SYNERGETIC
SYN AUD CON
AUDIO CONCEPTS

newsletter

Volume 13, Number 4
Summer 1986

P.O. Box 669, San Juan Capistrano, CA 92693
Ph: 714-728-0245

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.

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

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NEW SYN-AUD-CON SPONSOR--ALTEC

Successful companies are not made up of physical assets, nor do they belong to certain places. They are very much creatures of their time and the direct result of the caliber of men involved. When I think of the word Altec I can conjure up at least 5 periods, each distinct from the other, that stood for all that the word meant to differing groups of men.

(1) From 1926 to 1937, the Western Electric men of the ERPI division

(2) After World War II until about 1959, the theater men

(3) From 1959 to 1972, the remarkable growth years in the commercial sound business

(4) 1973 to 1985, the tragic years when the headless horsemen rode

(5) And now Altec is represented by a new breed of men who respect what the best of the old did in their day and who are seeking the path to their own and Altec's future.

We are pleased that these new men have chosen to be a sponsor of Syn-Aud-Con. We are impressed with the caliber of men and women that we have met at Altec recently. We sincerely hope that they will build unerringly back into leadership in their careful choice of marketplace. We welcome Altec wholeheartedly to the Syn-Aud-Con family of sponsors.

ALTEC LANSING®

STAFF

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A SUPER WORKSHOP - INTELLIGIBILITY

SEPT. 23-26, 1986 ST. CHARLES, IL. FEE: $600.00

(Suburb of Chicago)

STAFF:

ROLLINS BROOK, Bolt, Beranek & Newman, Los Angeles
DAVID KLEPPER, Klepper Marshall King, New York
VICTOR PEUTZ, Peutz & Associates, The Netherlands

PARTICIPATING MANUFACTURERS:

Bose Corporation Bruel & Kjaer Community Light & Sound
Crown International Electro-Voice JBL Professional

An audio avalanche is headed your way. For 57 years the only way to absolutely judge the audio quality of a given system or location was to conduct extensive, expensive articulation tests (H. Fletcher and J. C. Steinberg, "Articulation Testing Methods", **Bell System Technical Journal** 8, 806, 1929.) They stated that they first started such testing in 1919 and went on to say, "To obtain a desirable precision in the measurement of articulation, it is advisable to use at least five different voices and five listeners, at least 25 values being averaged in some way to obtain a final value for the condition tested." Few in the practical everyday sound business could afford either the time or the expense to conduct such tests.

In the early 1970s Peutz published his now famous $\%AL_{cons}$ equation which allowed us to predict with surprising accuracy the articulation index for a given set of electroacoustical conditions.

In 1985 Peutz developed a measurement of $\%AL_{cons}$ for the TEF analyzer. At nearly the same time, Bruel and Kjaer developed a Rapid Speech Transmission Index RASTI measurement using the modulation transfer function MTF technique put forward by T. Houtgast and H. J. M. Steeneken.

In our May TEF Workshop we discovered that $\%AL_{cons}$ were directly translatable into RASTI scores and vice versa by having Bruel and Kjaer personnel measuring side-by-side with us while we did $\%AL_{cons}$ measurement with the TEF analyzer.

As a direct consequence of this session we have worked out the following workshop for further detailed investigation of the prediction and measurement of speech intelligibility.

WHAT WILL WE DO?

We will work in three spaces: a well behaved auditorium, a good live auditorium, and a difficult room that would normally require acoustical correction before a sound system was installed in it.

In each room we will work with low, medium, and high Q loudspeakers raised on hoists to optimum source locations. We will divide the Workshop attendees into three groups and each group will have a full day in each space. Each group will also have a full day with each staff member. The fourth day will be a complete discussion of the data taken by the staff, supporting manufacturers, and open class discussion.

At each of the three sites we will predict intelligibility values and then measure them by means of the classical articulation tests using talkers and listener groups, $\%AL_{cons}$ measurements with the TEF analyzer and RASTI measurements with the Bruel and Kjaer instrument.

We will equalize the systems using conventional techniques as well as demonstrations of the Bruel and Kjaer two channel FFT using the SIM technique.

We will use electronic signal alignment to align two dissimilar horns in an array.

This workshop will headquarter at the Pheasant Run Resort in St. Charles, Il and we'll work out from there to the three test sites.

WHAT DOES ALL THIS MEAN TO YOU?

The real bottom line to all of this is that in the future **your** systems are going to be checked on behalf of your customer for intelligibility. If the sound systems fails the intelligibility test, you are going to lose money, reputation, time, and peace of mind. If you really want to understand and be able to use effectively these new techniques, plan systems that will measure well, and be in at the beginning of the new era, then this Workshop is for you.

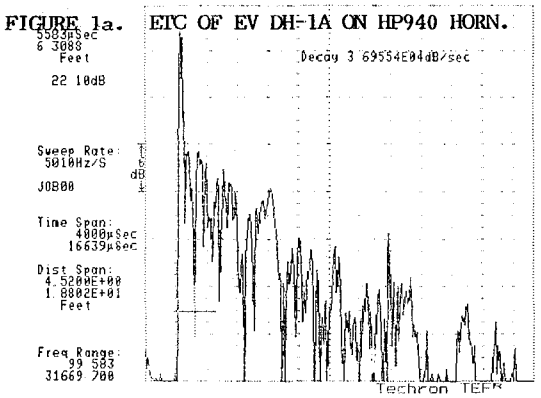
WHO SHOULD ATTEND?

Anyone who has anything to do with specifying sound systems. Anyone who has a poor sound system needing correction. Anyone involved in the installation or servicing of sound systems. Anyone involved in the study of articulation and its measurement and, finally, anyone who really cares about what sound systems are supposed to do and so often don't, namely make sure a listener hears and understands the talker's message.

NEW DRIVER FROM E-V

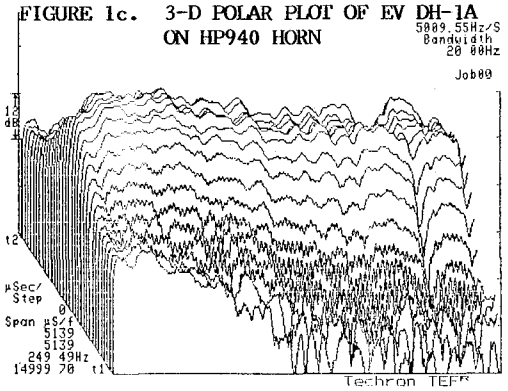
We recently had the opportunity to test a new high frequency driver Model DH-1A from Electro-Voice that was designed by Cliff Hendrickson. It was mounted on a HP 940 horn. It is easily the best unit of its type we have tested to date.

FIGURE 1a. ETC OF EV DH-1A ON HP940 HORN.



The polar response in 3-D and the overlaps at key frequencies show an unbelievable control over the total acoustic energy. See Figures 1c - 1g.

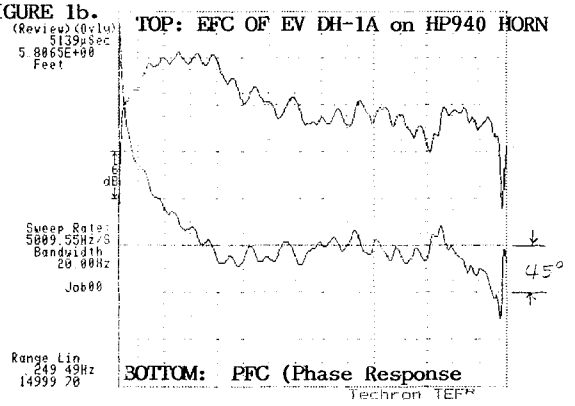
FIGURE 1c. 3-D POLAR PLOT OF EV DH-1A ON HP940 HORN



Vertical: 12dB/div
Horizontal: 210° through 0° to 160°
0° = curve #15 (i.e., 16th sweep)
Resolution: 2.5048E+02 Hz

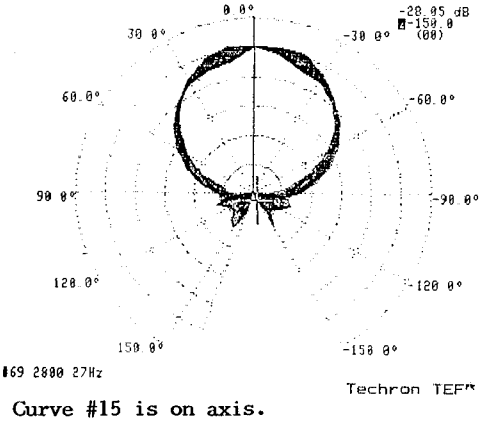
The ETC, EFC and PFC reveal a well behaved, exceptionally smooth phase response and less time smear than we have found typical in contemporary horns. See Figures 1a & 1b. The Nyquist showed increasing internal reflections at the higher frequencies but all of small amplitude.

