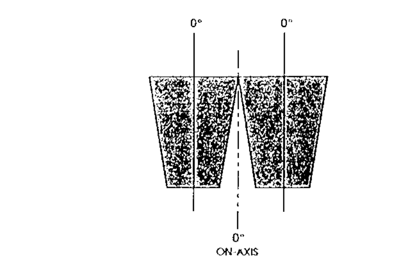
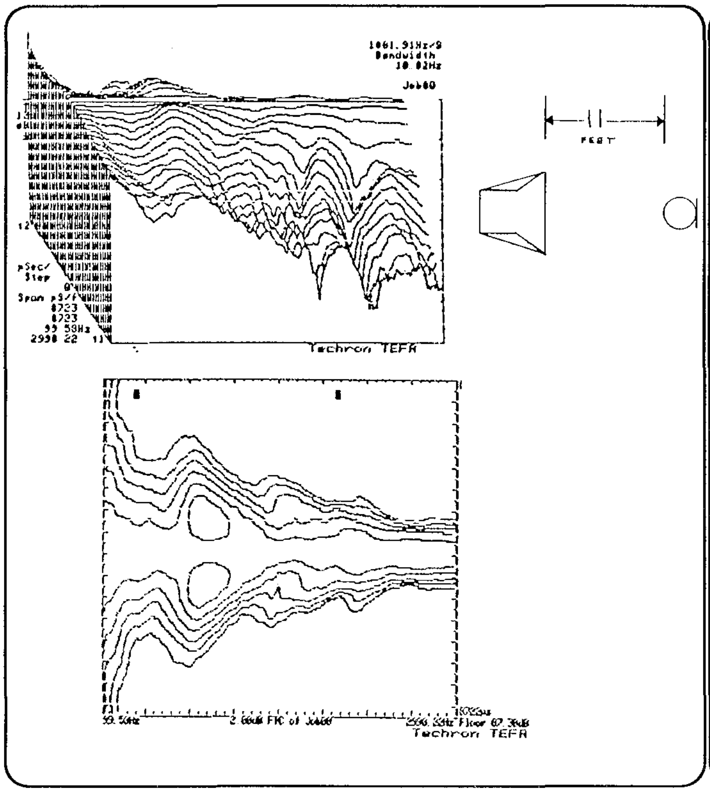


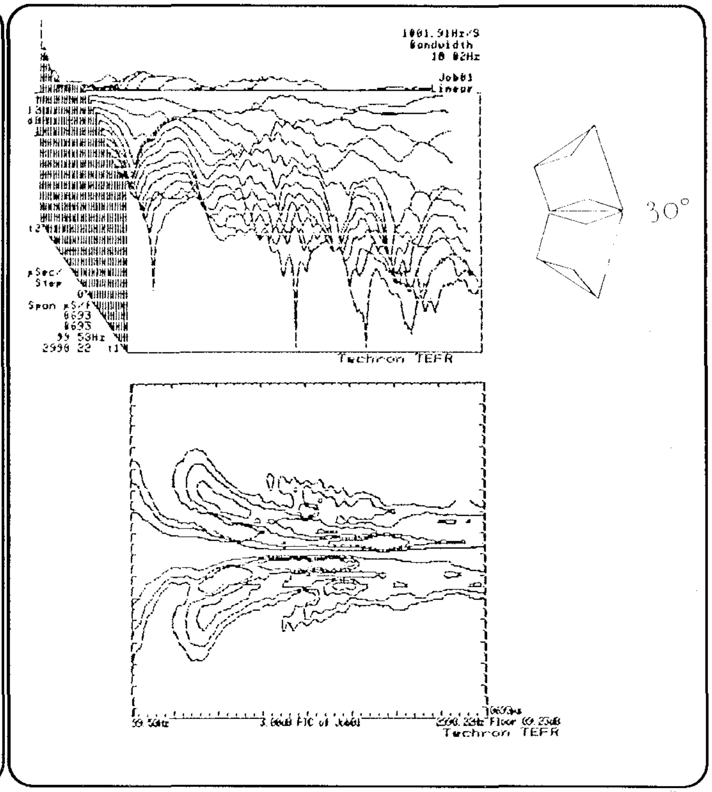
FIGURE 3b UPA Parallel Configuration

Figures 3a and 3b. Meyer concluded that "that the UPA is non-arrayable in the parallel configuration." He will have to re-write his full page ads

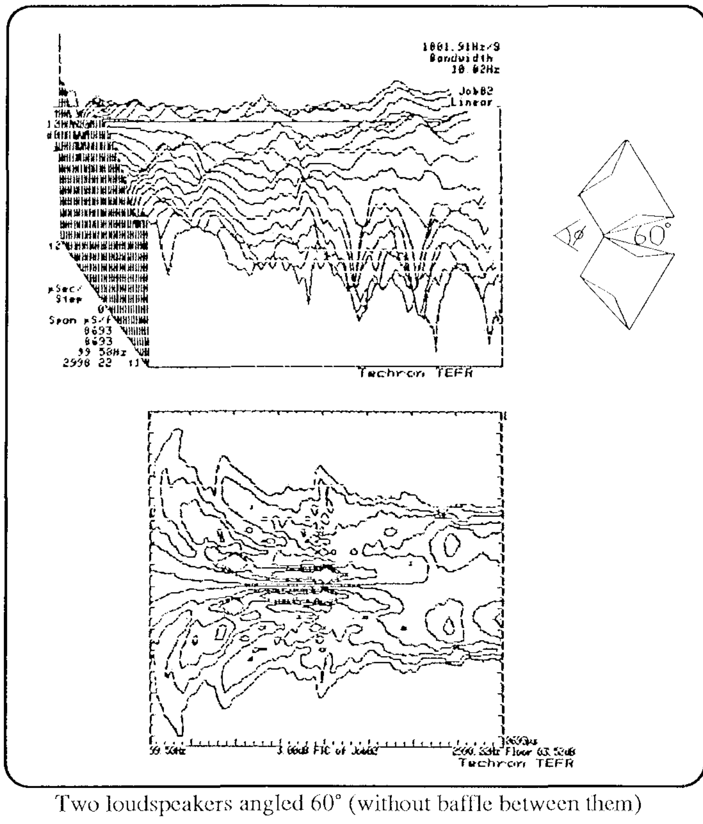
Mick Whelan's Study on Arrayability



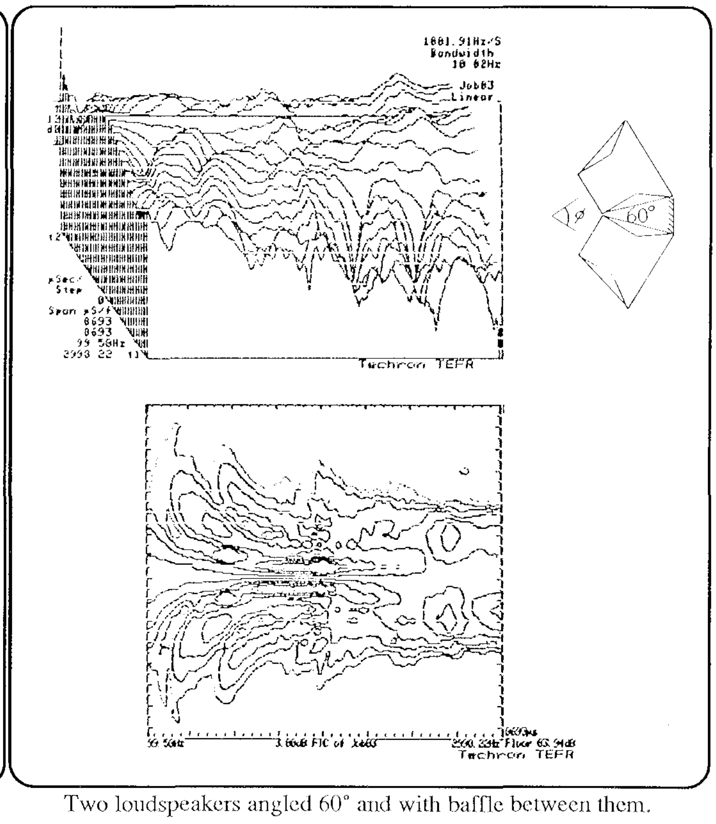
Single loudspeaker—Horiz. scale 100 to 3000 Hz—Vert. scale 10° per division on the waterfall and 3 dB per line on the contour polar plot.



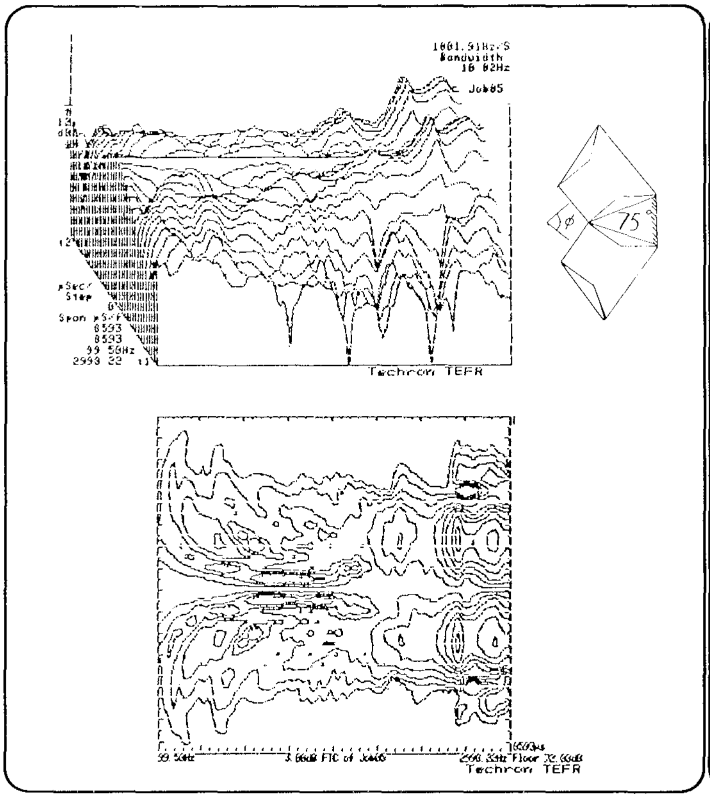
Two loudspeakers angled 30°



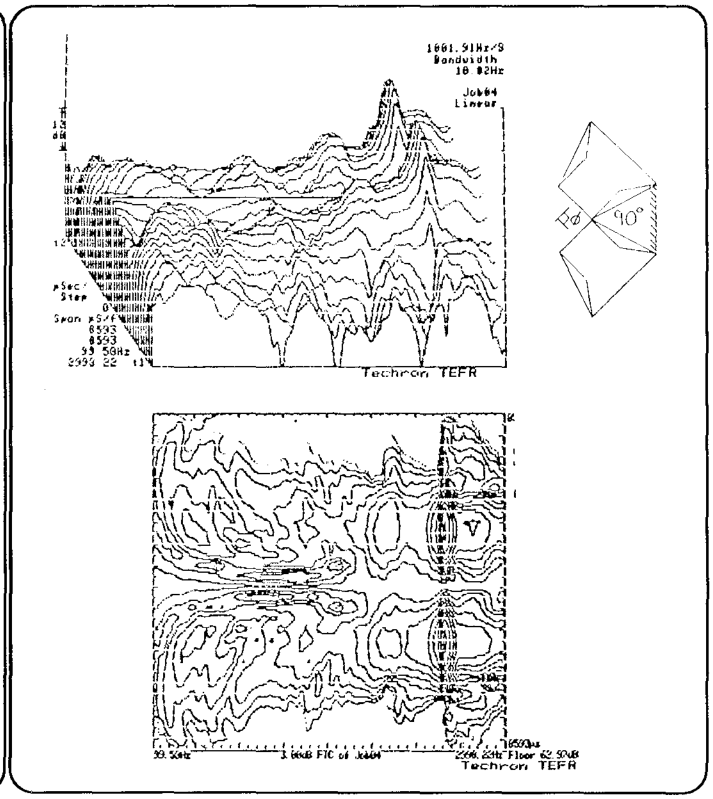
Two loudspeakers angled 60° (without baffle between them)



