SYNERGETIC AUDIO CONCEPTS

SYN AUD CON

newsletter

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Volume 14, Number 4
Summer 1987

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

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TECH TOPICS: VOLUME 14, NUMBER 7—HOW TO HANDLE CONFRONTATION
VOLUME 14, NUMBER 8—MORE ON INTELLIGIBILITY

FSR, INC

FSR equipment is a valuable addition to anyone doing creative system engineering. Our FSR control system has become a permanent part of our clasroom measurements and is in use everytime we make measurements in our new lab at the farm in Indiana. We recently received from FSR a packet of product sheets, especially introduing the new IRC-50 Infra-Red Control System. FSR product bulletins is like adding engineers to your staff.

1. The DL-64 conference control system
   The DL-64 is the heart of the FSR product line. The rack mount is only 3-1/2", up to 64 switches, only 4 wires between rack and each remote

2. The IRC-50 Infra-red control system.
   This is the newest product from FSR: One-to- thirty channels of wireless control for all audio/visual needs. A universal sysem let's you decide what to control - up to 40 feet. Two adjacent rooms can use the Infra-Red system with no interaction.

3. Remote control modules
   A. ac power switches
   B. Microphone/audio switching
   C. Remote volume \control
   D. Slide projector control
   E. Tape machine control
   F. Universal relay drivers
   G. Video control unit
   H. Shade and screen control
   I. Relay cards
   J. Video switchers

4. An "accessories" data sheet. This contained among other items VU meter interface cards VU-1 and VU-2 that allow you to interface a standard volume indicating instrument to 4Ω up through 70 volts (the VU-2) or 70 volt only (the VU-1). All are calibrated to the true level; a differential amplifier is used where the signal is too low as a result of the impedance mismatch.

The packaging of these various modules is impeccable and in combination allow a remarkable degree of custom engineering without the high cost of special engineering time. Get to know the engineers at FSR, Inc., 220 Little Falls Rd., Cedar Grove, NJ 07009 (201) 239-0988. You will be glad you did.

We wish to thank FSR for letting us use the cover of Newsletter V14 N3 for our tribute to Richard C. Hevser.

HEYSER AND "THE TWENTY", 1979

In 1979 Dick Heyser agreed to bring in his personal TDS system to discuss the theory behind Time Delay Spectrometry with a selected group of pioneer licensees (called The Twenty) who wanted to build their own TDS system out of combinations of commercially available standard test equipment.

Richard Jamieson, a member of that class, asked for and received permission to video tape the class. Recently, in answer to our call for any private tapes of Dick Heyser, Richard sent us excellent copies of three black and white tapes.

Seeing and hearing Dick discuss the theory at this early meeting put his famous statement, "It gives me a certain amount of pain to give away in ten minutes what took me ten years to acquire," into a whole new light. True, he was giving it away so-to-speak. But ten years later we are just beginning to feel comfortable with it. Almost everything the TEF analyzer has forced us to learn, Dick was freely discussing in this first TDS/LEDE Workshop. It's just that none of it really sinks in until you have your "hands on" a difficult measurement problem (difficult defined as "you haven't made that measurement before").

These tapes have it all. They contain the very essence of Dick Heyser. He stands there with his totally uncalibrated analogue equipment, which he has highly modified and twirls dials until a display appears. Time after time the question is asked by one of the viewers, "What are we seeing?", followed by Dick's explanation of a phenomenon no one had ever heard of before. Now, nearly 10 years later, those of us with TEFs can look back on this tape and see with what integrity Dick had adjusted his equipment to show us each new view, because today we all can duplicate it.

Herein lies a curious fact. Those of us who knew so little accepted all that he said - thank God - to our immense benefit. Those who felt they already knew it all would say, "How do I know if he's right? None of his equipment is standard or calibrated." In so doing they rejected the opportunity of a lifetime to know a true genius. The tapes will leave you immense sadness that this great man will no longer walk with us again.

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MINNEAPOLIS, MN 55406

The tapes contain early discussions of LEDE theory. It is interesting to see how well developed the correct views of diffusion (including Schroeder QRDs), initial time delay gap, and room geometry were, even at this early date.