FIGURE 1b. TOP: EFC OF EV DH-1A on HP940 HORN



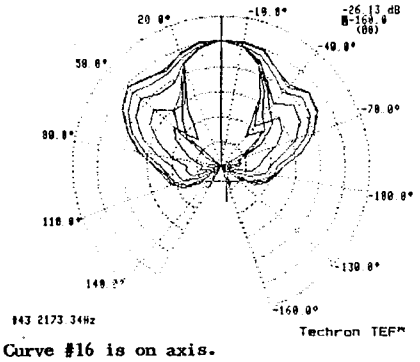
Vertical: 6dB/div
Horizontal: 249.49 Hz to 14999.70 Hz
Resolution: 4.5114E+00 Feet & 2.5048E+02 Hz

Figure 1d. Overlay of EV HP940 Horn 1000-2800Hz in 50Hz steps.



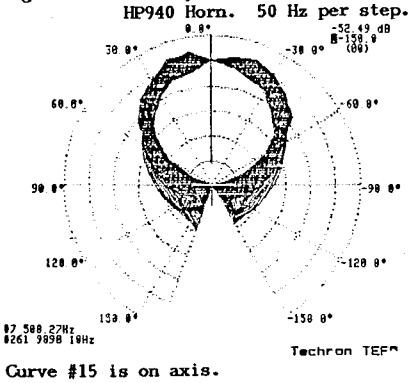
Curve #15 is on axis.
Grid spacing of 6.00 dB and data gathered at 10.0 degree increments.
Center of display is 30.00 dB down.

Figure 1e. Overlay of a system not as well controlled. 1800-2100 Hz @ 50Hz/step.



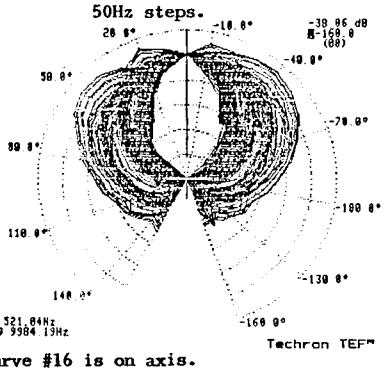
Curve #16 is on axis.
Grid spacing of 6.00 dB and data gathered at 10.0 degree increments.
Center of display is 30.00 dB down.

Figure 1f. Overlay of 500-10,000Hz for EV HP940 Horn. 50 Hz per step.



Curve #15 is on axis.

Figure 1g. Overlay of less well controlled horn from 500 to 10,000 Hz in 50Hz steps.



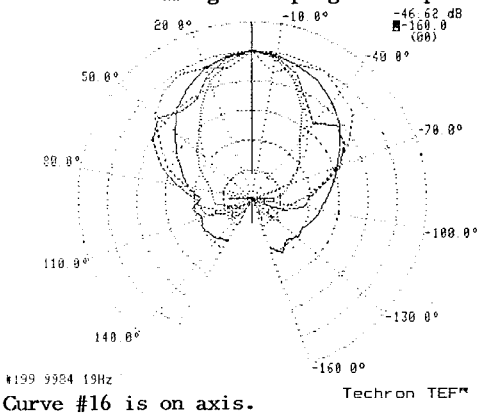
Curve #16 is on axis.

Figure 2 illustrates a very attractive feature of this new polar program from Techron. It allows 5 different overlaps to be distinguished by their lines, dashes, dots, etc.

Careful polar plotting of loudspeakers gives a new perspective on first order reflections in any kind of space -- from control rooms to uncontrolled rooms. Such plots allow careful planning of specular reflection energy for re-aiming at diffusors as well as the first energy encounters.

Perhaps the best part of our doing these measurements was that they confirmed completely the data sheets put out by EV on this horn. It's reassuring to know that it is safe to use their very comprehensive data with confidence in its integrity.

Figure 2. An example of overlays using mask program on polar disc.



Curve #16 is on axis.

SIGNAL ALIGNMENT

Just as we were finishing the writing of this Newsletter we received a package from Jim Carey of James Carey and Assoc in Nashville, TN. Jim had just finished two "long days of work" at the First Baptist Church, Dallas. Jim had physically brought an entire array into alignment in its overlap zones. Jim says that after two long days of work "the system performance proves our time was well spent."

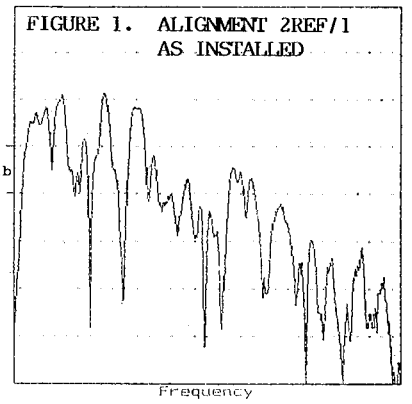
We want to include Jim's material in a Tech Topic for the fall mailing but couldn't resist including two of his measurements now.

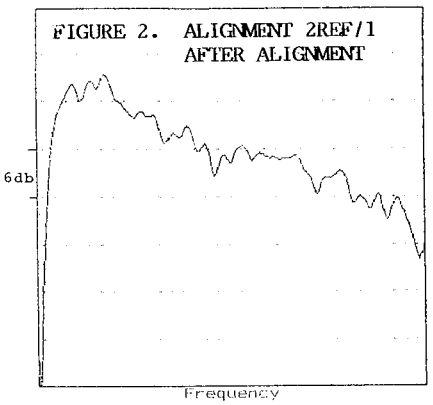
You'll recall that we published a church system that deteriorated as each horn was added to the array. (NL V12N4). In this case, Jim was in a very similar situation only he had been hired to correct it.

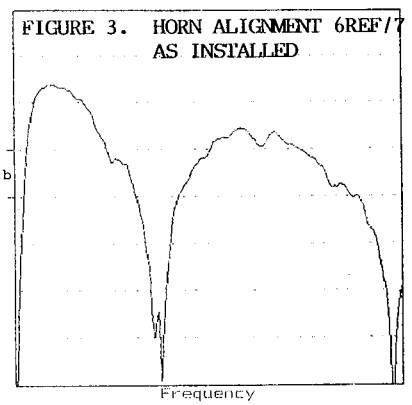
Alignment is vitally important and the sooner that we can show the real-life results the faster manufacturers will supply the devices needed and users will gain the necessary expertise.

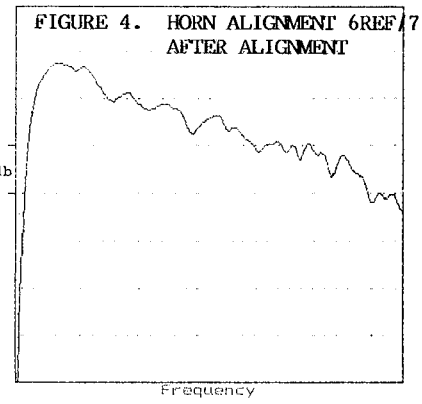
One caution: not all devices are alignable. The horns at First Baptist were.

Jim quotes a local acoustic consultant as asking skeptically, "In which seat do you want the alignment correct?". For the past three years we have demonstrated that when the wavefronts of alike devices are in alignment, the alignment holds over the whole angle. Read the Tech Topic on our TEF Workshop at St. Boniface church in May, 1986. When we electronically aligned a long throw and a short throw horn (the wavefronts were physically in alignment), there was a dramatic improvement in sound, not only in the overlap zone but all over the church.









MEASUREMENT PARAMETERS FOR FIGURES 1 - 4:

VERTICAL: 6dB/div HORIZONTAL: 50.33Hz to 14999.70Hz RESOLUTION: 500.96Hz

TRAGEDY

Sonny Metts, sound technician, Entertainment Facilities, City of Spokane, WA sent us a description of a local tragedy. We quote, with permission, from his letter

SPOKANE RIVERPARK CENTER

OPERA HOUSE CONVENTION CENTER
COLISEUM ALBI STADIUM
WEST 334 SPOKANE FALLS BOULEVARD
SPOKANE, WASHINGTON 99201
(509) 456-6000

I read some paragraphs in a recent Newsletter asking rhetorical questions as to the gullibility of purchasers of audio equipment. Unfortunately there appears to be a market for almost anything.

Enclosed you will find brochures for a line of speakers being made here in Spokane. I think the literature pretty much speaks for itself, but it get weirder. I have had these speakers demonstrated for me and have had a chat with the designer. When I asked the designer if there was a crossover in the cabinet he replied "Kind of, but it's my own design called Electro-Inherence and you wouldn't understand it." He's right, I don't. When I asked for the sensitivity specs he quoted me the driver manufacturer's specs. He had never measured his own design. When I asked for the polar response patterns he told me that they had a "Rhombic" pattern. A what? A little pink noise and an RTA - showed the frequency responses weren't even close to the specs he quoted me. When I asked the designer to explain the discrepancies he replied - "These speakers were designed as a stereo system and you can't measure just one, besides they are the wrong distance out from the wall." Say what? A frustrating, interesting and sometimes amusing afternoon. However, there was a final ironic twist. Our local school district purchased several speakers for use in highly reverberant, brick lined, gymnasiums. They believed every word the man said. Tragic.