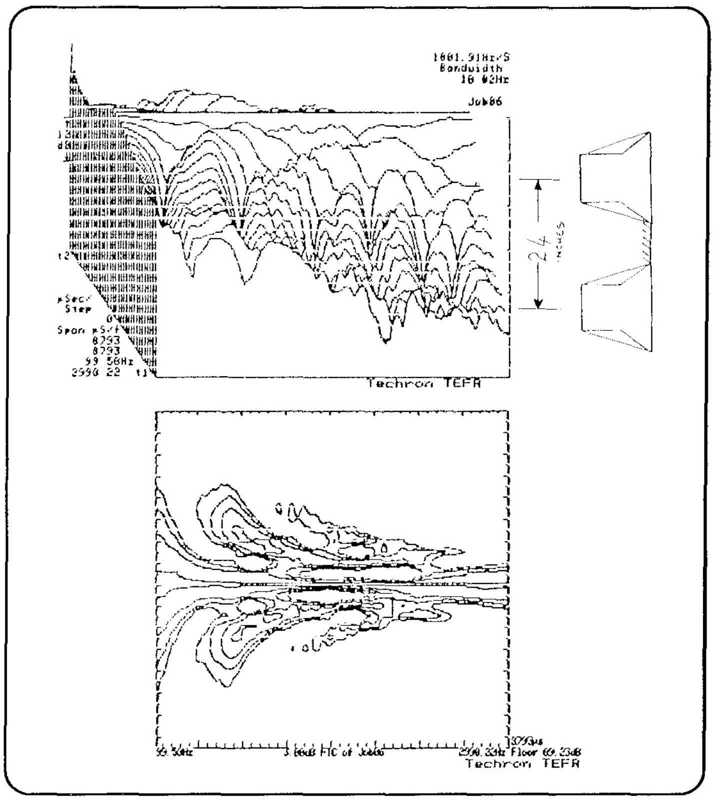
Two loudspeakers angled 60° and with baffle between them.



Two loudspeakers angled 75° and with baffle between them



Two loudspeakers angled 90° and with baffle between them



Two loudspeakers no angle between them 24" on center
and with baffle between them

Sound-Net, Electronic Bulletin Board System

Sound-Net is an electronic bulletin board system (BBS) dedicated to audio and acoustics. It is sponsored by the Toronto section of the Audio Engineering Society. Sound-Net has now been on-line for over 1-1/2 years and has over 200 members worldwide. Available on line is TEF user's group.

Sound-Net currently supports 1200 and 2400 baud. Membership fee is $45.00 for A.E.S members and $55.00 for non-members. For anyone interested in joining, please contact Sound-Net, 212 Fern Ave, Toronto, Ontario. M6R 1K4. Phone 416-530-4423 or Modem: 416-538-8777

The New Dallas Symphony Hall

McDermott Hall in Meyerson Center in Dallas is, in our opinion, a very successful collaboration of Texas wealth and the very individualistic artistic temperament of architect, I.M. Pei , and acoustician, Russell Johnson. (Cost of the full project is $157 million with about $81 million for the concert hall.)

When it looks like a concert hall, feels like a concert hall, and sounds like a concert hall, it must be a concert hall.

We had an exceptionally well informed friend showing us what we suspect will be a contender for inclusion in that select group of "great" concert halls in the United States. Certainly Symphony Hall in Boston, Troy Savings Bank concert hall in Troy, NY, and Ambassador Auditorium in Pasadena, CA are presently in that category, as are a mere handful of others.

Many contemporary concert halls lack good bass response coupled to good clarity at the higher frequencies. This hall has an exciting deep bass that is not exactly like that in one of the great European halls but is just as exciting when you hear and feel it.

We had to search into the odd corners of the hall to find questionable seats and we were astounded to learn that one of the best seats in the house could be had for $86 total for 14 concerts (called the Grand Tier.) At $6 per concert one might suspect a less than excellent orchestra but our sampling of the Dallas Symphony in rehearsal is that they are making every effort to live up to the Hall and they are blessed with a particularly skillful conductor who has enviable rapport with his musicians.

Since Artec does not seem to spend a great deal of time quantifying what they do, but simply doing it, we are willing to testify that subjectively they have done an exceptional job with this hall. Any anomalies I might measure would be cause for studying how to do the same.

The rehearsal we were privileged to hear included Manual De Falla's "Three Cornered Hat". The trumpet fanfares and ensemble hand clapping of the entire orchestra provided an ideal test source.

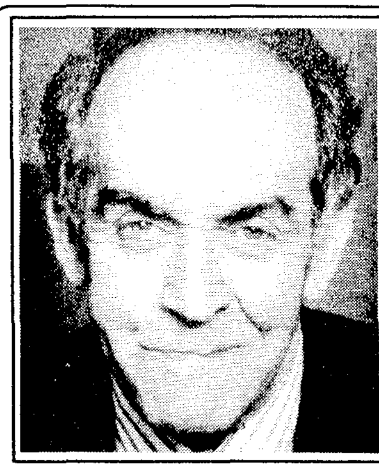
McDermott Hall, the concert hall in Meyerson Center, is 2,066 seats, counting the 225 seats behind the orchestra, and is 94 feet from the front edge of the stage to the back wall in a modified shoe box design. It is 928,000 cubic feet with 300,000 additional cubic feet in hidden reverberation chambers. (Nick Edwards was the project manager for Artec.)

Two and one-half ton concrete doors on a 30-foot-deep reverberation chamber around the top can be opened and closed to lengthen the room's late decay time (I don't want to call it reverberation). We were present for a rehearsal without audience. During the "Three Cornered Hat" we were in the main floor orchestra seats and were very much aware of the "tail" on the rate of decay. It would have been a different sound in the Grand Tier which is much closer to the reverberation chambers.

Mr. Peutz one time told us that a "great" concert hall is one that contains more good seats than just a "good" concert hall. I have sat in bad seats in the great Concertgebouw and in Boston Symphony Hall,but not in the Musikverseinssaal for we have had the opportunity to attend only one performance there.

Mr. Johnson is a great acoustician. He had one week to "tune" the hall before opening. Every concert is sold out for the season and concerts have been added to try to satisfy the demand for tickets. We could not get tickets for a concert while we were in Dallas. Fortunate for us that our good friends at Joiner Rose Group were able to plan such a feast for us.

The Dallas papers go on for 3 and 4 full pages discussing the chain of events which led up to the opening of the Myerson Center and they continue with the controversy surrounding the raising and lowering of Johnson's 42-ton canopy. Reviewers are not the most reliable source of information. (One reviewer wrote that sound, like heat, rises; therefore, the best seats are in the 5th level. Indeed they are, but not for the reasons cited.) Reading the pages and pages of reviews which Chuck Milam of Dallas and Troy Jensen of New York sent us, we are reminded of what Mr. Peutz once said when he was discussing how much he loved designing concert halls, "You never make any money and you may lose your reputation." It has to have been a great love on the part of everyone concerned with Meyerson Center to achieve a great concert hall.



Russell Johnson

One of the world's foremost acousticians, he has called the Dallas commission the high point of his career. Like Mr. Pei, a perfectionist. Unlike Mr. Pei, often described, even by his supporters, as a prickly character. "Russell pushed us to the limit," Mr. Meyerson says.

From the Dallas Morning Newspaper

1990 Syn-Aud-Con Classes at the Farm

Starting in April 1990 Syn-Aud-Con will again offer a series of three day, hands on, classes at their farm in Southern Indiana.

We have scheduled most of our classes on Thursday, Friday, Saturday so that those flying in can take advantage of the over-Saturday night reduced rates. June will be mid-week for those who hold religious services on Saturday.

Our farm is just four miles south of the 40,000 acre Hoosier National Forest in the Norman uplands (featured in National Geographic March 1976 issue). Syn-Aud-Con's farm is 260 acres within a 500 acre family farm that includes two streams winding through deep woods. Deer, wild turkey, coyote, coon, mink, groundhogs, squirrels, rabbits, quail, grouse, fox, hawks inhabit the surrounding woods. The area is famous for its geodes (rocks with a crystal hue center) and its shale bottom creeks. It is a working farm, raising corn, wheat, soybeans and hay. The current "family" includes two horses, two goats, two dogs, and four cats.

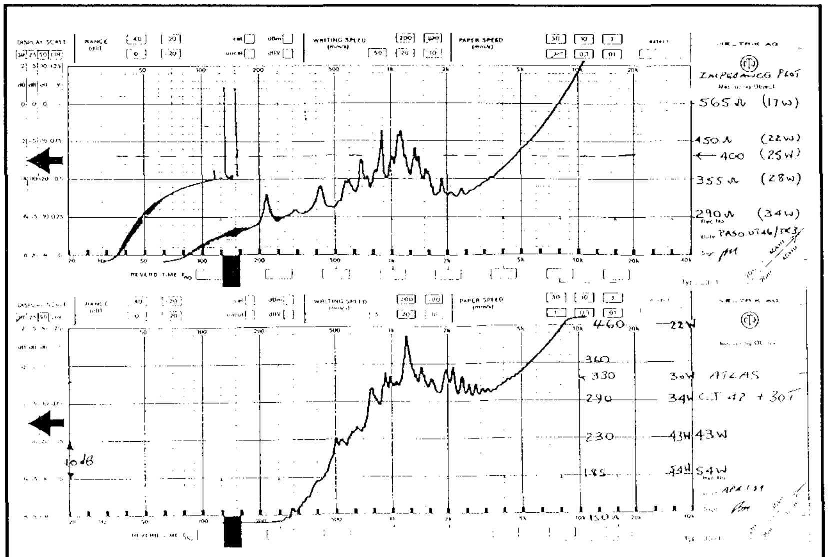
These classes are held in the 107 year old house (completed in 1883) which has been internally renovated including air conditioning. There are two separate laboratories, a lecture room, and a workshop in the building.

These farm classes are restricted to a maximum of 12 participants per session. There are two instructors for each class. We are able to actually demonstrate in detail such technologies as pinnae acoustic response playback of the In-the-ear ITE™ recordings, the 25 speaker Bessel array, and the latest in advanced computer techniques for both design and measurement.

For those desiring the opportunity to interface with Don and Carolyn Davis in a relaxed but exciting format of "hands on" audio and acoustic design, measurement, and equipment evaluation techniques, this is your chance.

Canonical Measurements from Peter Mapp

We sometimes get quizzical looks when we tell grads that the impedance meter they purchase must have multiple frequency capability. These measurements by Peter Mapp are striking examples of how devices can meet their spec at a single frequency. Peter is a world class consultant in Electroacoustics based in England, but working all over the world. We will be reporting further on his work regarding the intelligibility measurements of distributed sound systems, and as a result of this work, we have asked him to be part of the staff for Intelligibility II in May.



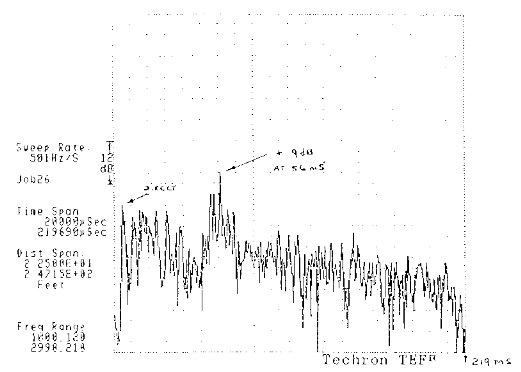
The other thing I came across recently and after only a moment's thought I knew I should have known anyway was the impedance characteristic of reentrant horns. (Very popular over here).