We have asked Richard Jamieson if it is possible to make copies available to others. He will let us know the cost of duplicating. Richard Heyser gave us permission to make and duplicate the tapes for members of The Twenty workshop. We will request permission from Amy Heyser for a broader distribution of the video tapes. If you have a special interest, please let us know. We will write more about it in the next Newsletter, but it would be good to know in advance how much interest there is.

LOUDSPEAKER ARRAY MUST BE HOUSED

The following measurements do not need a lot of explanation except to say that excellent equipment was installed by an exceptional sound contractor for an ideal client - a church technical department who wanted the best sound possible.

The measurements show a severe problem on stage because the loudspeaker array is not housed. Housing the array would have been a simple engineering job at the time of design and installation. Now it is a major expense to correct the problem.

The measurements were made on stage in the area where the minister stands. 125Hz seizes the sound system and requires the sound mixer to remove all bass frequencies to control feedback, thus emasculating the minister. You don't use Sonex to isolate bass frequencies; it requires mass, lots of it, and it is costly because it requires structural changes.

The sound system is also out-of-alignment and the sound system hits a balcony face returning late energy into the back 6 rows of the main auditorium, but the acoustics of the church (seats almost 5,000) is so good that it causes little intelligibility problem to the average member of the congregation. A trained sound person can identify the problem areas very easily but it is not noticeable to the congregation.

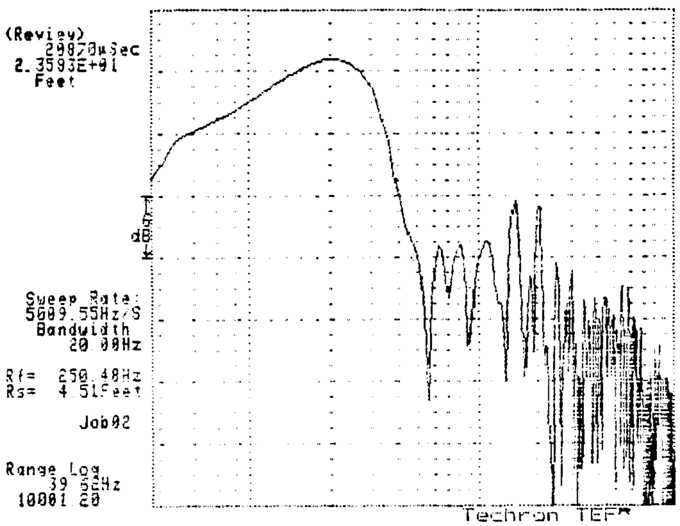


Fig. 1a. Frequency response of woofers main peak at 125 Hz.

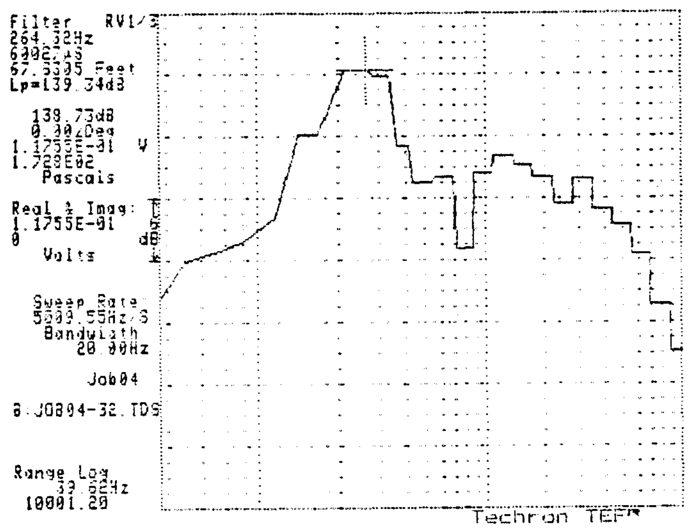


Fig. 1b. 1/3 Octave display of 1a.