Snake-Oil is (unfortunately) alive and well in Spokane.

When we wrote Sonny for permission he remarked in his letter back to us *"To be libelous a statement must be false. The story is sad but true."*

SWITCHCRAFT PART NO. CORRECTION

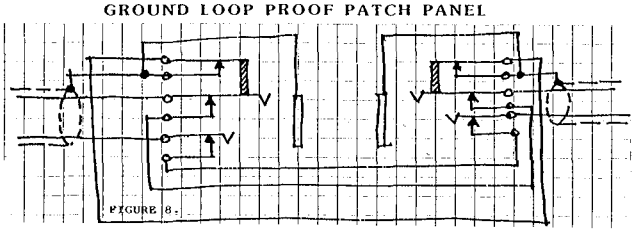
In the diagram shown here (from Tech Topic V13,N5,P3) we gave the part number Switchcraft MT-336 for building the Ground Loop Proof Patch Panel (designed by Farrel Becker). It wasn't long after sending out Volume 13 Newsletter mailing that we received a call from HIS Sound in Fresno. In discussing the part problem with Switchcraft it was determined that the correct part number, MP 338. was not a stocked item by Switchcraft.

The good news is that when Switchcraft realized that there was a genuine need for Switchcraft MP-338 to become a stocked item they proceeded to put it into stock for quick delivery.

We sincerely regret any problems this has caused (in one case having to custom make the patch panel metalware) and we hope that these correct numbers will lead to a lot of use for this better idea.

We are very pleased at the responsiveness of Switchcraft in correcting the stocking problem. If you have any ideas or suggestions that you want to discuss with Switchcraft, call Bill Kysak 312-792-2700. He's listening.

GROUND LOOP PROOF PATCH PANEL



AUDIO ACCESSORIES 322A SWITCHCRAFT MT-336A MIL. JJ - 075

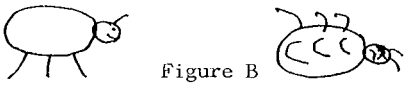
WE'RE LATE

We're late getting our Newsletter written this summer. For a good reason, though. When we arrived at the farm in Indiana for the summer in late May we had waiting for us 19 edited chapters of the 2nd edition of **Sound System Engineering.** It meant putting everything aside until the work was done, otherwise the publisher couldn't keep their publishing date, which is now November.

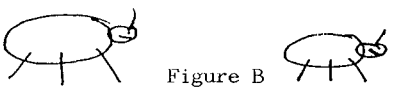
The first week in July the re-edited chapters went back to Sams and we turned our wholehearted attention to the Newsletter. One little difference in this Newsletter from ones published the past 7 or 8 years, the Newsletter was completely typed by me (Carolyn). One benefit from the editing of **Sound System Engineering** job was the purchase of a Compaq. I hope that it means a little better editing job of the Newsletter. The ability to change as we write is conducive to better work.

SIDEBAR

1. If Figure A is, by definition, a centimeter: what is Figure B?



2. If Figure A is, by definition, a weevil: what is Figure B?



ANSWERS:
1. an erg (a dyne-centimeter).
2. Obviously the lesser of two weevils.

Contributed by Richard Downes, Orlando, FL.

UNDEMOCRATIC PRACTICES AT AES

A few months ago we were called and told that the members of the Board of Governors of the AES could not get a detailed financial statement from the Society or even be told the salary of the executive director. Recently we called and talked with the president of the AES with a suggestion that all AES balloting and ballot counting should be conducted by an independent organization. We were told:

1. Only a special executive group has access to financial data relative to the society or the executive director's salary and compensation package.

2. No one was twisting our arm to be a member of the AES.

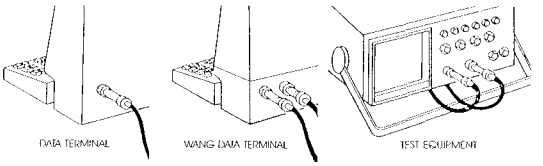
At this point Syn-Aud-Con has no choice but to agree that the AES management is hiding something and it is surely time for the Board of Governors and the membership as a whole to insist on a more democratic management of **their** society.

IMPEDANCE MATCHING ADAPTORS

We recently ran across OPT Industries, Inc. They have a line of impedance matching adaptors for interfacing computors with test equipment, data cabling systems, and local area networks. IBM uses a 93 Ω system whereas most test equipment is using 75 Ωs. OPT's address is 300 RED School Lane, Phillipsburg, NJ 08865. Ph 1-800-453-2580.

OPT IMPEDANCE MATCHING ADAPTERS

P.N.	FROM MALE BNC	TO FEMALE BNC	SIZE
IM 9375	75Ω	93Ω	9/16" dia. × 1 15/16" long
IM 9350	50Ω	93Ω	9/16" dia. × 1 15/16" long
IM 7550	50Ω	75Ω	9/16" dia. × 1 15/16" long
	MALE BNC	FEMALE BNC	
IM 9375W	75Ω	93Ω	5/8" dia. × 2" long



SYN-AUD-CON SPONSORS

Syn-Aud-Con is more than halfway through its 14th year of service to the audio industry. That time interval can also be described as 6500+ grads of the classes and it certainly is measurable in the support and loyalty of our sponsors.

Many of these sponsors have been with us since the beginning and we have treasured the special relationships we have been privileged to have with them.

Syn-Aud-Con's mission is multi-faceted.

1. We primarily exist to teach audio basics to all in our industry.

2. We provide special workshops that have state of the art tasks to perform free of political or commercial influences.

3. We serve as a third party channel of desired, needed, or neglected ideas from those in the field to the manufacturers.

Most of our sponsors are very receptive to new ideas and concepts. Our work in the classes exposes us to industry needs. At the same time we see the bright people with the answers to the needs. Often our role is to bring them together and then help them let the industry know about solution. This aspect of Syn-Aud-Con gives us enormous pleasure.

The most important aspect of our sponsorship program is the support they give to our efforts to provide education. Our seminars and workshops are essentially non-profit. Our sponsors make it possible for us to bring audio seminars and workshops to your area and at a price that is affordable.

We held our sponsor group to ten for many years and more recently to 12. Much has changed over this 14 years and many new faces have become familiar in our business.

Because we do perform valuable recognized services it has become increasingly apparent that we could expand our usefulness by accepting qualified manufacturers desirous of supporting what we do for the industry.

With all the above in mind we have opened the list to include more sponsors and hope that through this step we are able to include those additional worthy sponsors who have been on our waiting list.

New sponsors since the last Newsletter include Altec and Biamp. Our current list of sponsors is:

Altec Lansing Corporation
Benchmark Media Systems, Inc.
Biamp Systems, Inc.
Bose Corporation
Community Light & Sound, Inc.
Crown International, Inc.
Electro-Voice, Inc.
Emilar Corporation
HM Electronics
Industrial Research Products, Inc.
JBL Incorporated/UREI Electronics
Shure Brothers Inc.
Switchcraft, Inc.
TOA Electronics, Inc.

"STUPERSPACE"

David Wright recently sent us an article entitled "Stuperspace".

My favorite equation in this paper is

$$r = \textcircled{\scriptsize -1}\,\psi\bar{\psi}$$

where $\textcircled{\scriptsize -1}$ is the telephone operator.

"As usual, intermediate vector bosens become massive by eating Kibbles [35-1/2]. Reference General-Mills Stetle and Mae West. Wee Parton's and Dolly Partons (fermions and bos'ns) in the south Parton Sea. J. Nautical Phys. 36(24)36"

While this paper appeared in a Physics journal, a fair facsimile can be obtained in almost any issue of current audio publications, such as,

"I don't use 1/3-octave equalizers because their phase shift causes bad breath and your feet to swell." To which a Letter to the Editor by someone who senses something is wrong but doesn't know what, writes: "Did the author mean smell or swell?"

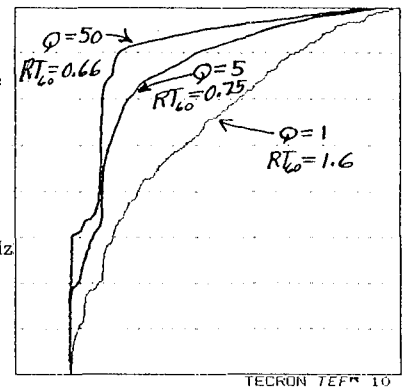
EFFECT OF Q ON EARLY DECAY

A possible way to measure Q may well be to measure the change in early decay rate in dB/sec or the early decay time EDT. Both change in relation to the changes in Q of the source. Early guesses indicate that the square of the EDT ratios are the Q ratios.