A supplier rang me to say that a contractor was continually blowing up drivers and amplifiers and reckoned that the horns were taking too much power. Could I look into it.

To cut a long story short I got some samples and had a quick session in the lab. On an impedance meter at 1 kHz the readings were within a couple of %. But at 250 Hz and 500 Hz the impedance was 25% lower than it should have been (and 25% higher at 8 kHz). The result was that the units were potentially taking about 35 watts instead of 30 watts. However, I noticed large variations in impedance as the frequency altered slightly—so I did a swept plot. I enclose 2 examples. I do not recall having ever seen the impedance plot for a re-entrant horn before so they came as a bit of a shock, but obvious when you stop to think about it. (Isn't it interesting to see exactly the right value at 1 kHz but nowhere else?)

The Atlas horn error is incredible 54 watts instead of 30 watts. It is rare to see a horn protection capacitor in the UK. It is even rarer to see it installed or see a high pass filter inserted in the signal path.

Is it true that there is life above and below 1 kHz? It seems to be the only frequency people know how to measure!



"I enclose an interesting ETC. It is one of the strangest rooms I have ever heard. The RT is less than a second (~ 0.8/.9) yet at some positions the echo is incredible—(What else do you call +9 dB at 56 mS!). You literally hear 2 separate but apparently simultaneous sound sources. (i.e., like a stereo system, but both channels are the same but separate and locatable sources.)

Whilst your eyes, ears and experiences tell you what the problem is, the TEF confirms and quantifies it. The feeling I got when the ETC with the echo popped up on the screen and confirmed my judgement is difficult to describe. (In case you haven't guessed, the answers to what cause a +9 dB reflection at 56 MS in a nominally 0.9 sec environment is called a Dome—absorptive at LF and reflective at HF.)

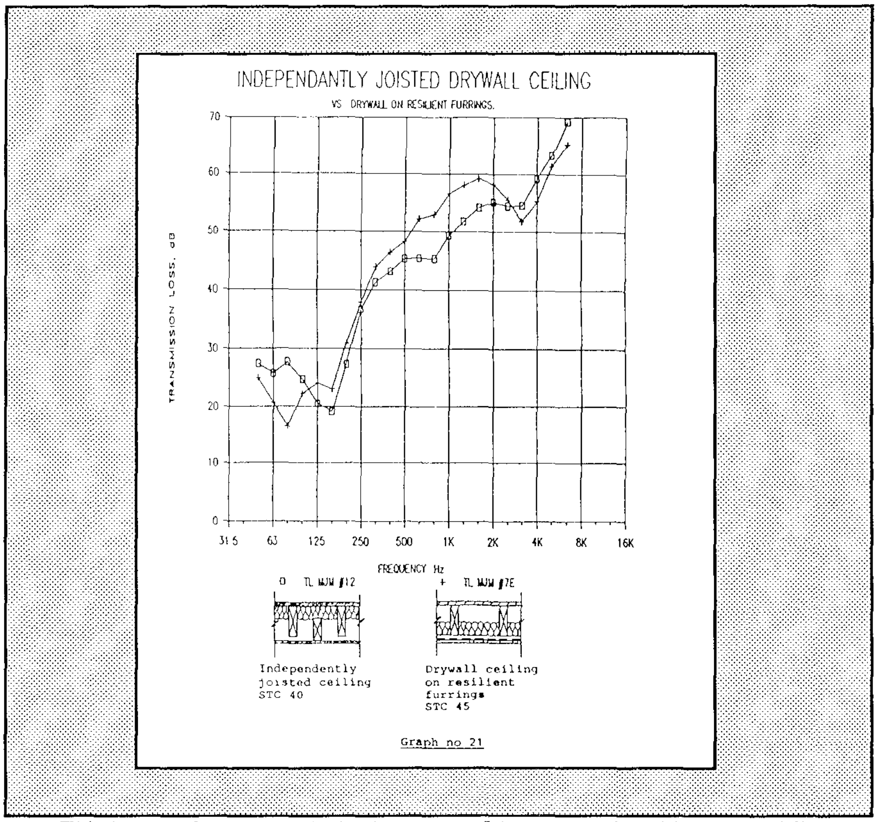
Michel Morin's Research Project on the Noise Isolation Provided by Floor/Ceiling Assemblies in Wood Construction

MJM Acoustical Consultants Inc., (grad Michel Morin) was selected by the Canada Mortgage & Housing Corp to conduct the first phase of a research project on the sound isolation provided by floor/ceiling assemblies in wood constructions.

The objective of the study was to:

1. provide builders and construction professionals with practical information on the acoustical performance of different materials and techniques.
2. provide acousticians with reliable data which could allow them to deduct the insertion losses resulting from adding and deleting materials.

Michel sent us a copy of the excellent 50 page report. He writes that M. Jacques Rousseau, Project Director, Canada Mortgage & Housing Corp., 382 Montreal Rd., Ottawa, Ontario, K1A 0P7 Canada, phone 613-748-2013, who is responsible for the research program in acoustics at the Canada Mortgage and Housing Corporation, will make the report available free of charge to consultants who request the report on their letterhead. This is a very generous gift.



This is one of many graphs in the report. I have reproduced it because Michel comments in the report that the very poor performance of the independently joisted drywall ceiling compared to the more conventional drywall ceiling installed on resilient furrings was a surprise.

"We Are All Agreed That Your Theory is Crazy"

The first page of Carolyn (Puddie) Rodgers' Ph.D. dissertation contains only this quote.

Freeman Dyson has expressed some thoughts on craziness. In a Scientific American article called "Innovation in Physics," he began by quoting Niels Bohr. Bohr had been in attendance at a lecture in which Wolfgang Pauli proposed a new theory of elementary particles. Pauli came under heavy criticism, which Bohr summed up for him: "We are all agreed that your theory is crazy. The question which divides us is whether it is crazy enough to have a chance of being correct. My own feeling is that it is not crazy enough." To that Dyson added: "When the great innovation appears, it will almost certainly be in a muddled, incomplete and confusing form. To the discoverer himself it will be only half understood; to everybody else it will be a mystery. For any speculation which does not at first glance look crazy, there is no hope."

Kenneth Brower in The Starship and Canoe (1978: 150)

What words better describe Richard C. Heyser's last papers - which the AES Journal has refused to publish.

Interchannel Phase Part 1

By
Brett Johnson & Doug Jones
EASI

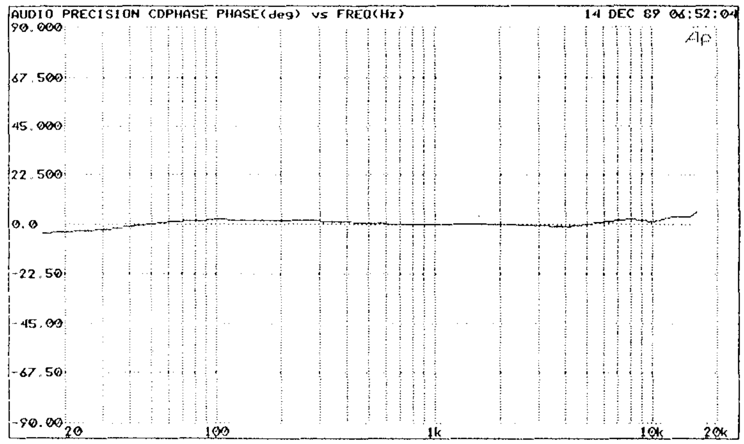
We were prompted to look into the problem of interchannel phase response of CD players for a number of reasons. We noticed that many of the albums that had reasonably decent spatial imaging on vinyl seemed to have quite different imaging on CD. In some cases the music is remixed for the digital medium but we were curious to see if there were any other reasons for the difference. The second reason that we were initially interested was that we were planning on releasing the CAVEAT header tones on CD and the interchannel phase is crucial since analog tape recorder azimuth would be tested with the track off the CD. Lastly, when we agreed to release LEDR on the Prosonus CD, we had to be sure that the interchannel phase was acceptable. One of the primary reasons that we stopped producing LEDR on 1/4 in analog was that the interchannel phase (i.e., the azimuth) was too hard to control. The sensitivity of LEDR to azimuth misadjustment was noted one of the first times that LEDR was shown at the Control Room Designer's workshop in Nashville. We had been playing LEDR on one tape machine with good success then changed tape machines only to find the patterns and changed dramatically. The second machine was found to be out of azimuth. It should be noted that we are not equating the interchannel delay present in many CD players with azimuth in analog tape machines but we do believe that the effect on stereo image is similar.

The data displayed in the following graphs were taken with the Prosonus SRD and the Audio Precision test set, AP 1. The curves are all rather self explanatory. The first is a professional analog 1/4" 1/2 track machine running at 15 ips., properly calibrated, shown for comparison. The rest of the curves 2 through 9 are CD players. It is important to note that we did not find any correlation between price and interchannel phase behavior. In fact, some of the least expensive were the best performers in this one aspect.

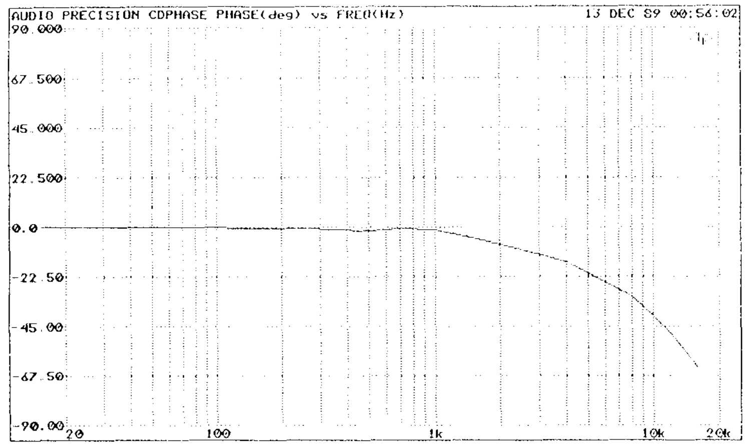
We do not intend this to be an exhaustive listing of all CD players and it may not even be representative. We simply went into one of the larger studios in Chicago and tested each of the players present. We do feel that these are typical of what the common man is likely to be using! So if you do not see your machine here, simply take this as a warning. Get a SRD and a scope and test your player. You may be surprised at what you see.

We plan on a continuation of this investigation looking at DAT machines and plan to have some subjective listening tests between different CD players and between DAT players.

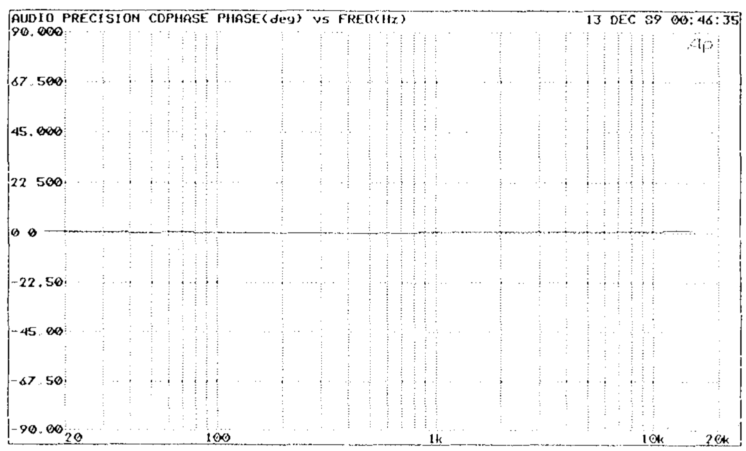
The response to the SRD offer has been good so we are going to extend the offer one more month. Until March 31, 1990, the SRD is available from EASI for $50.00, $5 of which will be donated to the Charles Bilello fund. Our new address is EASI, 701 Main St., Evanston, IL 60202.