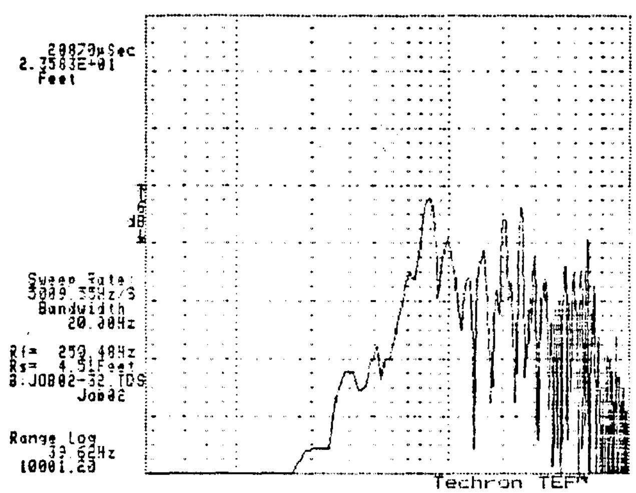


Fig. 2a Array minus woofers.

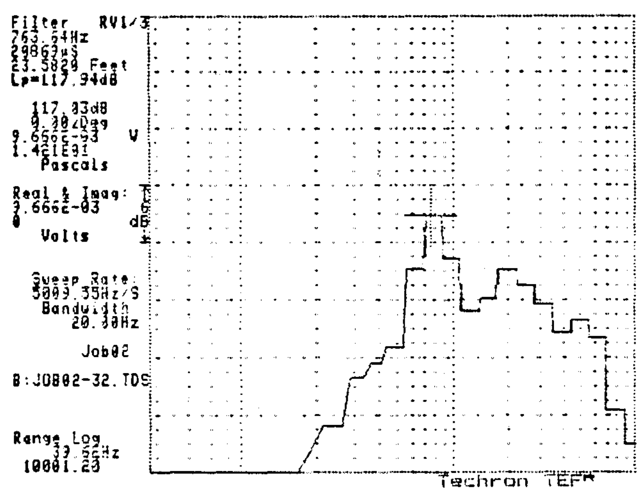
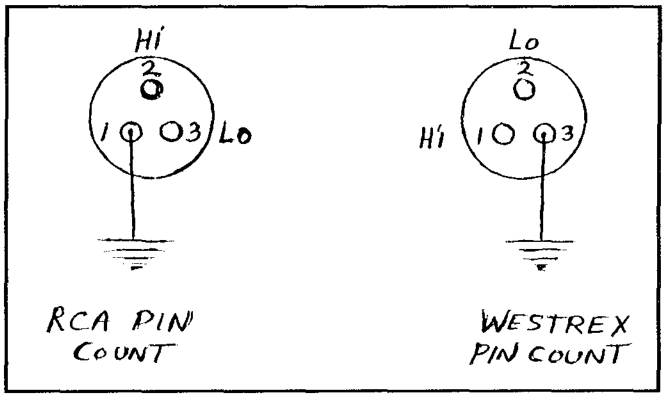


Fig. 2b. 1/3 Octave display of 2a.

MICROPHONE POLARITY

`The two main "pin counts" are shown here. Today most manufacturers in the U.S. use the RCA pin count. The intent of any microphone polarity standard is to insure that a positive pressure increment above ambient pressure at the microphone produces a positive pressure increment at the loudspeaker of a correctly polarized sound system.



The best way to check microphones, in our opinion, is to use a polarity checker such as the Sounder units.

There are both relative polarity and absolute polarity. Relative polarity is, for example, when two or more microphones are all in polarity with each other. Absolute polarity is when a positive pressure increment at their diaphragm produces a positive pressure increment from the loudspeaker.

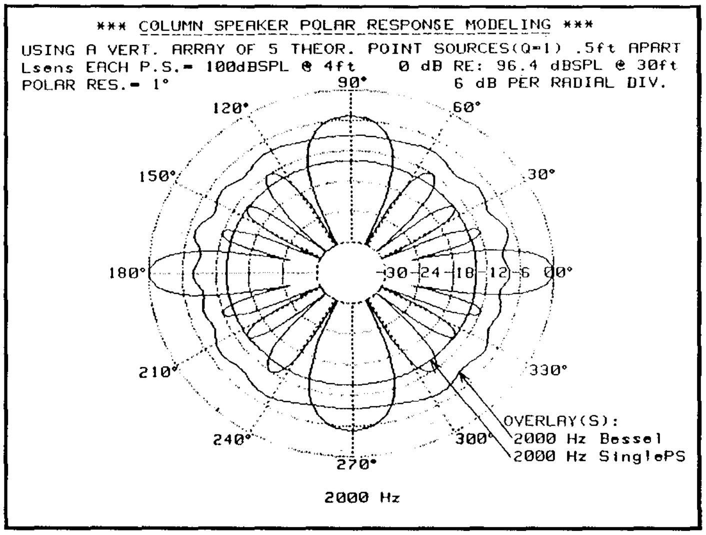
Many new to audio confuse polarity with phase. A change in polarity shifts the absolute phase at *every* frequency by 180 degrees and thus *is not* frequency dependent. Also the relative phase is unchanged by a polarity reversal so far as its frequency dependent behavior is concerned, but merely selects a new reference point for the epoch being measured (remember the definition of phase is that it *is* frequency dependent.)