One problem with our data is that the Q values assigned to devices we have tested have not all been made by the same techniques. We will soon correct this problem when we conduct the special Intelligibility Workshop as all devices used in it will have their Q measured by the same method.

This relationship has important implications: all pertinent measurements of a sound system and its environment should be made using the sound system's loudspeaker system in its installed location.

The effect of loudspeaker Q on the excitation of the reverberant sound field's level is evident and proven. What yet needs careful investigation is the effect of Q on the density and distribution of the reverberant sound field on real life situations.



SYN-AUD-CON SCHEDULE 1986

SYRACUSE, NY

Civic Center - Onondaga County
August 18 - 19, 1986

"ON LOCATION"

Crouse-Hinds Concert Theater
August 20, 1986

CHICAGO, IL

Pheasant Run Resort Hotel
September 17 - 18, 1986

MINNEAPOLIS/ST PAUL

Rodeway Inn
October 1 - 2, 1986

MISSOURI

To Be Announced
October 7 - 8, 1986

NEW YORK AREA

The Hartz Inn
October 22 - 23, 1986

WASHINGTON, DC

Sheraton Hotel-Tysons Corner
October 28 - 29, 1986

ATLANTA, GA

The Presidential Hotel
November 5 - 6, 1986

ORLANDO, FL

Hilton Hotel
November 18 - 19. 1986

INTELLIGIBILITY WORKSHOP

September 23-25, 1986

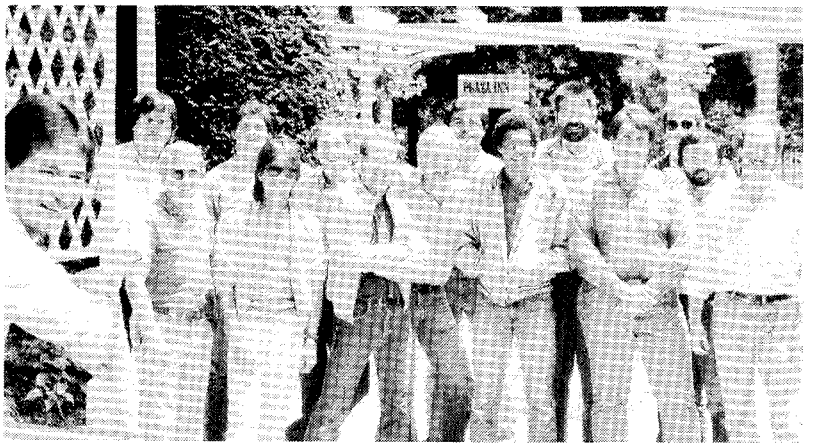
Pheasant Run Resort Hotel St. Charles, IL

FEE: $600.

STAFF: V.M.A. Peutz Rollins Brook David Klepper

OPRYLAND CLASS

We held an especially enjoyable special class for the audio people at Opryland.



The evening of the first day of class we were invited by Mark Johnson and Terry Smith to dinner and a show on The General Jackson which has the only self-powered theater in the world on a river boat.

SPEAKER MEASUREMENTS

The next day in class we measured a few of the different speakers that were used at Opryland. One of the speakers brought in for measurement was of the same model as the speaker on The General Jackson. Someone said, let's measure what emits from the back of the box!

That quiet statement opened up a whole new area to study. See Figure 2b. The top curve is the on-axis frequency response. The bottom curve is from the back of the box.

Bass frequencies are omnidirectional. The more directional high frequencies are aimed at the audience but the microphone under the loudspeakers is seized by the bass radiating off the bottom and back of the box, thus requiring equalization in the 200-500Hk region which can directly affect on-axis response. While the bottom curve looks much lower in level than the upper curve, it isn't as far as the microphone is concerned.

Speakers A B & C

Let`s call the speakers we measured A, B, and C inasmuch as we have them shown here in their real alphabetical order. "A", since it measured so well is identified. Its a Community 327I packaged system. Kurt Wagner uses it in the park for wide angle coverage. And it is not hard to see from the measurements that the 327I delivers even coverage over 100°.

The Three ETCs

A has the least time smear. Note that all three ETCs were taken with identical measurement parameters. See Figures 1a - 1c.

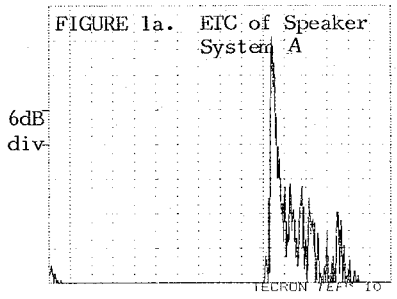


FIGURE 1a. ETC of Speaker System A

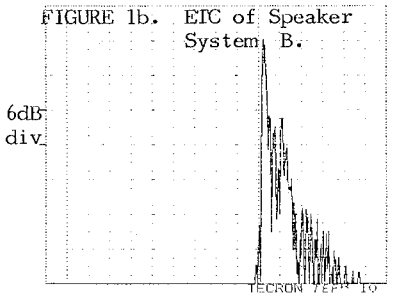


FIGURE 1b. ETC of Speaker System B.

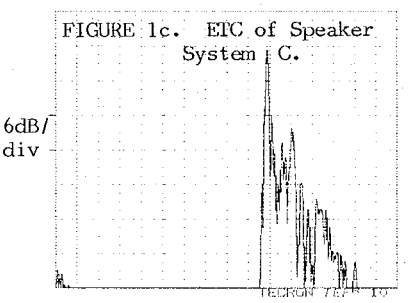


FIGURE 1c. ETC of Speaker System C.

Horizontal: 0 microseconds or 0 Feet to 15959 microseconds or 18.0342 Feet
Scale: 4.9307E+00 Feet/inch or 1.9412E+00 Feet/cm
4363 microseconds/inch or 1717 microseconds/cm.

EFC and PFCs

Here we begin to see differences that many of us know how to listen for in music and speech. Both A & B have good extended smooth frequency response (Figure 2a & 2b).

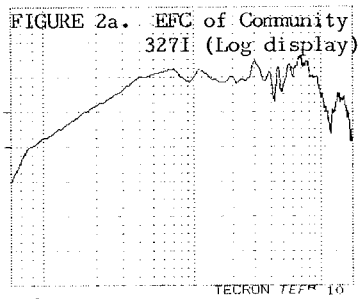


FIGURE 2a. EFC of Community 327I (Log display)

Vertical: 6dB/div with base of display at 22.4dB
0dB is located at .00002 Pa

Horizontal: 39.62Hz to 17997.90Hz
Log freq axis (2.7decades)

Resolution: 4.5114E+00 Feet & 2.5048E+02Hz

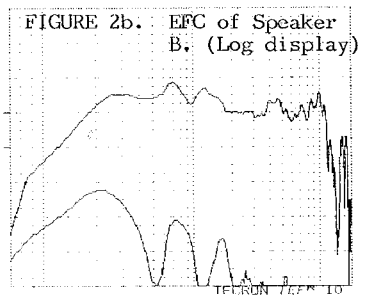


FIGURE 2b. EFC of Speaker B. (Log display)

C is in serious trouble. Figures 2c and 2d reveal at least one of the problems is an inadvertent polarity reversal. Figure 2e shows Speaker C with midrange covered (bottom curve).

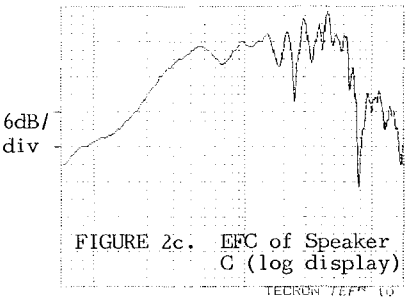


FIGURE 2c. EFC of Speaker C (log display)

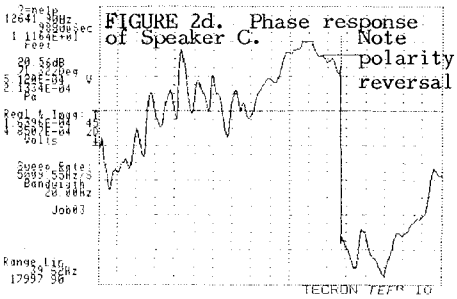


FIGURE 2d. Phase response of Speaker C. Note polarity reversal

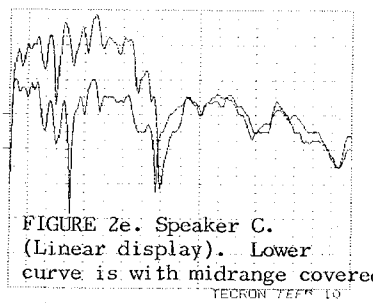


FIGURE 2e. Speaker C. (Linear display). Lower curve is with midrange covered.