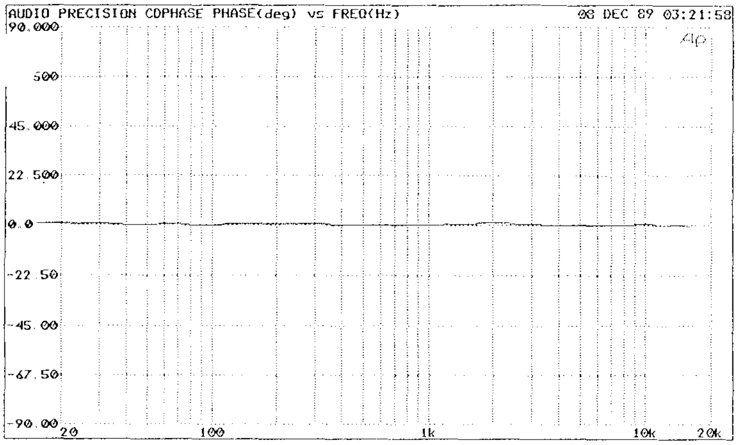
CDPHASE.TST measures phase vs frequency of a Compact Disc Players using a CD with a continuous swept (glide) tone. (see 1.60 manual section 28.2.3)
SONY-5002 15ips



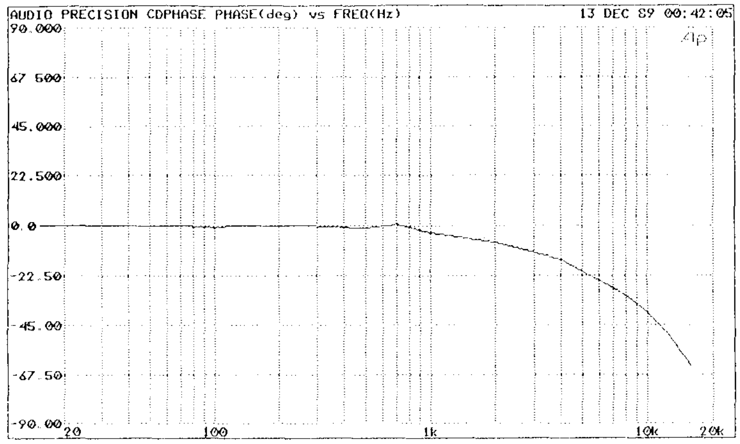
CDPHASE.TST measures phase vs frequency of a Compact Disc Players using a CD with a continuous swept (glide) tone. (see 1.60 manual section 28.2.3)
SONY CDP-550



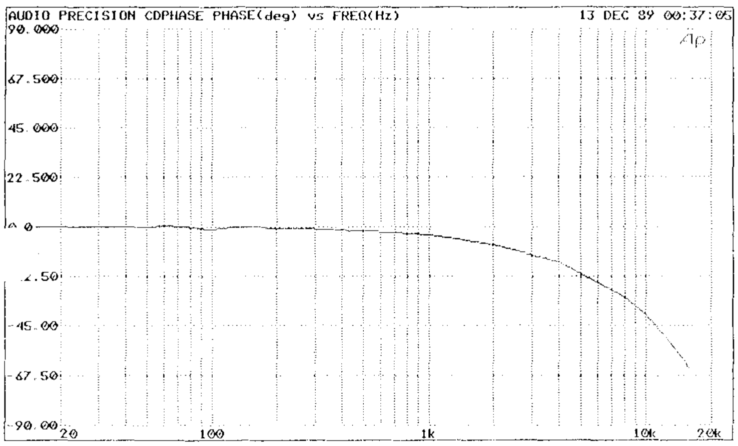
CDPHASE.TST measures phase vs frequency of a Compact Disc Players using a CD with a continuous swept (glide) tone. (see 1.60 manual section 28.2.3)
MAGNAVOX CDB-472



CDPHASE.TST measures phase vs frequency of a Compact
Disc Players using a CD with a continuous swept (glide)
tone (see 1.60 manual section 28.2.3)
TASCAM - CD-701



CDPHASE.TST measures phase vs frequency of a Compact
Disc Players using a CD with a continuous swept (glide)
tone. (see 1.60 manual section 28.2.3)
TECHNICS SL-PJ1



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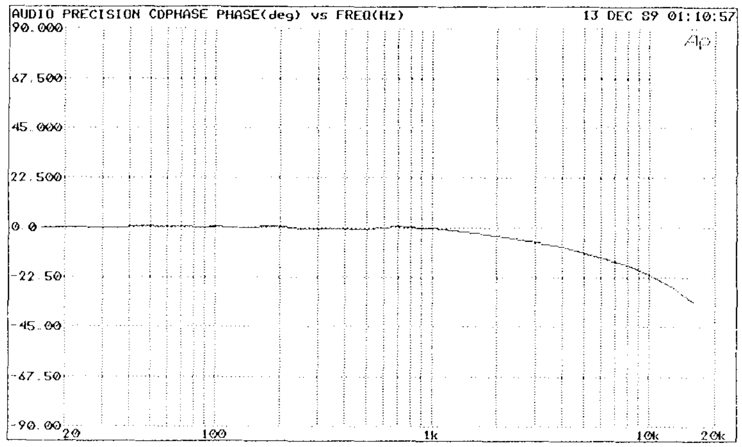
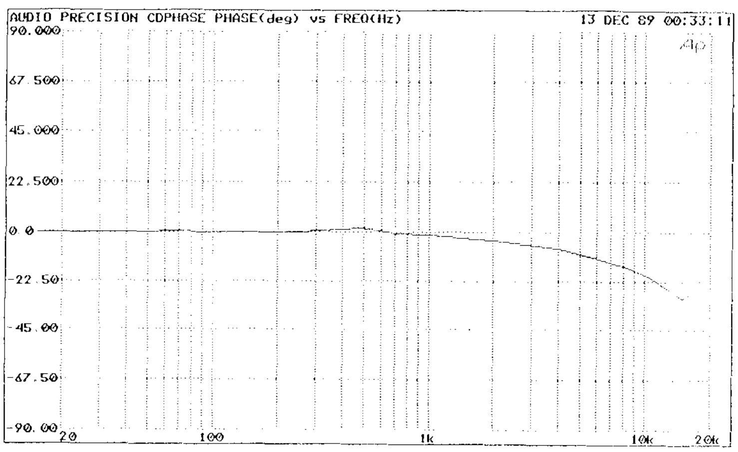
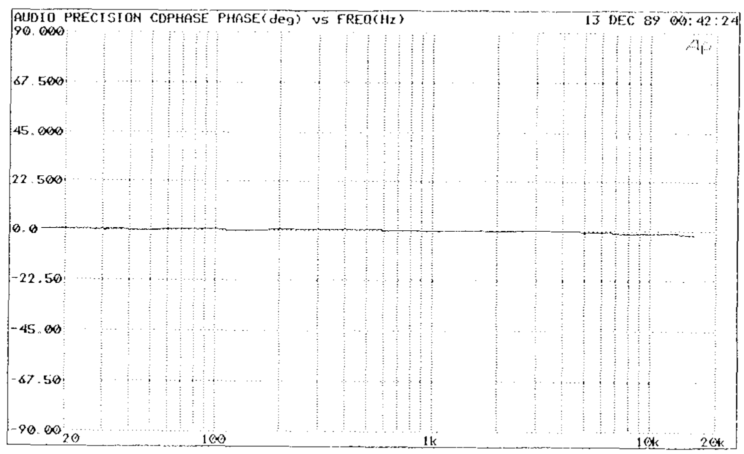
Disc Players using a CD with a continuous swept (glide)
tone. (see 1.60 manual section 28.2.3)
TECHNICS SH-CDB7



CDPHASE.TST measures phase vs frequency of a Compact
Disc Players using a CD with a continuous swept (glide)
tone. (see 1.60 manual section 28.2.3)
TECHNICS SL-XP5



CDPHASE.TST measures phase vs frequency of a Compact
Disc Players using a CD with a continuous swept (glide)
tone. (see 1.60 manual section 28.2.3)
TECHNICS SL-P116



CDPHASE.TST measures phase vs frequency of a Compact
Disc Players using a CD with a continuous swept (glide)
tone. (see 1.60 manual section 28.2.3)
PANASONIC SL-4300

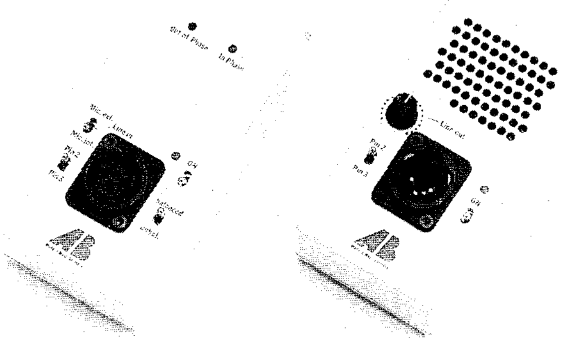
Polarity Checker From AB Inc.

AB International Electronics of Roseville, CA is now importing the excellent polarity tester we have been using in our classes this past year. Both electrical and acoustical polarity measurements can be made with these units. Our sole negative comment would be the labeling of the lights as "in phase" and "out of phase". Syn-Aud-Con's experience with these units has been that they are the best ones we have been privileged to test.

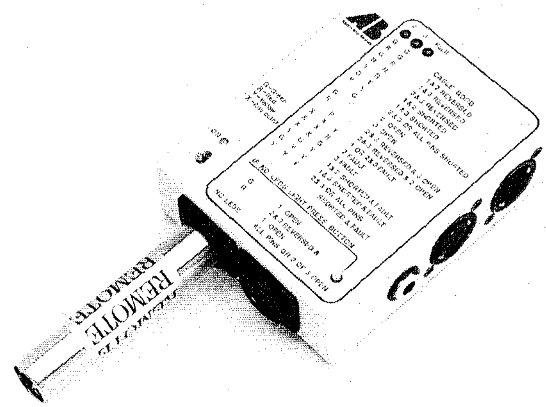
We are endebted to AB Electronics for distributing this excellent polarity checker. AB is making the checker available to all Syn-Aud-Con grads for $390, which is dealer cost. AB asks that you note on your order the year (or last year if attended multiple times) you attended a Syn-Aud-Con class.

For more information you may contact:

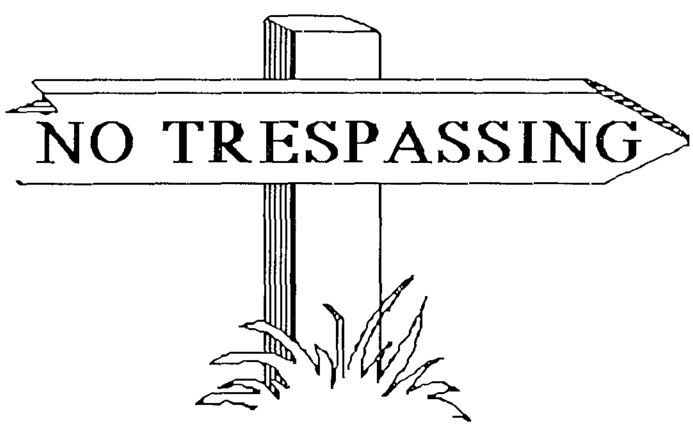
AB International Electronics Inc.
1830-6 Vernon Street, P.O. Box 1105
Roseville, CA 95678
916-783-7800
Fax: 714-586-8229



Polarity Checker



Cable Tester



"Trespassers Will Be Violated"

The sign to the left was seen, where else, but in the San Francisco area. Others we like are:

"Those found here after dark will be found here in the morning,"

"Is there life after death? Trespass here and find out."

and of course there is:

"Never mind the dog; beware of the owner."

But that has been superseded by:

"Beware of the dog; he eats everything I shoot."