To properly understand phase it is best to study the difference between signal delay and relative phase from a chosen zero reference point. Lengthy AES papers fail this point.

NEW ORLEANS APRIL 2-3, 1987

BESSEL ARRAY SYSTEMS

Arrays are often used to alter the polar response of loudspeaker systems. One of the most common and least sophisticated is the sound column wherein a stack of loudspeakers through phase interaction narrows the vertical polar response.



The penalty paid is spurious "lobes" that radiate from the top and bottom of the desired pattern at certain frequencies. See the plot of the lobing of a 5 point source column. The excellent modeling plot was generated by Joe Mitchell of the St. Germain Foundation.

The Bessel Array is unusual in that it is used to, for example, take a sound column and return its polar response back to that of a single device but with additonal power output from the other devices. See the plot labeled 2000Hz Bessel and the 2000Hz single P.S, Note the difference in level between the single P.S. and the Bessel Array (approx. 5dB)

Why go to all this trouble? There are several answers. One could choose a directive horn and raise the level or they could choose a more efficient driver or an infinity of other alternatives. The attractions of the Bessel Array are these:

1. You can choose a cone speaker (with a very wide angle of coverage but low acoustic output as a result) and make it a high level device by using a large number of drivers.

2. Such wide angle devices are far less susceptible to temperature and wind effects. As sound is refracted the listener remains in the very wide and uniform coverage pattern

3. It is often the most economical solution.

The Bessel Array is another very powerful tool in the audio professionals tool kit.

RECENT PAPER ON PSUEDO INTELLIGIBILITY MEASUREMENTS

This particular lecturer shall remain nameless. He managed to imply that the Sabine equation was his during his talk, suggested that all percent articulation losses of consonants became equal at critical distance, and proceeded to demonstrate a ray tracing program that made one of the poorest low Q polar response devices equal to one of the best behaving devices in all kinds of environments.

Perhaps, most offensively of all, this salesman garbed as an engineer managed to completely eliminate VMA Peutz and his techniques from the list of methods of measuring intelligibility but managed to pass off the side comment that "as you know I consider the original Peutz equation as inaccurate.

We had believed at an earlier period that this approach stemmed from pure ignorance. Not so. It is pure unadulterated lying on behalf of convincing the gullible that a markedly inferior device deserves the same consideration as well designed constant directivity devices in spite of concrete factual measurements to the contrary.

We have personally watched these same individuals do their "rain dance" with an impulse program on ordinary PC, after which, without letting anyone see any measurement they had taken, they claimed to do the same measurements as a TEF. We simply say SHAME!

TEF MEASUREMENT OF ABSORPTION COEFFICIENT

As the number of TEF analyzers increases so do the calls to us for information on correctly measuring the absorption coefficients of various materials. Dr. Patronis has set forth the most complete guide to this measurement. By his solving all the equations for 500 Hz, all you have to do is ratio them to any other low frequency cutoff you desire. (i.e., 250 Hz make everything twice the value given by Dr. Patronis.)

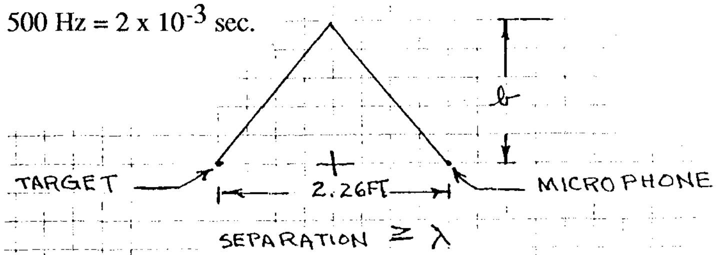
TEF absorption coefficient measurements are very accurate but, of course, for the angle of incidence chosen when you set the test up. To most of us, that's an advantage. Interestingly, we have never observed a major deviation from the reverberation room values compared to the TEF on-axis measurements for any product we tested so far. Once the true polar response of a control room monitor is known, then the amount of energy and its angle of incidence to a given treated surface can also be easily ascertained.