Horizontal: 39.62Hz to 17997.90Hz

Scale: 4909.96Hz/inch or 1933.06Hz/cm.

Directivity

Keep in mind that these were quick tests run during a class for a group of audio professionals already using these loudspeaker systems. The marvel of TEF measurements to us is that we can produce rapid, repeatable, laboratory accuracy tests on the spur of the moment with tools such as "quick difference". These responses at varying angles off-axis were with on-axis response normalized to uniform in the center of the screen's vertical axis.

If you look carefully you can see that A at 10^{o} off axis is almost exactly the same as the normalized on-axis plot. Except for the narrow notch at 2500Hz the response stays remarkably uniform out to 70^{o} (included angle 140^{o}). See Figure 3a. B on the other hand is running off the screen at 30^{o} (included angle 60^{o}) and only 10^{o} is really usable. See Figure 3b. C is in real trouble at 20^{o} (included angle 40^{o}) and has same off-axis high frequency characteristics that would indicate potential feedback proclivities in a sound reinforcement system. See Figure 3c.

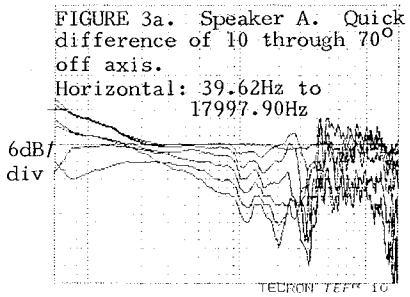


FIGURE 3a. Speaker A. Quick difference of 10 through 70^{o} off axis.
Horizontal: 39.62Hz to 17997.90Hz

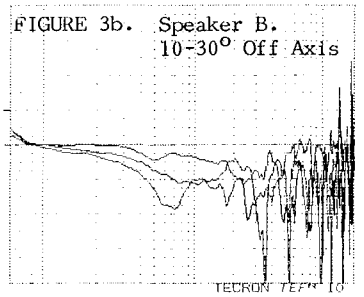


FIGURE 3b. Speaker B. 10-30^{o} Off Axis

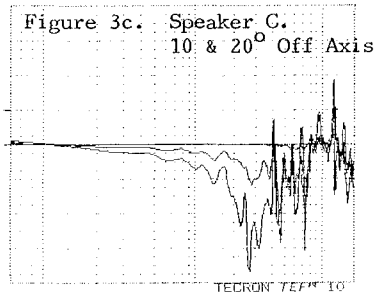


Figure 3c. Speaker C. 10 & 20^{o} Off Axis.

The EV Sentry

The Nashville Network brought in the EV Sentry 100 which they used for near field monitors. We failed to save on the disk anything but the frequency response with and without grill. It is plus or minus 3 dB, with good horizontal polar pattern, but a better vertical, which would indicate that it might be better used on its side for many applications rather than upright. The minor anomolies are about 2000Hz apart, indicating a path difference of about 6".

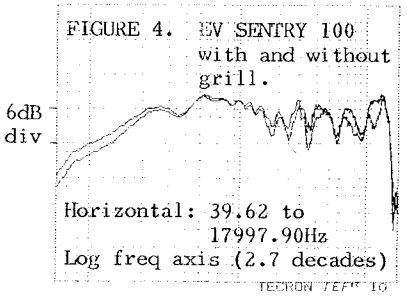


FIGURE 4. EV SENTRY 100 with and without grill.
Horizontal: 39.62 to 17997.90Hz
Log freq axis (2.7 decades)

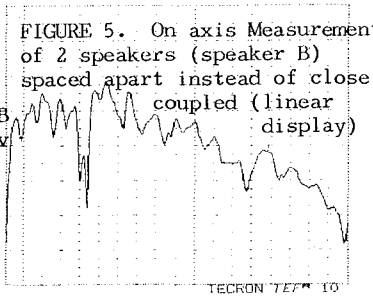


FIGURE 5. On axis Measurement of 2 speakers (speaker B) spaced apart instead of close coupled (linear display)

WRAP UP

After the class we wrote Mark Johnson and ask him who said, "let's measure what emits from the back of the box". Kurt Wagner wrote, "It was either Rick Shimer or myself, but we got the idea at the same time. Perhaps it would be best to just think of it as an Opryland Sound Department idea. It is a very good example of synergism in action as we were all stimulated to think together."

VU AND PEAK-PROGRAM METER

William W. Seton III of Lake Worth, FL sent us an interesting article on the VU Meter and the PPM written by Randy Hoffner, a staff engineer with NBC Operations and Technical Serivces. The article appeared in the May 1986 issue of **TV Technology**, pp 11-12. The illustration shown here appeared in the article and provides the three scales in common usage.

The typical PPM scale (A scale) is shown as Figure 3 and the scale specified in EBV-3205 (the E scale) is shown in Figure 4. The alignment point is called "ref" on the A scale and "test" on the E scale. EBV stands for the European Broadcasting Union.

Figure 1. Block Diagram of the Stages of a Typical Standard Volume Indicator

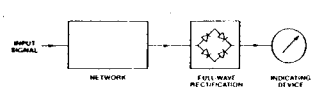


Figure 2. Arrangement of a Typical SVI Scale

Figure 3. Arrangement of a Typical Peak-Program Meter Scale

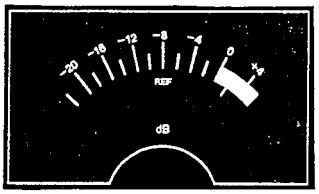


Figure 4. EBU "E" Scale

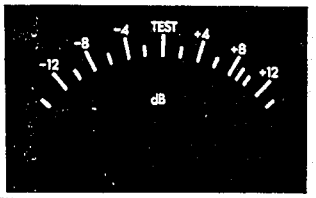
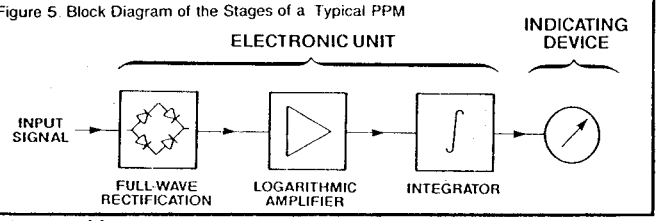


Figure 5. Block Diagram of the Stages of a Typical PPM



Mr. Hoffner goes on to explain how to calibrate both the VU meter and the PPM when they will be used side by side. Use a test signal that causes the VU meter to indicate ∅ VU on its scale (Mr. Hoffner makes it clear tht the actual reading is the algebric sum of the indication and the associated attenuator network.)

When the VU meter is indicating ∅ adjust the A scale PPM to Ref or the E scale PPM to Test. In actual operation, the program material will be held to ∅ on the VU meter, 8dB above Ref on the A scale PPM and 9 dB above Test on the E scale PPM.

Mr. Hoffner's key remark, in our opinion, is "In the hands of an operator who understands them, the two meters used together can be very informative about the characteristics of the audio signal".

The main difference between the two types of meters is their integration times: 150 msecs for the VU meter and 10 msecs for the PPMs. To again quote Mr. Hoffner, "The VU meter displays an average volume level, while the PPM displays the program peaks within the constraints of its 10 millisecond integration times".

My Ralph Townsley designed peak reading meter has a fast integration time of 100 usecs (microseconds).

We were interested that no where in the article did Mr. Hoffner define the VU as a level and by implication from the calibration instructions regards it as a voltage rather than a level. On a sine wave calibration when the algebraic sum of the indication and the network equal ∅ VU, then the power in the circuit should equal 0.001 watt or a level of 0 dBm. If it does not, then there is either an impedance mismatch or a faulty device.

Mr. Hoffner's article is well researched and well written. He points out that the IEEE 2.1.2. audio measurements sub-committee is currently in the final stages of a document, project 152, which will become a contemporary audio measurement standard. Our prayer is that they come up with a standard on the reference level.

NEW TEF OWNERS

We keep an updated list of TEF owners in our computer. We can print out by zip, by state, or alphabetically. If you would like a listing send $1 for each print out to Pat in our California office.

Mr. Chip Davis
Cape Cod Audio
80 Enterprise Road
Hyannis, MA 02601
(617) 775-7710

Ms. Rita Turske
NASA MA 500-303
2100 Brookpark Road
Cleveland, OH 44135
(216) 433-2248

Mr. John Lehmann
Dove & Note Recording
P O Box 741705
Houston, TX 77274
(713) 723-7109

Mr. John Solleciho
JSE Corporation
519 E. Middle Turnpike
Manchester, CT 06040
(203) 643-2160

Mr. Craig Thompson
Thompson Electronics
3522 W. Harmon Highway
Peoria, IL 61604
(309) 637-2277

Mr. Marshall Buck
Cerwin-Vega
12250 Montague Street
Arleta, CA 91331

Mr. Tim Tardo
Peavy Electronics
711 A Street
Meridian, MS 39301
(601) 483-5365

Mr. Jay Mitchell
Frazier
1930 Valley View Lane
Dallas, TX 75234

S V C
BP 50056
95947 Roissy Aeroport
FRANCE

Mr. Bill Webner
Audio One
515 N. Abbey Road
Elyria, OH 44035
(216) 323-6414

Mr. Tony Rodriguez
Sierra Recording
669 Seminary South
Fort Worth, TX 76115

Ing. Manssons Akustik
Box 43215
S-100 72
Stockholm, SWEDEN

REFERENCE OUTPUT

The reference output is one of the most frequently overlooked points when someone new to precision digital delay devices, PD^3, first examines one.