Then there's the homeowner covering the burglar with:

"Don't move; I've got a two pound hold on a four pound trigger!"

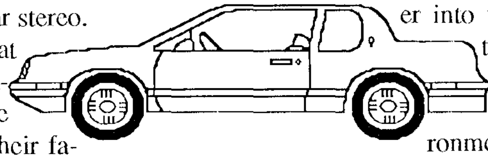
If any of you have "toppers," please send them in for sharing with the Syn-Aud-Con family.

Aspects of the Vehicle Listening Environment

by

Neal House – Harman-Motive

There are some bright people in our audio field. We are very fortunate if those people have access to the funding to put those talents to work. Such is the case with Neal House of Harman-Motive in Martinsville, IN. Neal , Jon Lane and their associates are concerned with the automobile as a listening environment, in other words, car stereo.



We have followed their work at Harman-Motive since moving to Indiana a couple of years ago. A long time grad, Dan Fields, invited us to tour their facility. Forty thousand loudspeakers are produced each day on a completely automated line. (Dan is now chief engineer at Oxford.) WE WERE IMPRESSED.

Neal House and five of his associates attended our 3L Workshop (The Loudspeaker, The Listening Room and the Listener) in the summer of 1988. They saw the introduction of our In the Ear recording using the probe microphones. They had already been using on-the-ear recording for their measurement work.

Neal's paper at the 1989 AES, "Aspects of the Vehicle Listening Environment", Preprint # 2873, tells you how far their current research has taken them. They have a TEF and they have used it well, along with their native intelligence. Reading the paper made us proud to say that we know these guys. If you have any interest in car sound, get the paper. The paper is 15 pages. I am excerpting a few sentences from pages 13 and 14 of a very important paper:

"Small 60mm speakers were placed in the headliner above each ear of the listener. The benefit gained by close coupling like this is control of the direct to reflected energy ratios. In essence, the effects of the environment are removed from the signal. This can be quite useful since the spatial, spectral, and temporal aspects are all in part determined by the combination of direct and the reflected energy. Other benefits include an increased listening envelope size, the conventional speakers locations are much less critical and the headliner speakers are firing down into the seats and carpeted floor which reduces the number of reflections. With the speakers in such close proximity, the direct signal level can be increased as much as 30 dB over the reflected information."

"Several headliner locations were auditioned ranging from directly overhead to forward just above the windshield. The overhead locations had excellent left to right isolation due to the head shadow which reduces the interaural crosstalk and enhances imaging.... "

"Another method tried, with the overhead locations, processes the headliner signal through a circuit that simulates a frontal localization transfer function is designed to compensate for the headliner speaker locations by tricking the listener into thinking that a front image exists. With this method, good time response, frontal imaging, staging and left to right isolation can be acquired in the vehicle environment.

"As a final note: the author believes the defined directivity and close coupling methods described give audio system designers a powerful tool for controlling the sound field characteristics in the automotive environment. When used in conjunction with digital sound signal processors, accurate and realistic sound field reproduction can occur. Without defined directivity and close coupling, the signal is more or less at the mercy of the environment."

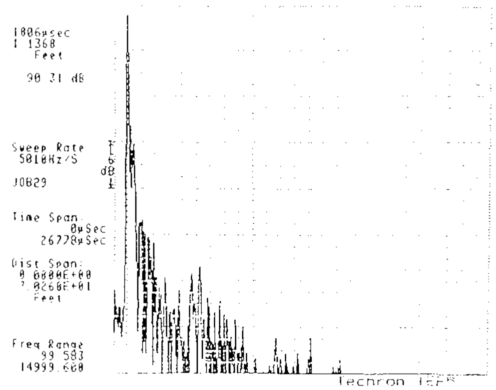


FIGURE 9A ETC OF LEFT OVERHEAD SPEAKER

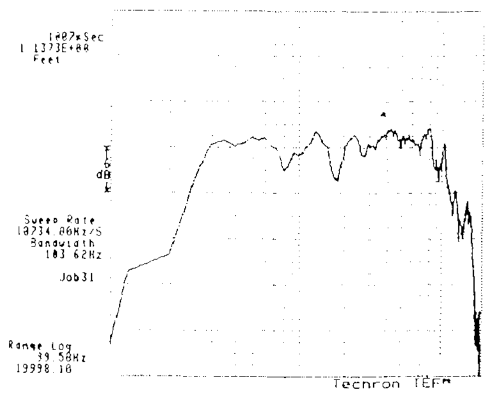


FIGURE 10A LEFT OVERHEAD RESPONSE

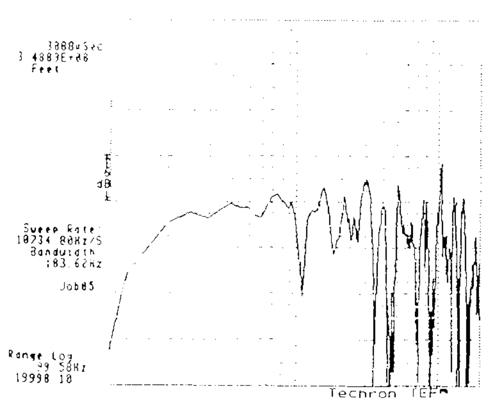


FIGURE 10C LEFT INSTRUMENT PANEL RESPONSE

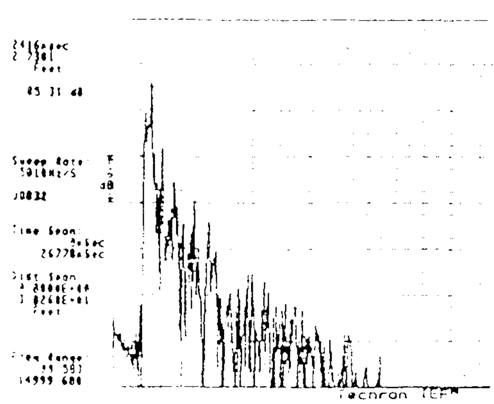


FIGURE 7C LEFT FRONT IP

Dense, Dense, I'd Love To

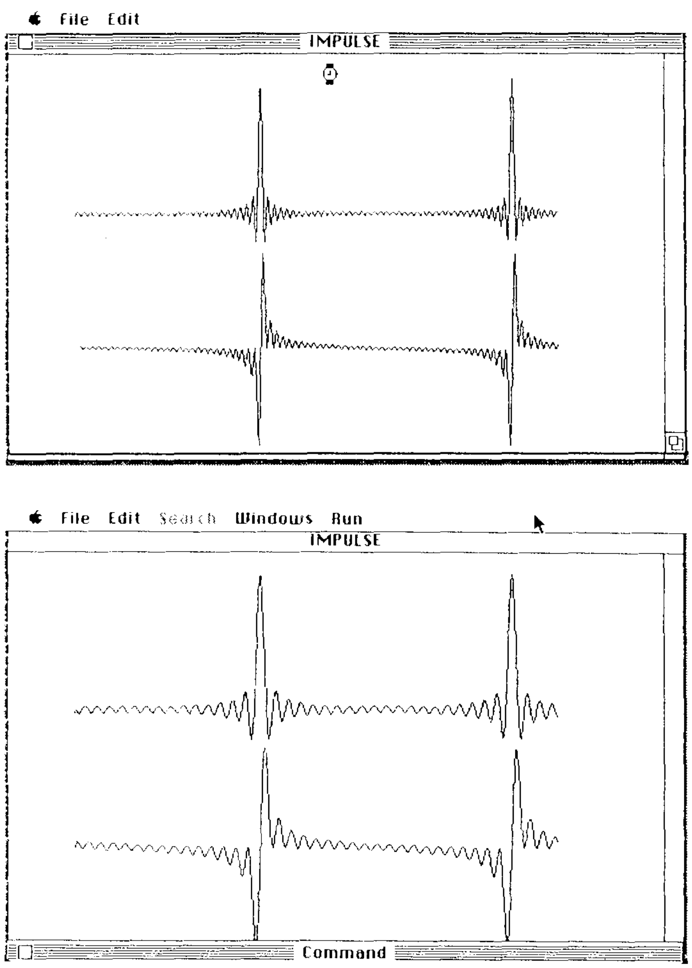
The ETC measurements have been under attack by two people ill equipped to make judgments about processes designed by their superiors.

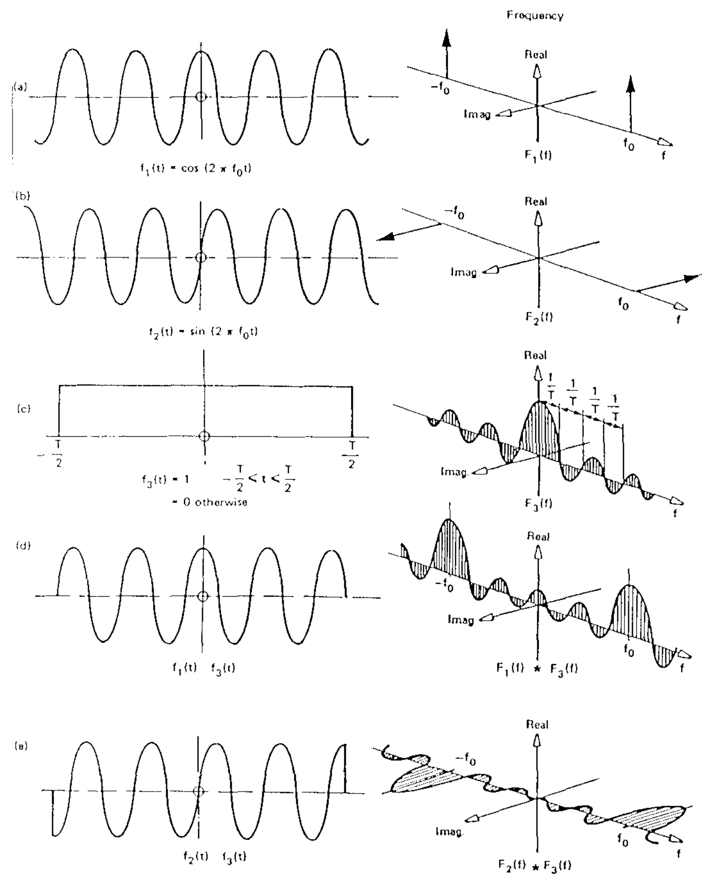
Fortunately, Dr. Patronis and Dr. Bertram have been at hand to demonstrate the differences between inferiors and peers.

The second figure is a B & K version of what happens when you restrict a sinusoid to other than infinite time so far as Fourier analysis is concerned.

We object to the use of the office of President of the AES as a platform for unsubstantiated attacks on a legitimate measurement technique by one participating in the development of what they think is a competitive system. The whole episode of how the AES has handled Richard C. Heyser's posthumous paper disgraces that institution beyond any ability of mine to describe. The following extract is from a letter by Dr. Bertram on the claim that the Hilbert Transform of the real part of the analytic signal is non causal. As he so succinctly demonstrates, both parts can be so considered if you don't understand the underlying mathematics.

". . . the Fourier series for the discrete form of the function is just a series of cosines of the same amplitude and its Hilbert transform is a corresponding series of sines. The enclosed includes 20 and 40 term calculations using Basic. The significant item that refutes the Lipshitz and Varderkooy's argument is that both δ and its Hilbert transform are non-causal if only a finite number of terms are used to represent them, and both are causal if an infinite number of terms are used since the variation on the base line would not be visible on a scale where the infinite peaks (for both functions) could be seen. They didn't question the representation of the δ function since they have its definition in mind rather than its analytic representation in the form of either a Fourier series or Fourier integral, particularly in the band-limited form. It is important to remember that the Hilbert transform is just what the doctor ordered to produce a new function, equal to the the sum-of-squares of the two, that doesn't have the fluctuations associated with the finite form of either: Dick needed it for his loudspeaker measurements."