TEF Measurement of Absorption Coefficient by Dr. Patronis

1. Determine minimum target size.
   The target perimeter should be at least three wavelengths at the lowest frequency of interest. As an example assume this is 500 Hz. Then $\lambda = c/500$ Hz $= 1130$ ft. per sec./500 Hz = 2.26 ft.
   Perimeter = $3\lambda = 3 \times 2.26$ ft. = 6.78 ft.
   If the target is square, its perimeter is 4 x L where L is the edge dimension of the square. L = 6.78 ft./4 = 1.695 ft.

2. As the lowest frequency of interest is 500 Hz, the frequency resolution need be no better than 500 Hz. Now $B = S/f_R$ where S is the sweep rate and B is the Bandwidth. With a sweep rate of 10^4 Hz per sec, the required bandwidth is B = 10^4 Hz per sec/500 Hz = 20 Hz.

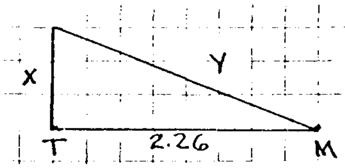
3. Determine the free field ellipsoid.
   With a frequency resolution of 500 Hz., the uncertainty relation requires a free field measurement time $\Delta t = 1/\Delta f = 1/500\ \text{Hz} = 2 \times 10^{-3}$ sec.



$\Delta t = 2 \times 10^{-3}$ SEC $= \dfrac{d_r - d_d}{c}$, $d_r = c\Delta t + d_d = 2.26$ FT $+ 2.26$ FT $=$ 4.52 FT. THE SEMI-AXES OF THE ELLIPSE ARE a AND b. $a = 2.26$ FT AND $b = \sqrt{2.26^2 - 1.13^2} = 1.957$

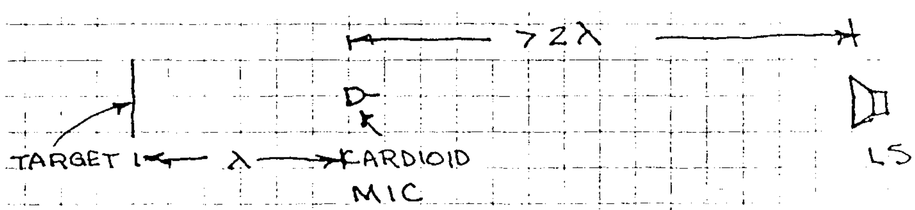
4. Ascertain that the entire target lies within the ellipsoid.
   The constraints are:

   $x + y = d^n = 4.52$ ft.
   $x^2 + 2.25^2 = y^2$



   In order for the entire target to lie within the ellipsoid, x must exceed $(\sqrt{2}/2)$ L where L is the edge dimension of the target. From the constraining equations x is found to be 1.695 ft. Recall that L was also 1.695 ft. $\therefore$ $(\sqrt{2}/2)$ L = 1.199 ft. which is less than x.

5. Set up



   a. The measurement proceeds in two steps.
      Make a target from the sample wall surface which is to be treated and measure EFC as reflected by this target.

   b. Cover the target face with the absorber in question and make a difference EFC measurement

6. Calculate absorption coefficient.
   Suppose the measured reflected level in step b at some frequency is x then the relative reflected power is $10^{x/10\text{dB}}$ and the absorption coefficient is $1 - 10^{x/10\text{dB}}$ example let $X = -2$dB, $1 - 10^{-2/10} = 0.37$

1987 SYN-AUD-CON SCHEDULE

CHICAGO
Holiday Inn - Oakbrook
September 15-16

DENVER, CO
Stapleton Plaza Hotel
September 29-30

KANSAS CITY, MO
University of Missouri
October 6-7, 1987

NEW YORK, NY
The Hartz Inn
Secaucus, NJ
October 14-15

WASHINGTON, DC
Sheraton Tysons Corner
October 27-28

UNDERSTANDING LOUDSPEAKER SPECIFICATIONS

While attending the NSCA convention it became apparent to us that many sound contractors and loudspeaker engineers have some element of confusion about pertinent loudspeaker specifications.