We define PD^3 as precision digital delay devices having steps of **10 usecs or less.** If you were to connect directly to one source and through the PD^3 to another source, they would have to be at least 70-80 usecs apart before you could utilize even the first step as it takes that long to pass through the analog-to-digital convertor ADC and then straight back through the digital-to-analog convertor DAC. While 70-80 usecs may seem inconsequential to anyone accustomed to thinking in millisecond steps, such delay amounts to an **acoustic** travel distance of about 1":

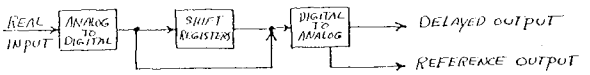
$$D = R \times T.$$

If R = 1130 ft/sec and T = 0.00008 secs, then D = 1130 (0.00008) = 1.08 inches.

To those who have witnessed such misalignments on TEF analyzers and listened to them with their ear-brain, the whole high end seems to disappear.

Thus enters the reference output. See Figure 1. An output is established to act in place of a direct connection in parallel with the input. However, this **reference** output has passed through the ADC and DAC and the delayed output can now be adjusted to be 10 usecs later.

REASON FOR REFERENCE OUTPUT ON PDDD



APPROXIMATE DELAY THROUGH ADC AND DAC EQUALS 70 - 80 MICROSECONDS.

Another interesting benefit can be derived from using a reference output. A circuit can be devised to look back at the real input and see events that are "in the future" from the perspective of the reference output. This allows non-causality to operate so far as the reference output listener can tell.

Our advice. Don't buy a PD^3 without a properly designed reference output.

THROAT MICROPHONES

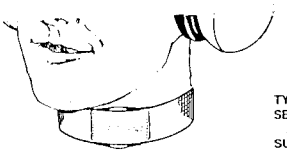
A few months ago we had a phone call from a Boeing engineer in Huntsville, AL who needed a source for throat microphones. We didn't know of anyone at the time but since then have found two.

Ferd Boyce of Northshore Marketing (our rep in the Northwest) sent us the name of Controlonics Corp, Communications Division, 49 Power Rd, Westford, MA 01886. Ph (617) 692-5434.

More recently David Clark sent us a microphone flyer announcing several microphones that can be attached to most type of protective headgear and breathing apparatus. David Clark makes an electret throat microphone model TM-1 P/N 18882G-01 (see description in Figure 1). A throat microphone is a form of acceleratometer (sensitivity 16-40 millivolts at 1KHz/3m/S^2 acceleration with 8v/10K Ω bias and 6200 Ω load).

The David Clark Company manufacturers the astronauts space suits as well as the best hearing protectors we have been able to find. Their address is 360 Franklin St., Worcester, MA 01613-0155.

We failed to get the engineer's name. If any of our readers might know who called, please show him this Newsletter.



DAVID CLARK MODEL TM-1
P/N 18882G-01

TYPE: Electret (Throat Microphone)
SENSITIVITY: 16-40 millivolts @ 1 KHz/3M/S²
Acceleration 8V/10K Ohm bias and 6200 Ohm load
SUPPLY VOLTAGE: 3-20 VDC

MULTI-IMPEDANCE CONNECTION

Don Will of 3M Co called with a question. How do you connect devices to both the 70V line and the voice coil taps of a power amplifier? We couldn't answer Don's question, so we called Dr. Patronis. His answer:

1. Determine the voltage ratio between various taps as an open circuit measurement
2. The impedance ratio is the voltage ratio squared
3. Adjust the impedance ratios according to the maximum power output available.

Example

If you had a 100 watt power amplifier and wished to feed an 8 Ω speaker 20 watts, what's the lowest impedance you can attach to the 70 volt connection (assume no insertion losses are present)?

100w - 20w = 80 watts

$$W = \frac{E^2}{R}$$

so

$$R = \frac{E^2}{W}$$

When bringing the gain up on the amplifier, use a voltmeter to insure that the voltage does not exceed

$E = \sqrt{WR} = \sqrt{20 \times 8} = 12.65V$ at the 8Ω tap

and

$\sqrt{80 \times 62.5} = 70V$ at the 70V tap

MICROSECOND SIGNAL DELAY

As readers of our Newsletter have probably noticed we are on the alert for any and all precision digital delay devices PD^3™. At the NSCA show we talked with Gary Hardesty of Audio Digital Inc of Eugene, OR. His products look superb -- on paper. We have yet to test one and will give detailed TEF measurements of them when we do.

The first signal delay product is under $1,000. (One input and 3 outputs unbalanced in and out $849. Jensen transformer for 1 in 3 out $330.) It doesn't quite make it into our definition of a PD^3. It has 15 usec steps instead of 10 or less. No mention is made of a reference output. Frequency response, S/N, distortion are all state-of-the-art. The model number is ADD-3 Digital Processor.

The other model of interest to us is the ADX-2000 which can be had with 1.0 usec steps if desired. Standard configuration is 1 in and 4 out which can be expanded to 40 output modules and 6 input modules. One of the output modules can be used as a reference output. Fully programmable. Basic unit costs $3500, which is not out of hand if you were aligning a large array rather than just a near throw, far throw combination. One feature that is intriguing is the display of the delay in either milliseconds or feet.

We are eager to have a chance to test one. Sometimes the distance between prototypes and production is years instead of months. We'll report more later. The only reason we mention it now is that many people have an immediate need for a PD^3.

LEDR™

We are including an order form for Doug Jones' LEDR tape in this Newsletter mailing. If you have any reason to determine the accuracy of stereo imagery in a listening environment, you need the LEDR tape.

We especially support Doug's work because he is producing a tangible product from Puddie Rodgers valuable PhD work.

FINDING DIRECT SOUND

Finding Direct Sound in Acoustically Large Rooms on an ETC

What constitutes direct sound level L_D has two different meanings in acoustics. One definition is "that sound which has travelled to the microphone without having undergone reflection".

In psychoacoustics the hearing mechanism (including the brain) is believed to integrate the early reflected levels L_{RE} along with the L_D. Perhaps we should introduce a new symbol for such a situation: L_{D+RE}.

In **measuring** speech intelligibility such integration indeed appears to be the case. During the measurement process we are required to place a measurement cursor at the time interval we believe represents the end of the direct sound energy.

To the best of our present knowledge, here's how to do it. Figure #1 is an ETC taken at the rear of a fairly live hall. Note that the total time scale on the horizontal axis is 177 msecs. The time difference between the arrival of L_D and the beginning of L_R is approximately 50 msecs. If we chose 30-40 msec, sufficient in this case to include all relevant L_{D+LRE} energy, we would not be very far off.

CAUTIONS ABOUT L_{RE}

If a significant reflection occurs within three feet of L_D then you have a problem needing correction, not integration. If the first significant reflection occurs well after L_D (say more than 50 msecs) you again have a problem so far as speech intelligibility is concerned.

A significant reflection can be defined as any reflection in the reverberant sound field that rises above the exponential decay rate of the early reflections or the surrounding late reflections. This is easy to see on an ETC because exponential decay is a straight line slope. When a reflection rises more than a few dB above this slope it should be investigated. The energy shown in Figure #1 at 132 msec after L_D is not of sufficient level or density to be a problem but if it were 6 dB higher, it would be a clearly audible problem.

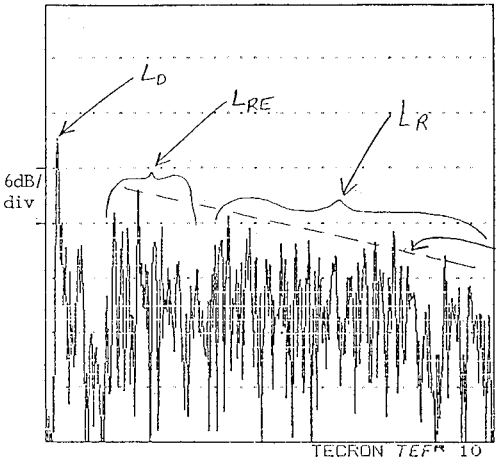
INDUSTRY BLUE BOOK

Every August **Sound and Communications** magazine issues an audio industry Blue Book. The issue lists almost every audio-related manufacturer, products, address, phone number, key factory personnel and in many cases, the manufacturer's representatives.