Restriction of sinusoidal signals to a length of T

IRP

A Company With a Bright Future

Industrial Research Products started with one product, Digital Signal Delay, in 1970. Over the next 20 years eclectic products were developed: Voice-Matic automatic mixer, TEQ Transversal equalizer, power amplifier, precision signal delay, crossover/limiters and finally the System 41—a complete modular system. IRP has always represented the finest quality and the highest engineering integrity.

Acoustical consultants were the first to appreciate IRP, and specifications for IRP were often written by acoustical consultants. It was a rare sound contractor in the early 70s that understood the need for signal delay and automatic mixing. Selling was one-on-one.

Now their distribution is worldwide with reps and a contractor organization, in addition to the magnificent support from acoustic and electroacoustic consultants: 72 channel Voice-Matic in Bangkok, 102 mic channels installed by Slyc Electronics at the National Academy of Medicine in Washington, D.C., 120 channel audio mixer in Antwerp. The new System 41 mainframe and modules has a diversity of applications - the only limitation to using System 41 is your imagination.

We're proud of our many years of association with Industrial Research Products.

In Memorial

We were saddened to learn of the deaths of two prominent men in audio and acoustics, both from sudden heart failure.

Deane Jensen

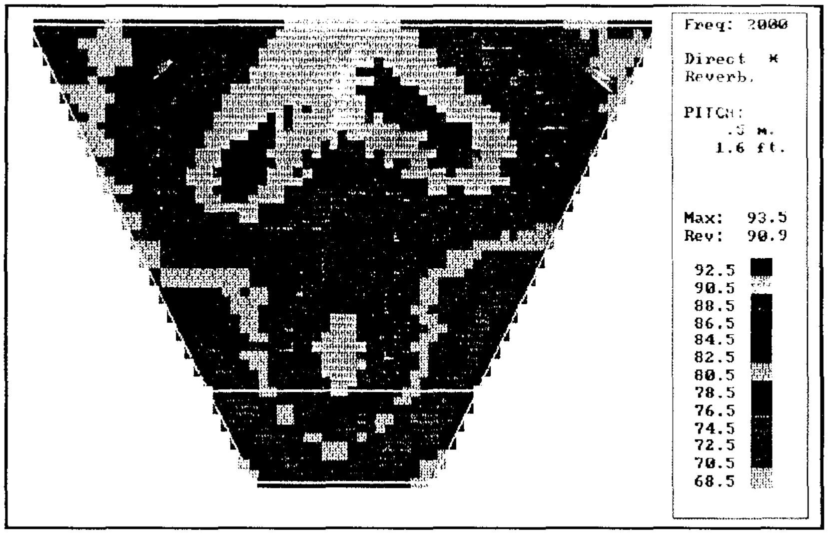
Deane Jensen of Jensen Transformers, the leading audio transformer designer in the world, passed away the weekend of October 21.

Theodore Schultz

Ted Schultz, well known to Syn-Aud-Con grads for his remarkable translation of the landmark book, "Principles and Applications of Room Acoustics" by Lothar Cremer and Helmut A. Muller, passed away on August 6th.

Both men were friends of Syn-Aud-Con and truly giants in their fields of endeavor. Our material world is diminished by their physical absence but enriched by their lifetime of meaningful contributions to the life of the mind.

Altec AcoustaCADD Design Program



Altec has recently provided us with their Acousta Cadd™ computer program. We will be testing it in the near future. Our new computer has not yet arrived and we are postponing testing until it does. The only computer Don has had anything to do with in recent years has been the TEF analyzers. He is about to devote 1990 to getting in the swim again with a large fast computer as he feels that this year will see design, testing, and operation of sound systems all accomplished optimally via computers. Enough said for now.

The Radio Shack SLM & Sound Level Measurements

Weighting scales come up in every Syn-Aud-Con class. The two most often used by sound men are "Flat" and 'A' scale. The very economical Radio Shack SLM is a useful device because:

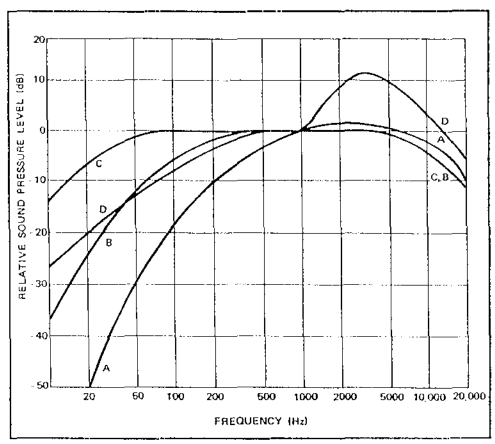
1. It has an 'A' scale and a 'C' scale.
2. It has an output jack
3. It is the lowest cost device with both of the above features.

The 'D' curve, so far as I am aware, never became a standard and I've only seen it on equipment in Europe.

Sound Level Measurements

The first attempt at measuring loudness was made quite some time ago in the form of the sound level meter In this instrument, sound pressure is transformed into voltage by a microphone, a weighting network shapes the voltage to account for the frequency response of the ear, and a quasi-rms voltmeter with a logarithmic scale indicates the weighted sound pressure level.

Until recently sound level meters had three possible weighting curves These are called A B and C and are specified in IEC Recommendations 123 and 179 and in US Standard S1.4–1961 Measurement results are given in dB (A) dB (B) or dB (C)

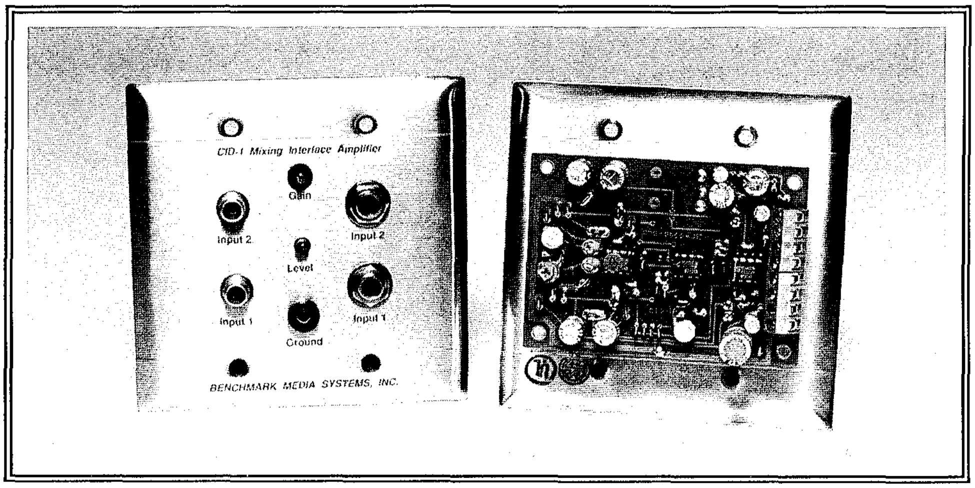


International standard A, B, and C weighting curves for sound level meters. Also shown is the proposed D weighting curve for monitoring jet aircraft noise.

Recently a new weighting curve the D curve has been proposed for measuring jet aircraft noise

A Black Box From Benchmark

The Benchmark CID-1 Mixing interface is one of those devices that is increasingly needed in audio and almost impossible to find with broadcast quality specifications. What more ideal way to acquire a needed A + B third channel, a mono feed from a stereo source, or a precision null amplifier set for an out of polarity alarm. Balanced or unbalanced inputs 100 KΩ differential 50 KΩ single ended. Outputs are 60Ω balanced line level and 200Ω balanced mic. level. 100 dB common mode rejection from 20 Hz past 2 kHz at the input. Five year warranty and same day turn around on repairs. In a unit with >200kHz RF free bandwidth and a 20kHz THD of 0.0012% (i.e., -98.4 dB), what else could you ask for.



Bandpass Filters

Bandpass filters are one of the most fundamental of measurement tools. Fig. 1 illustrates the key parameters of such a filter such as:

1. The center frequency f_c
2. The -3 dB bandwidths f_L and f_U (The lower frequency and the upper frequency)
3. The effective noise bandwidth
4. The ideal vs practical filter
5. The ripple within the filter bandpass.

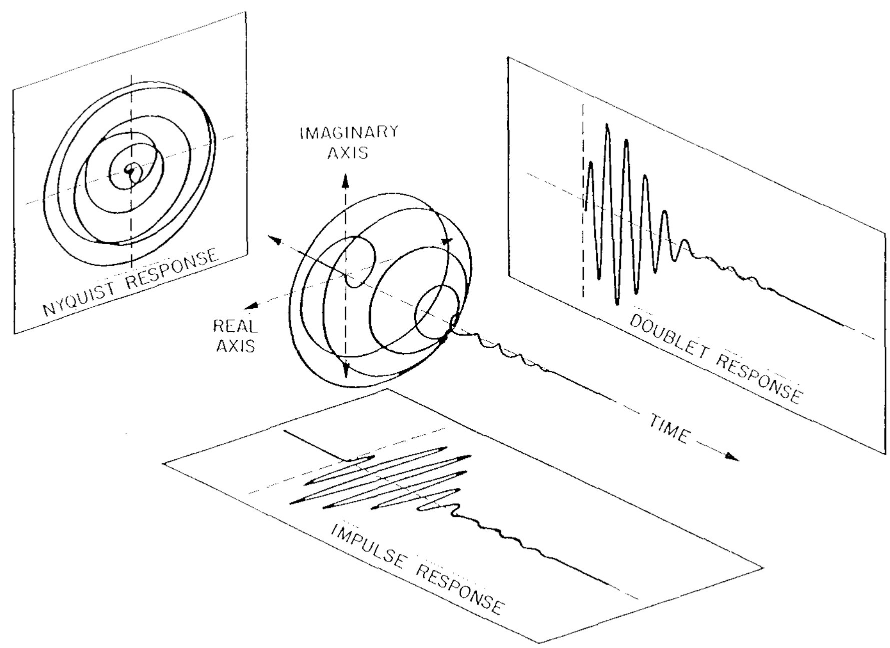


Figure 2 *Courtesy of Andrew Duncan*

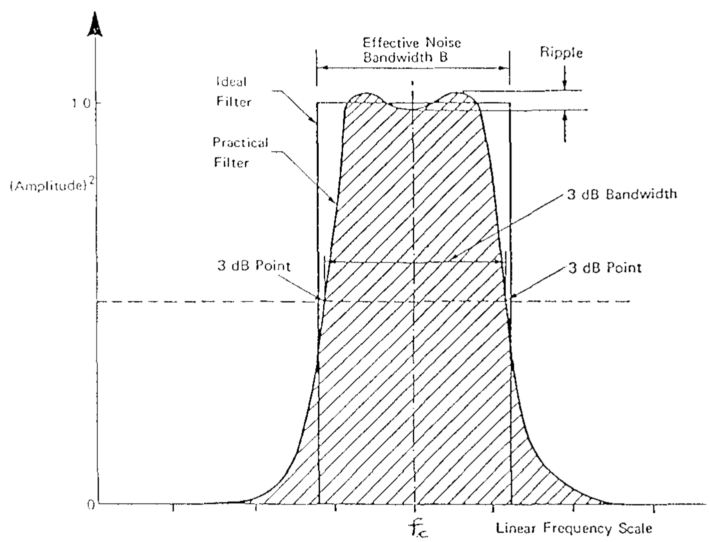


Figure 1

Two Fundamental Types of Filters

There are two fundamental types of bandpass filters used in audio and acoustic analysis instruments. They are:

1. The constant bandwidth filter
2. The constant percentage bandwidth filter

The Constant Bandwidth Filter

The constant bandwidth filter is exactly what its name describes. At any f_c its bandwidth remains the same. A 20 Hz CBF is 20 Hz wide for an f_c = 100 Hz or an f_c = 10,000 Hz.