What do we want the loudspeaker to do for us? We want it to deliver the necessary acoustic watts to each listener but not to the reflective surfaces of the environment where they are receiving the signal. Unfortunately, loudspeaker sensitivity figures do not provide this information.

Loudspeaker Specification Terms

Manufacturer's normally supply some limited parameters such as:

1. Sensitivity: This is the sound pressure level in decibels L_P at some rating distance D_R, for some specified electrical input power, W_e. Note particularly that a sensitivity rating is *not an efficiency rating.*

2. Coverage: This is the angular coverage for two planes, the horizontal and vertical, usually without specifying the level limits, though minus six decibels is often used. Frequency of test is rarely specified.

3. Electrical input power rating: Manufacturers have been careful to avoid any common standard here. If there ever is an accepted standard, it will have to be administered by an authority separate from the manufacturers.

4. Mechanical data: Size, weight, mounting details, type of magnet, etc.

What Specifications Would be More Useful

The sound power level, L_W, and the directivity factor, Q, would be infinitely more useful than the current sensitivity figures. Efficiencies would then be directly calculated either as absolute efficiencies or as relative efficiencies by subtracting 10 LOG Q from each L_P.

Overlaid Polars and Frequency vs Angle Curves FAC Plots

A most useful tool is to observe the total variation in polar response over a relevant frequency span for at least two planes. The frequency span 500 to 5000 Hz comes quickly to mind. If the Q values were to be computed from the widest envelope from these overlaid polar plots (made every 250Hz), then it would be found that the Q values obtained would correlate with measured intelligibility to a remarkable degree except in the cases of severely lobing devices. In the past, we always saw excellent correlation between superbly controlled constant directivity devices and the simple Peutz equation *because the difference between the best and worst polar plot was very small* . As the plots showed greater variance between the narrowest and widest plot, so did the calculated and measured %ALcons.

Attempts to use Ray Tracing (useful only to the second order reflection at the most charitable estimate) could only be fruitful if absolutely accurate frequency dependent polar information were provided. In the case of several current products it is our opinion that attempting to predict their intelligibility scores in real spaces is an exercise in futility simply because better behaved devices are available at the same prices.

Serendipity

It must always be kept in mind that a perfectly terrible polar response may accidentally interact with an unusual environment to either cancel defects or focus energy in a useful way.

Witchcraft survives in technology because unexpected accidents can occur. Most of us prefer the engineered approach. As one commentator remarked at an NSCA panel on loudspeaker design after hearing several designers put forth their philosophies, " I'd like to separate the sensual from the psychoacoustic for the engineering approach." So would we.

WHY USE A BESSEL ARRAY?

It appears that many who witness our demonstration of the Bessel Array in class don't fully understand what it is actually doing. Some measurements sent to us by J.W. Davis & Company help reveal what's going on.

When the column is operating in its original mode the higher frequencies are cancelling each other and putting out spurious lobes and unpredictable angles, while the lower frequencies are adding about 6dB.

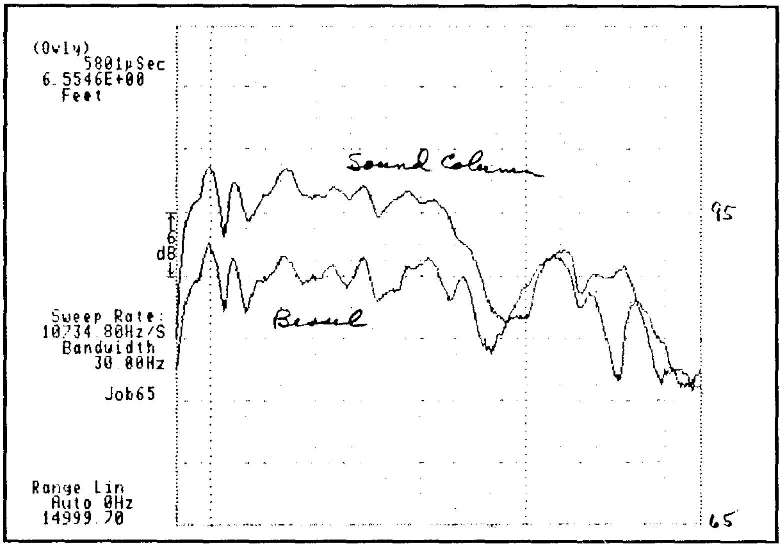


Fig. 1. EFC of Bessel sound column comparison

When the switch is thrown to the Bessell configuration, the high frequency lobing and interference with each other stops and the low frequencies no longer sum but become the side pattern of a single device. Note that the tonal balance is now normal.