We get many phone calls each year at our office in California asking who manufactures a certain product, or does anyone make a given product. Many times we consult the Blue Book for the answer.

If you don't get the Blue Book we suggest you get one this year. It's out now. Contact Sound and Communication, Testa Communications, 220 Westbury Ave, Carle Place, NY 11514. Their subscription rate is $15/yr and the Blue Book comes with the subscription. We always get an extra copy, one for the office and one for the road, and I think we pay about $5-6. Its worth it.

ETCs often provide more detail than we presently understand or know how to interpret. By viewing them as L_D, L_{RE} and L_R and using the concept of L_{D+RE} for intelligibility testing we can extract valuable information from complex statistical sound fields.



Horizontal: 54000 microseconds to 231186 microseconds

COMMUNITY

Community Light and Sound is our nominee for the sponsor who has improved the most. Fourteen years ago they were rarely given serious consideration by any acoustic consultant. Today when we ask "Whose equipment do you specify?" Community increasingly is the answer from the same consultants.

Community was the first manufacturer to receive a TEF analyzer. They have really used it effectively for the past three years. Community's Pattern Control PC horns have been setting new standards for minimum temporal interference.

The M-4 driver remains in a class by itself. Other manufacturers have ignored the tremendous engineering advantages of using only one decade.

In talking with Community personnel we find that they are working on what we feel is the real future of our business. They leave us with the feeling that each of their contributions will bear their unmistakable mark of original thought.

We are seeing increasingly sophisticated data sheets from Community (A couple are included with this mailing.) and lots of new products.

Bruce Howze has built the first prototypes of the new M4 horn and matching 2" horn that will allow contractors to build super compact boxed arrays of M4's and 2" entrance horns. Each cabinet will be a 22^{o} wedge 40"h x 25"W x 22-1/2"D. This little box puts out about 1 acoustic horse power peak, yet occupies less than 13 cubic feet.

Vitality and vigor are the hallmarks of this young but experienced company. So is responsiveness to the end user. Being run by its original entrepreneurs means rapid response to legitimate technical needs in the field.

HOW ANALYZERS DIFFER

Figure 1 is the energy frequency curve of two loudspeakers out of alignment. The frequency scaling is linear. Figure 2 is a logarithmic frequency scaling of exactly the same event. Figure 3 is a 1/3-octave view of the same event (note that fractional octaves are logarithmic scaling.) Figure 4 is the 1/2-octave viewpoint and Figure 5 is the 1/1-octave.

Looking at Figure 3, the 1/3-octave viewpoint, notice that the first two cancellations are apparent. Shutting off one of the loudspeakers could confirm the suspicion that they are due to comb filtering. It might also be suspected that only the amplitude abberrations visible on the 1/3-octave display - really count until it is realized that the same misalignment causes severe polar response abberrations as well. See Figure 6.

FIGURE 1. CONSTANT BANDWIDTH ANALYZER

Horizontal: 50.33Hz to 10001.20Hz

6dB/div

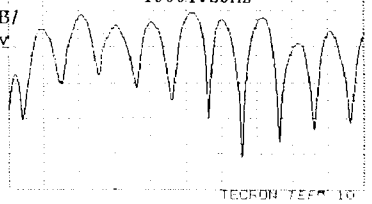


FIGURE 2. 2.50 Hz Resolution

Horizontal: 50.33Hz to 10001.20Hz
Log freq axis (2.7 decades)

6dB/div

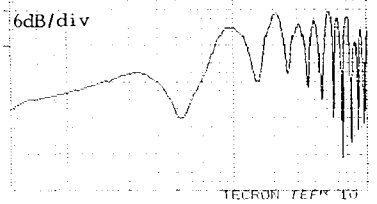
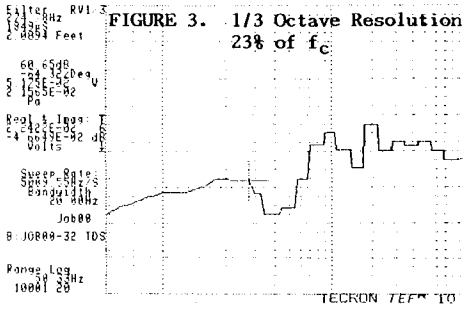


FIGURE 3. 1/3 Octave Resolution 23% of f_c



TOP: Polar of aligned speaker

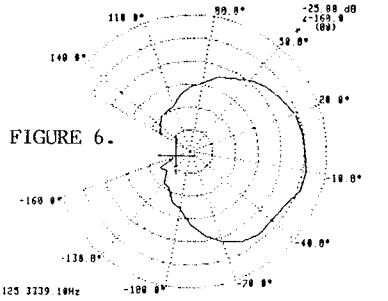
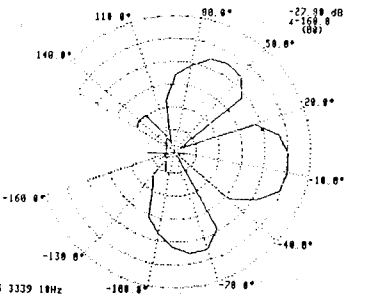


FIGURE 6.



BOTTOM: Polar of unaligned speaker

FIGURE 4. 1/2 Octave Resolution 35% of f_c

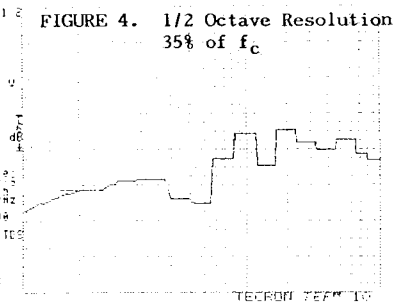
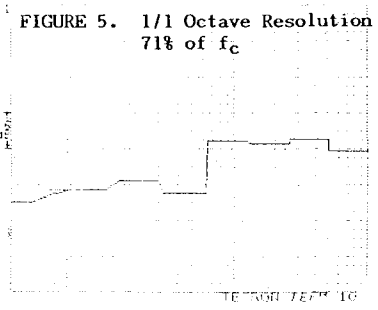


FIGURE 5. 1/1 Octave Resolution 71% of f_c



Whatever form of analyzer you choose to use, remember to carefully study its resolution before making critical judgments or adjustments. The TEF analyzer always operates as a constant bandwidth analyzer CBA but can display the material as if it had been taken with a constant percentage bandwidth analyzer CPBA. FFT analyzers do the same. 1/3-octave analyzers are true CPBA.

FUNDAMENTALS OF LOUDSPEAKER DESIGN

We would like to hold a workshop on the Fundamentals of Loudspeaker Design.

Our staff will be Dr. Patronis, Ed Long and Cliff Hendrickson.

If you are interested would you send a note to our office so indicating. No obligation. It will let us schedule the Workshop when we estimate that there is sufficient interest.

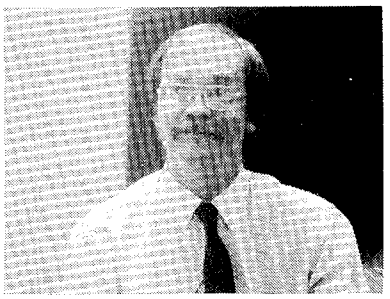
NEW PRICE FOR TRANSVERSAL EQUALIZER

IRPI has reduced the price of the D6-4017 transversal equalizer, thanks to the increased use by all of you. The new price is $650. If you haven't become acquainted with this new and better way to equalize, now's a good time.

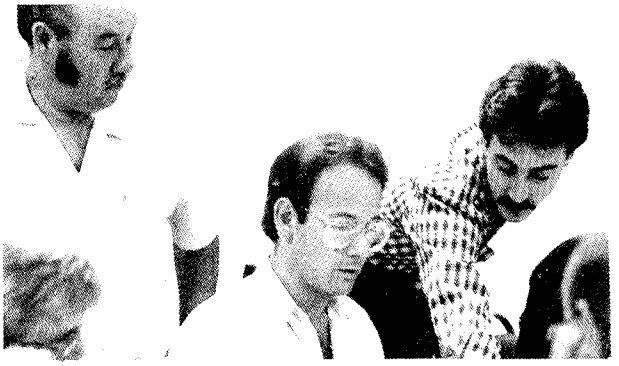
SPECIAL DAY FOR INSTALLERS

"Topper" did a super job!

San Antonio was the site of a special "add on" day to our regular basics class. The subjects for the special day were wiring, grounding and shielding. The instructor for the special day was Christopher (Topper) Sowden, Director of Electroacoustics at the Joiner Rose Group in Dallas.



Topper, the son of an architect, established instant rapport with the class by starting the day with an overhead transparancy (See Figure 1).



A good representative turnout of sound contractors took advantage of this special day to add to their expertise and test themselves against Topper's excellent exercises.