The Constant Percentage Bandwidth Filter

The constant percentage bandwidth filter has a bandwidth that is a constant percent of whatever f_c it is tuned to. For example a 1/3-octave filter is a constant percentage of 23%. Therefore, a 1/3-octave filter tuned to an f_c of 100 Hz would have a -3 dB bandwidth of 23 Hz. A 1/3-octave filter tuned to an f_c of 1000 Hz would have a -3 dB bandwidth of 230 Hz and a 1/3-octave filter tuned to an f_c of 10,000 Hz would have a -3 dB bandwidth of 2300 Hz. Table I gives some common fractional octave filters bandwidths and shows their series number in the Renard series.

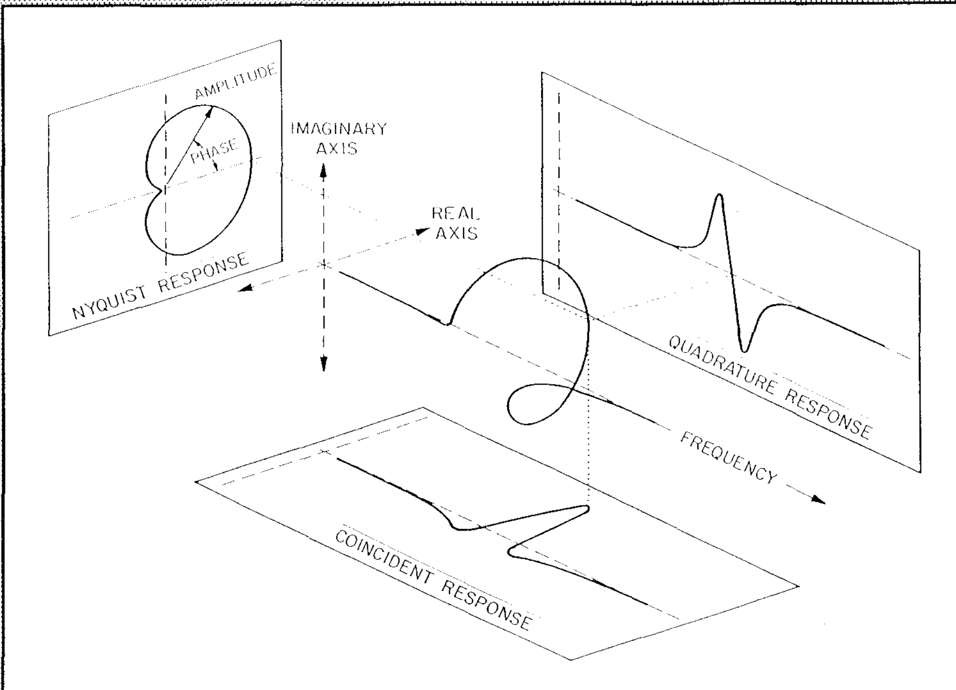


Figure 3 *Courtesy of Andrew Duncan*

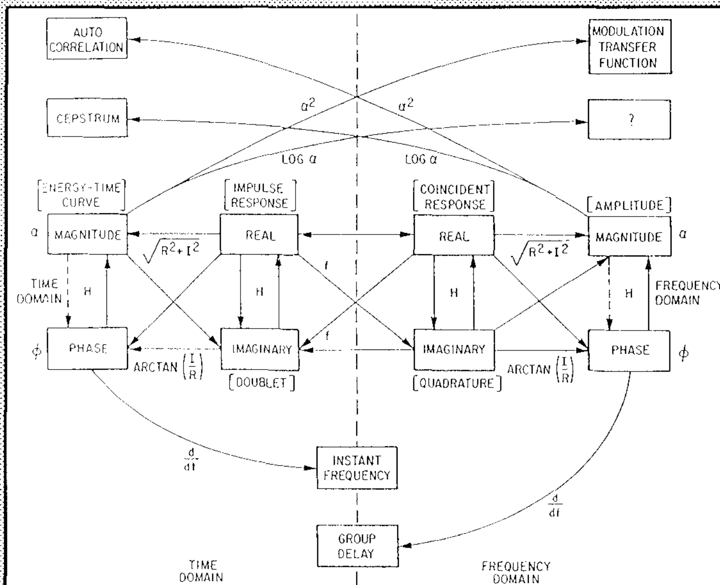


Figure 4

Fractional Decade Filters

Correctly designed real time analyzers do not actually use 1/3-octave filters. They employ 1/10 decade filters. An octave is a 2/1 frequency span. A decade is a 10/1 frequency span a basic 1/3-octave increment would be:

$$2^{(1/3)} = 1.25992104989$$

A basic 1/10 decade increment would be:

$$10^{(1/10)} = 1.25892541179$$

The difference between these two values is: 0.00099563810 or roughly one part in a thousand. If you place the 1/10 decade increment in a calculator and repeatedly multiply it by itself you will get all the 1/10 decade increments possible. Note particularly that the f_c thus obtained only match the labels at the decade points (i.e., 10, 100, 1000, etc.) The label increments are:

Labels	Exact Numbers
1.000	1.00000000000
1.250	1.25892541179
1.600	1.58489319245
2.000	1.99526231495

Fractional Octave Filter Equations

Fractional Octave	% Bandwidth	Renard Series*
1/1	70	3-1/3
1/2	35	6.67
1/3	23	10
1/6	11.5	20
1/10	7	33-1/3

*** Series = 3-1/3 x reciprocal of fractional octave**

Upper and Lower Limits

$$f_{LIMIT} = b^{+\left(\frac{1}{2 \cdot N}\right)} \times f_c$$

Fractional Octave

$$\text{Fract.Oct.} = \frac{1}{0.3\left(\frac{230}{\%BW}\right)}$$

$$\text{Series} = \frac{230}{\%BW}$$

$$\%\ BW = \frac{230}{\text{Series}}$$

Examples

$$f_{LIMIT} = 10^{+\left(\frac{1}{2 \cdot 33\text{-}1/3}\right)} \times 100 = 103.51\ \text{Hz}$$

$$f_{LIMIT} = 10^{-\left(\frac{1}{2 \times 33\text{-}1/3}\right)} \times 100 = 96.61\ \text{Hz} \quad \text{Difference} = 6.9$$

i.e., A 1/10 octave filter is a 7% of center bandwidth filter.

$$\text{Fract.Oct.} = \frac{1}{0.3\left(\frac{230}{10\%}\right)} = 1/7\ \text{octavefilter*}$$

Table I

* (1/6.9 octave rounded)

2.500	2.51188643148
3.150	3.16227766012
4.000	3.98107170546
5.000	5.01187233616
6.300	6.30957344464
8.000	7.94328234701
10.000	10.00000000000

What Order Filter?

While at first glance the higher the order (i.e., the greater the attenuation in dB per octave such as 6, 12, 18, 24, 30, 36 dB/oct) the nearer the ideal filter is approached for most audio and acoustic work; the lower order filters quite often are more satisfactory than their steeper counterparts. For one thing, higher slope rates have poorer transient response manifested by "ringing" of the filters after the transient signal has passed through them. Another useful property of the lower order filters is the opportunity for the knowledgeable operator to observe their skirt's interaction and tell sinusoid signals to within a few Hertz.

Loudspeakers as Bandpass Filters

All loudspeakers exhibit a high pass filter action at the lower frequencies and a low pass filter action at the higher frequencies, thus approximating in the acoustic domain the response of an electronic bandpass filter in the electrical domain. A loudspeaker can be very realistically modeled by a series of "band pass" and "all pass" filters.

Analytic View of a Band Pass Filter

Figs. 2 and 3 are the time domain and frequency domain views of a four pole Butterworth 1/3-octave bandpass filter. Fig. 4 is the domain chart to help you locate how these first two displays relate to each other via the Fourier transform and the Hilbert operator.

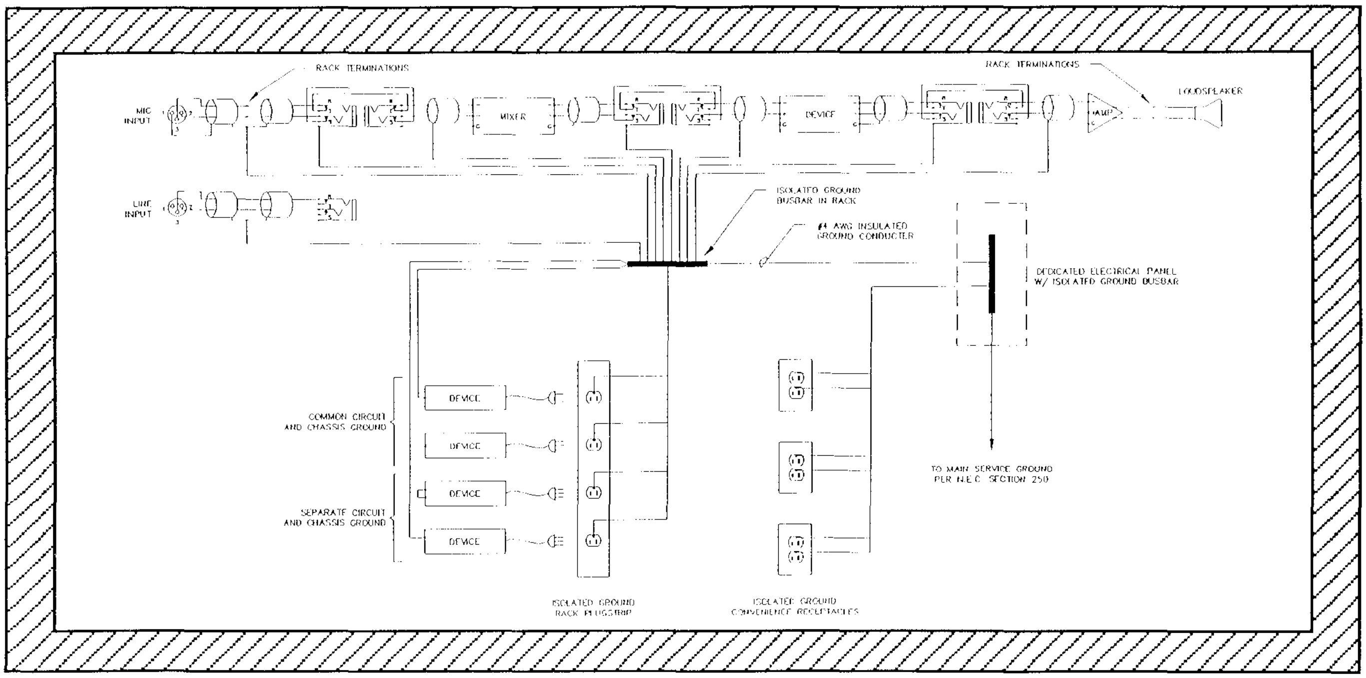
Conclusion

We have discussed the bandpass filter as commonly used in audio and acoustic work. The constant bandwidth and the constant percentage bandwidth types have been described. Finding the center frequencies of fractional decade filters as well as their upper and lower -3 dB frequencies is shown mathematically. Finally we have provided the analytic response of a 1/3-octave 4 pole Butterworth filter as an illustration of the time domain and frequency domain view of the transfer function. Careful study of this material should assist you in becoming familiar with the parameters of the bandpass filter.

Grounding & Shielding Schematic Guideline

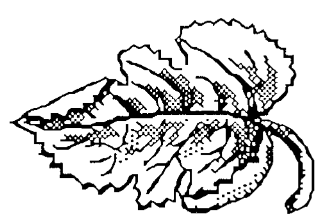
Troy Jensen of Peter George Associates in New York has shared with us the guideline schematic he uses to instruct contractor personnel. We note that he uses the RCA convention of pin 2 high. The Westrex convention is pin 3 high. Either is, in our opinion, acceptable. Just be sure you always know which convention is in use with each system you have to deal with.