The angle of coverage is now much wider and the system is actually putting out more *useful* acoustic power, but its on-axis sensitivity would appear to be lower at the low frequencies and the same at the higher frequencies. Actually, the higher frequencies now are covering a very wide angle and thus the real efficiency is greater. The low frequency units are about the same efficiency as earlier but over a wide angle as well.

Why Choose a Bessel Array

Bessel arrays are chosen when you need a very wide angle of coverage and a load that can absorb more amplifier power than likely from a single device. When you want *higher* levels on-axis, use a conventional column. A major use of Bessel arrays has been to overcome the effects of a cross wind by making the horizontal angle so wide that it could not be moved out of coverage by the temperature gradients the wind caused.

THE ANCIENTS KEEP STEALING OUR INVENTIONS

In moving our library of technical books to the farm in Indiana, it was natural to browse through favorites as they were put on their new shelves. In so doing the item here was found in Harvey Fletcher's **Speech and Hearing in Communication**. Shades of Diana Deutsch.

One of my privileges of this life was the chance to meet Dr. Fletcher (age 90 and a new bridegroom) when he gave a paper at a technical convention I was attending. He and Eyring of Norris-Eyring fame had married twins. When both Mrs. Fletcher and Mr. Eyring had passed on, Mr. Fletcher married Mrs. Eyring.

216 SPEECH AND HEARING IN COMMUNICATION

Other Binaural Phenomena

The following experiment suggested by Arnold showed some very interesting effects. A high quality transmission system was provided with a filter system so that all the frequency components below 1000 cycles were sent into one channel and delivered to the left ear. Those above 1000 cycles were sent into another channel and delivered to the right ear. When speech was transmitted over such a system, there was apparently no distortion produced, although if either one or the other of the two receivers were taken away the speech sound was very distorted, and it was hard to recognize what was being said. When both receivers were used, the speech seemed to be good quality, and no difficulty was experienced in following what was being said. Apparently, in this case, the brain was able to combine the sounds obtained from the two ears to complete the proper picture. However, when music was transmitted, a different situation resulted. This was particularly true when listening to music from the piano. In this case the tones appear first in one ear and then in the other ear depending upon the pitch. This causes confusion and gives a very wierd sort of sensation. When listening to sounds which have frequencies fairly well scattered in both the ranges below and above 1000 cycles, the sensation produced was about the same as that obtained by combining the frequencies into the same ear. When the sounds were predominating in either one or the other ear, localizations were produced first at one ear and then at the other as described above.

HOW TO MISUSE Q

At NSCA we witnessed a demonstration that exemplified how to misuse a directive loudspeaker. A manufacturer wishing to show that their uncontrolled directivity loudspeaker would have the same speech intelligibility as a well controlled device simply set both up in a set of reverberant spaces so they were aimed at highly reflective surfaces and then recorded the words spoken over them for evaluation later by a limited listener group using headphones.

As should be obvious to almost anyone, the difference between a high Q horn and a low Q device becomes dramatically evident when an audience (or absorption area) is present and the high Q is utilized to "steer" energy into the absorption, thus denying energy to the reflective surfaces in that environment. When both devices are deliberately aimed at a reflective surface first all bets are off.

Again, if properly aimed, the high Q device will provide the listener the same L_P at a lower L_W than can the low Q device, thus again reducing the reverberant level.

Rest assured that when you see data saying that low Q directionally erratic devices have the same intelligibility as higher Q well controlled devices, that intelligibility is not the question, but simply intelligence.

DALLAS APRIL 14-15, 1987

NSCA SHOW IN NEW ORLEANS

The professional audio magazines have unanimously reported that the NSCA show in New Orleans was very successful, and so it was. The sound contractor is king at this show and NSCA Board of Directors intend to keep it that way. It is show that deserves our support.