SPECIAL DAY FOR INSTALLERS
SAN ANTONIO, TEXAS MAY 15, 1986

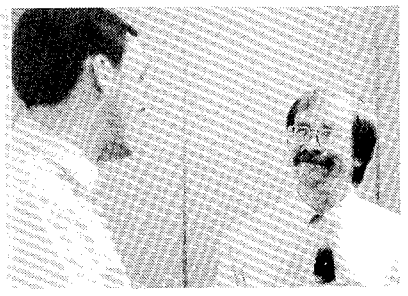
Jr. John Borden Sound Distributors 4242 North FamAm Expressway San Antonio TX 78208	Mr. David S. Hennum 9422 Shields Dr. San Antonio TX 78245 *	Mr. Lloyd Rael 8822 Angel Valley San Antonio TX 78227
Mr. Scott R. Carley 1651 Lakeside Drive Canyon Lake TX 78130 *	Mr. Robert C. Herrick Production Consultants 643 A West Rhapsody San Antonio TX 78216	Mr. H. Lee Rimmer Electro Acoustics 3507 W. Vickery Blvd. Ft. Worth TX 76107
Albert D. Emmons 1456 Cochese Trail San Antonio TX 78250 *	Mr. Skip Jones Firehawk Safety Systems 901 North Georgia Amarillo TX 79103	Mr. Johnny Roark TAFT 1837 Hidden Valley Houston TX 77088
Mr. Tim Ezzell 4934 Woodstone #706 San Antonio TX 78230 *	Mr. Chris Jordan Electro Acoustics 3507 West Vickery Blvd. Fort Worth TX 76107	Mr. Tony Rodrigues Sierra Warehouse 869 Seminary South Ft. Worth TX 76115
Mr. Raleigh George Qui-Fi Sound & Communicat 4501 Empanada #2105 Houston TX 77083	Mr. Joseph F. Kerr Lawlor Events Center University of Nevada-Reno Reno NV 89557-0036	Mr. Jeffery Schneider Southwest Sound 2323 Loop 410 NW San Antonio TX 78230
C.C. Haley 10408 Country Horn San Antonio TX 78240 *	Mr. Logan M. Lewis Sun Sound Company 8211 Cattle Bend Converse TX 78109-2403	Mr. Blair Sereda 4317 Crabapple Fort Worth TX 76137 *
Mr. Frank Haller The Musician 4595 Washington Blvd. Beaumont TX 77707-4425	Mr. Robert R. Merlo Southwest Sound 2323 Loop 410 NW San Antonio TX 78230	Mr. Thomas Walbran Southwest Sound 2323 Loop 410 NW San Antonio TX 78230
Mr. Thad Harper Bear Creek Sound & Comm. 18118 Lake Bend Drive Houston TX 77084	Mr. John R. Miller, Jr. Southwest Sound 2323 Loop410 NW San Antonio TX 78230	Mr. Billy Woodard Tom Padgitt Co. 11600 South Congress Ave. Austin TX 78733
Mr. Kevin Hawkins Laurie Auditorium-Trinity 715 Stadium Dr San Antonio TX 78284	Mr. James W. Payne Southwest Sound 2323 Loop 410 NW San Antonio TX	* Indicates Home Address

SYN-AUD-CON

SYNERGETIC AUDIO CONCEPTS / CONSULTING - SEMINARS P.O. BOX 888, SAN JUAN CAPISTRANO, CA 92693 (714) 728-0345

Subjects covered included:

* The green, black and white wires - why they are there
* Power grounding for safety
* Signal commons - zero voltage, multipoint and star
* Shielded cable
* Twisted cable
* Balance, unbalanced, low impedance and high impedance
* Patchbay techniques (wiring and testing)
* Isolation transformers



TECHNICAL JOURNALS

How poorly supposedly trained people can mis-assign cause and effect in terms of loudspeaker measurements and subjective judgments has been made devastatingly clear in recent **AES Journal** articles. The authors of the articles add still more misinformation to the literature.

There seems to be unbelievable confusion between producers of sound and reproducers of sound. Arguments relative to sound production by original musical instruments are cited as arguments to be taken seriously in judging sound reproducers.

When the **AES Journal** publishes a series of so-called phase responses that are total trash and related in no way to reality we are concerned. Many read the **Journal** as a factual peer group publication. It has become a political peer group publication.

When the author describes Fourier transformation of amplitude to phase rather than the Hilbert transform, we know that the author, reviewer, and editor don't know what's true and what's false. The **AES Journal** is unfortunately a poorly edited unrepresentative example of Audio's Golden Age.

FOOT IN MOUTH AWARD

"I prefer a parametric for equalization because one of the flaws in 1/3-octave equalization is that you're stuck with the frequency -- it's a fixed frequency and a fixed width, and that's kind of useless when you're trying to pin down resonances and stuff.....That's another bummer with 1/3-octave equalizers. By the time you get all the equalization in it, you've reached diminishing returns due to all the phase distortion in the equalizer itself."

The chap spouting all this went on to say,

"There was a lot of that hot dog engineer stuff for a lot of years. I think that's Bull." and then goes on to this statement,

"We use one of those ____ fast fourier analyzers, which performs all sorts of transfer functions and mathematical functions ....We've adapted it to the audio world, which it basically had the programs for, but for which we had to write different frequency parameters."

We'll pass without further comment out of compassion for the perpetrator of this doubletalk.

DECADE CALCULATIONS

Some analyzers when converting data from linear to logarithmic frequency scaling are limited to a certain number of decades. A decade is a 10/1 ratio such as 30 - 300 or 300 - 3000.

If you wished to set up a set of scales for 2.7 decades, then you could calculate the frequency limits as follows: Choose either a low frequency LF limit or a high frequency HF limit.

10 exp (log HF - 2.7) = LF limit

10 exp(log LF + 2.7) = HF limit

and

Log HF - log LF = decades

10 exp(log(15,035.62Hz) - 2.7) = 30Hz

10 exp(log 30 + 2.7) = 15,035.62Hz

Log 15,035.62 Hz) - log 30 = 2.7 decades

Looked at exponentially instead of logarithmically (for calculators with y^x keys)

$$LF \times 10^{(decades)} = HF$$

$$\frac{HF}{10^{(decades)}} = LF$$

$$\text{Log } \left(\frac{HF}{LF}\right) = \text{decades}$$

HELP

Do you know this man? He registered in the Vancouver BC class as Neil N. Kroetsch #3 1338 Commercial Drive, Vancouver,BC V5L3X6. If you can help us, we would appreciate it.

A BRAVE MAN

Sidney Harmon, owner of JBL, Harmon-Kardon and Infinity, is a brave man and a patrotic man. He plans to manufacture components in the U.S. for his audio lines. With sales of $180,000,000 for a privately held company, he says that *"if you don't manufacture, you forget the art".*

PRO-DESIGN II CAD PROGRAM

Electro-Com is an experienced sound contractor in the Seattle area that operates as a professional engineering firm. They are dedicated solely to high quality sound contracting work and have been very successful in their chosen marketplace.

While visiting them this Spring in their new facility we watched Morris Fosse use a CAD program that seemed to have very few limitations and was priced remarkably low. Called ProDesign II, it costs $299. ProDesign II can produce very high resolution output on an ordinary dot matrix printer--better than many plotters.

ProDesign II needs only an IBM-PC or compatible with graphics capability, 512K memory, 2 floppy disks or hard disk drive, and a printer or plotter. ProDesign's exclusive HPGL and IGES translators allow drawings from other graphics software to be used. An 8000 to 1 zoom capability is included, scale drawing, and you can use text from other word processor programs.

The descriptive literature is extensive and can be obtained by writing: American Small Business Computers, 118 S. Mill, Pryor, OK 74361. Phone (918) 825-4844.

As they say in their literature and apparently with justification, "Remember, ProDesign II only costs less - it doesn't do less".

CLASSIFIED

NEEDS INFORMATION

Robert Hagenbach would like to hear from anyone that

1. has ideas about an independent loudspeaker test service
2. has experience with military surplus antenna pedastals or gun mounts.

8000 Cranbrook Court, Largo, FL 33543. Phone: 7-(813) 397-8946.

FOR SALE

Hewlett Packard 3580 Spectrum Analyzer... $3,000.00
CONTACT: Dave Andrews (212) 736-9570.

SYN-AUD-CON SPONSORS

Syn-Aud-Con receives tangible support from the audio industry, and twelve manufacturing firms presently help underwrite the expense of providing sound engineering seminars. Such support makes it possible to provide the very latest in audio technology while maintaining reasonable prices relative to today's economy and to provide all the materials and continuing support to all graduates of Syn-Aud-Con.

Personnel from these manufacturers receive Syn-Aud-Con training which provides still another link in the communications circuit between the ultimate user and the designer-manufacturer of audio equipment. They are "in tune" with what a Syn-Aud-Con graduate needs.

Their presence on this list as a Syn-Aud-Con sponsor indicates their desire to work cooperatively with you in professional sound.

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