We sincerely appreciate this sharing. If I were the contractor receiving this instruction I would respect the explicit directions as that would tell me that I was dealing with someone having practical as well as theoretical capability.

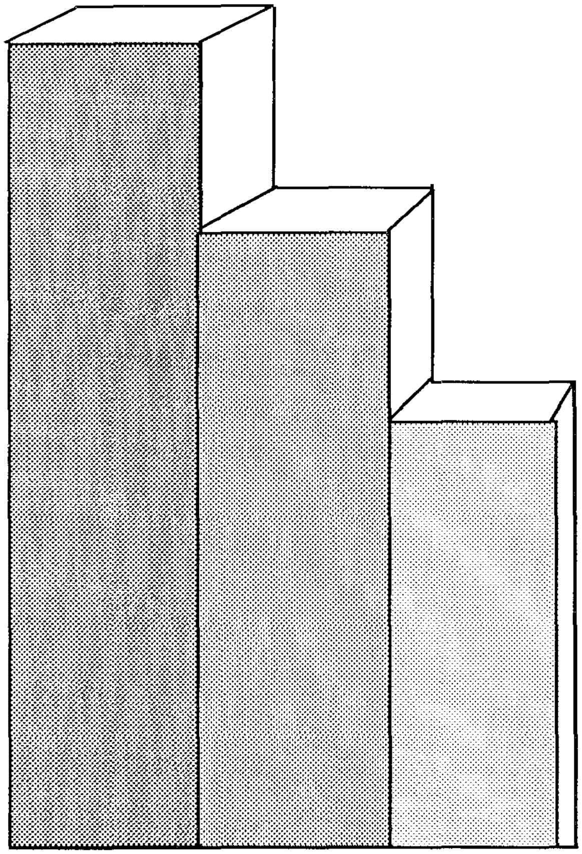


The Fall 1989 AES Convention

The Fall 1989 AES Convention in New York was in the hands of good friends: Glen Ballou, Convention Chairman; Ted Uzzle, Papers chairman, and Mary Gruszka, Workshop chairman. David Andrews was the facilities chairman. How could it be anything but a winner? The only complaint we heard was that it was not possible to be everywhere at once and to hear really important papers and attend the workshops.

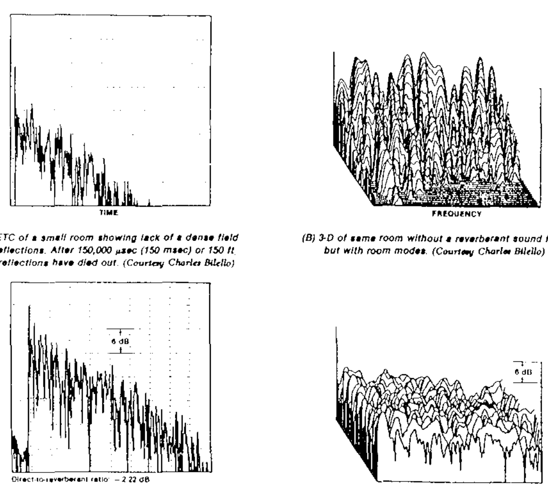


Peter D'Antonio conducted a 4-day workshop, "Optimizing the Listening Environment" dedicated to our friend, Charles Bilello. The session was originally Charles' dream. There is serious talk about printing the papers from the workshop and making them available as a book. Audio and Recording greats occupied the podium each day. A true feast. I can't tell you about the other workshops because if we had any time, we were at Peter's sessions. We didn't even get to the exhibits at all!



The Large Room Frequency

The term *large room frequency*, *critical frequency* or *Schroeder frequency* is a very useful concept and scaled from it is the modal zone, the diffusion zone, the specular frequency zone and the pressure zone. Farrel Becker's analysis of the basic equation ends up with the pertinent question of what frequency range for the average absorption value. It would seem to us that it should be that frequency corresponding to the room's largest dimension. In any case we are reprinting below Farrel's comments.



(A) ETC of a small room showing lack of a dense field of reflections. After 150,000 µsec (150 msec) or 150 ft, all reflections have died out. (Courtesy Charles Bilello)

(B) 3-D of same room without a reverberant sound field but with room modes. (Courtesy Charles Bilello)

(C) ETC of a large room where a sound field is still present at 1,134 msec or approximately 1000 ft (Courtesy Ruth Eckerd Hall)

(D) 3-D of a large concert hall with a good reverberant field.

FIGURE 9-1 Proof that there is a fundamental difference between small and large reverberant spaces.

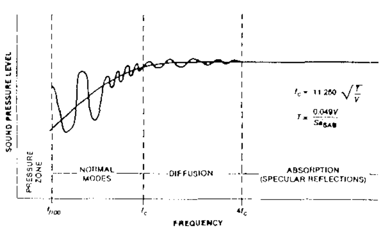


FIGURE 9-2 Controllers of steady-state room acoustic response. *(Courtesy Bolt, Beranek, and Newman)*

The equation for "Controllers of Steady-State Room Acoustic Response" (figure 9-2 on page 210 of SSE #2) is:

$$Fc = 11{,}250 * \left(\frac{T}{V}\right)^{1/2}$$

where T is the reverberation time and V is the volume.

Substituting the Sabine reverberation time yields:

$$Fc = 11{,}250 * \left[\frac{\left(\frac{0.049 * V}{Sa}\right)}{V}\right]^{1/2}$$

The Vs cancel and we get:

$$Fc = 11{,}250 * \left(\frac{0.049}{Sa}\right)^{1/2}$$

Bringing the constant outside of the radical we get:

$$Fc = 11{,}250 * 0.221 * \left(\frac{1}{Sa}\right)^{1/2}$$

Which yields:

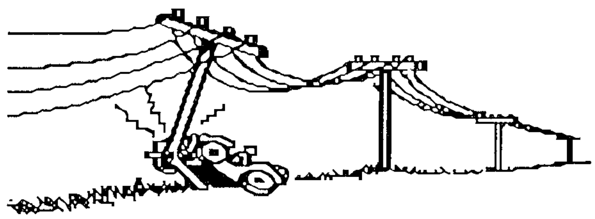
$$Fc = \frac{2{,}490}{Sa^{1/2}}$$

This seems to say that the critical (or crossover) frequency is solely dependent on the average absorption in the room. The question is: The average absorption at what frequency?

Cause and Effect

There are some people who sincerely believe that:

Cars go out of control;
Guns kill people;
Submission is better than fighting;
More money buys better equipment.



The list is endless. The people we are discussing are not necessarily the disturbed portion of the population (suicidal, necrophiles, hypochondriacs) but merely those who have given little thought to cause and effect.

I've heard people say, "My car went out of control." Having ridden with some of them I can say without equivocation that the car never was under their control—they were merely steering it about from place-to-place without any knowledge whatsoever of what control is.

When I can slide around a Ferrari on a wet road in a Volkswagon Bug, the lie is given to the car making a driver.

In audio, spouting the questionable specification of a stack of equipment does not make one an experienced audio engineer.

Zero Degree Fahrenheit

Gabriel Daniel Fahrenheit (1686-1736), a German physicist born in Danzig, spent a good deal of his life in England and Holland. The inventor of the Mercury in glass thermometer, he chose 0° as the lowest temperature obtainable with a mixture of ice and common salt and proposed to divide the interval between this temperature and that of the limit of heat which is found in the blood of a healthy man into 96 divisions. Today science uses the scale named in honor of William John Macquorn Rankine the earliest of the three founders of the modern science of thermodynamics (the other two being Sadi Carnot and J.P. Joule). The Swede Anders Celsius described the centigrade thermometer in 1742 (i.e., divided into 100 intervals) and Lord Kelvin developed a scale named after him in 1862. (The ice-steam interval fixed at 100°). Time does not allow discussion of such interesting men as Rene de Reaumur (1683-1757) who divided the scale into 80 intervals.

What all this is leading up to is that we have a large outdoor test of 0° F going on here at the farm even as I write.

Nose crinkling, servile behavior from the dogs wanting in, rapid "U" turns by the cat who thought he wanted out, all testify to the early human scales of:

Damn
Too damn hot
Hot
Warm
Pleasant
Cool
Cold
Very cold
Too damn cold
Damn

While ten points on the scale would seem adequate for self expression, weather men have always been fond of the Fahrenheit scale for its closely spaced gradients.

In the old days at the farm in this kind of weather we slept in unheated bedrooms with so many comforters that your limbs were tired in the morning from supporting their weight. In

the present good old days with well insulated houses, central heating, and electric blankets, living at the farm in the presently "Very cold" weather is a delight of ski clothes outdoors and warm cats in our laps, dogs at our feet, evenings spent reading good books or watching video movies.

The bird feeder just outside the picture window keeps the cats in a pleasurable stage of evil intentions while their fearless leader stalks the crunchy ground underfoot while afield with his 45-70 rifle looking for coyotes.

On a winter day like this we can truly say, "When it's all said and done, there's more said than there is done."

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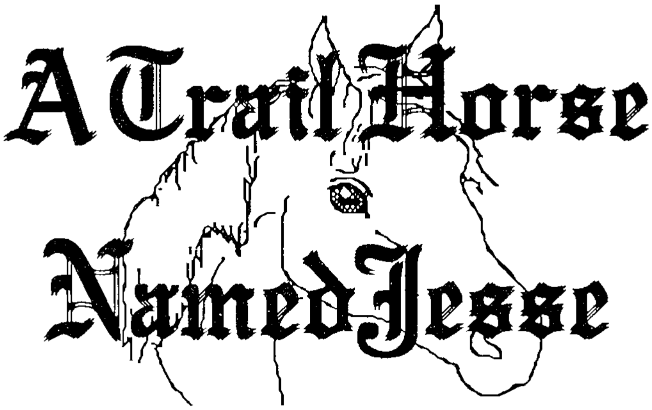
A Trail Horse Named Jesse



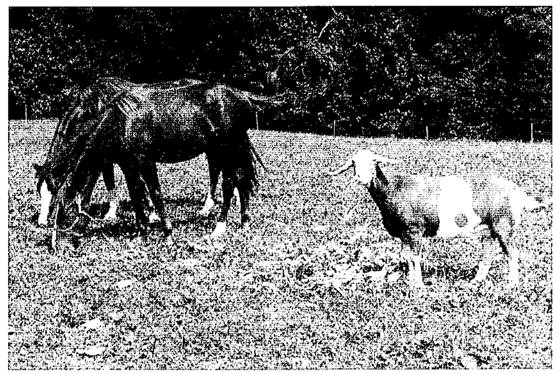
I hadn't been on a horse for two years. When My Laddie accidentally rolled on me and then stepped all over me while getting back up, I lost all interest in horsebacking

Carolyn doesn't like riding alone so I'd occasionally hike along with her at a horse rate. That led to considering the possibility of finding a gentle, well-trained horse for me. One try was a "whip broke" horse named Ben. He was fine to ride but shuddered all over when touched by a human hand. Another horse named Missy was offered and she truly was gentle. In fact she just stood there and wouldn't move.

The week before we were to leave on our winter tour, a relative of Carolyn's let us have their nine-year old mare named Jesse, a trail horse.

Jesse cautiously crosses deep ditches rather than jumping them, steps carefully over the logs of fallen trees, walks, trots, or canters at a touch of the heel and, to make a long story shorter, led me back to horsebacking.

The clincher came the day after we purchased Jesse. I walked into the barnyard. She walked right up to me, laid her head on my shoulder and had me rub her neck. I'd never had any horse do that and she made me hers.



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CONTACT: Tom Young, Audio Technologies 203-274-2202.

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I am a consultant who prepares plans and specifications for electronic systems: sound, audio-visual, video, security, computers, control, etc.

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CONTACT: Don Null, Null Engineering Co., P. O. Box 150, Topanga, CA 90290

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