We would like to devote a few paragraphs to new products, new ideas, new and old manufacturers. All of our sponsors were there, except Benchmark, which is heavily devoted to broadcast industry, though they have exceptional products for sound system installations by the sound contractor.

NSCA is no longer the show that you can stand at one end of the exhibit space and call to a friend across the room. We saw friends at the pre-show get-together and never saw them again during the show. It's a big show now.

Our sponsors are good about keeping us updated with new product information and we pass it along in the Newsletters. Here we would like to tell you about a few manufacturers and their products that we saw at the show.

Frazier is on an upswing. SoundCraft from Arkansas bought Frazier. They hired Jay Mitchell as chief engineer. (a Dr. Patronis student and protegee). Frazier introduced The Cats, a new line of small speakers at the show. Frazier's advertising department is as good as their engineering. They prepared an excellent ad to introduce the new line. It is heartwarming to see one of the very early audio manufacturers under the protective wing of good management.

Oxmoor Corp, named Oxmoor because the plant is located on Oxmoor Street in Birmingham, AL, has some real talent working on new products. Lynn McCrosky of Sonics started Oxmoor to have products that he needed in this installation work. See our write up about their new equalizer.

"Retired" Vic Hall of **Communications Company** was there doing what he does best: **Sell with a capital S,** which is pronounced Successful. Communications Company, another sound contractor turned manufacturer, has an excellent line of equipment that they developed over the years because they needed a special piece of equipment to do a job or the manufacturers were charging more than Vic thought it was worth, so he built it.

Innovative Electronic Designs. We have seen their name in print for several years but really knew very little about them except that their well respected automatic mixer was distributed by JBL. We went to their demo room to hear an old friend, Tom Roseberry, give a run down on the product line. We then stopped to see IED in Louisville on our way from New Orleans to our farm in S. Indiana. IED is as much an Artier as it is a manufacturing facility. Artists are at work. IED equipment is used in the really big computer controlled sound systems. While the sound systems where IED equipment is used are often large, the company is small enough that they can build to meet the individual needs of the customer.

Bob Davis of **Yamaha** walked us through their new Digital Mixing Processor, DMP7. The brochure states, "The revolution in music and sound production has begun" and so it has. All parameters -- from fader positions to effects and EQ settings -- are programmed and stored in digital memory.

It takes pages to tell all that the DMP7 does, but it is the price that will blow you away. Astonishingly inexpensive for what it does.

Alpha Audio introduced Sonex 1, a new flame resistant Sonex. Cedar Knolls Acoustical Labs tested Sonex 1. There is almost no difference between Sonex 1 and 3" Sonex from 1,000Hz to 4,000Hz. There is about 20% at 500Hz. It is more effective over the entire range than 2" Sonex.

I would like to slip in a couple of Sponsors here: **EV** and **Shure**. We have written with enthusiasm about the conceptual design of the EV Manifold M4. At the show we were able to hear it in their demo suite. Very, very impressive. The EV rep from Michigan, Tom Petchell (and Syn-Aud-Con's) was in the demo room while we were there. Noting our wide-eyed enthusiasm for the wild bass along with startling clarity of the mid- and high frequencies, he said, "You can understand why we have 8 Manifolds going into a church in Michigan." Yes, I can understand. A church in a Chicago suburb sold 28,000 tickets for their annual "musical" (the church seats a little less than 5,000 so there were many performances). Without an outstanding sound system, they wouldn't have filled the church for one performance.

Shure Brothers is back in the electronics business. Also a new line of speakers is rumored to have the magic of Ed Long in the box. (See our write up about Shure in this Newsletter.) Ten years ago Shure had excellent electronic products but less than excellent marketing and industrial design. We have a lot of respect for Shure electronic enginers and it appears that the engineers are now well supported by the other departments.

One of the more interesting stops we made was at the **University** demo room. We wanted to see what was being done to breathe new life into any old company. Plenty!

There is a whole new look at University Sound. Doug Wilkens, formerly with Pierce Phelps, has true depth of experience in commercial sound applications. The new Installation Guide, the new specification sheets, and the power of EV and University's combined line of commercial sound equipment lends real excitement to Doug's approach.

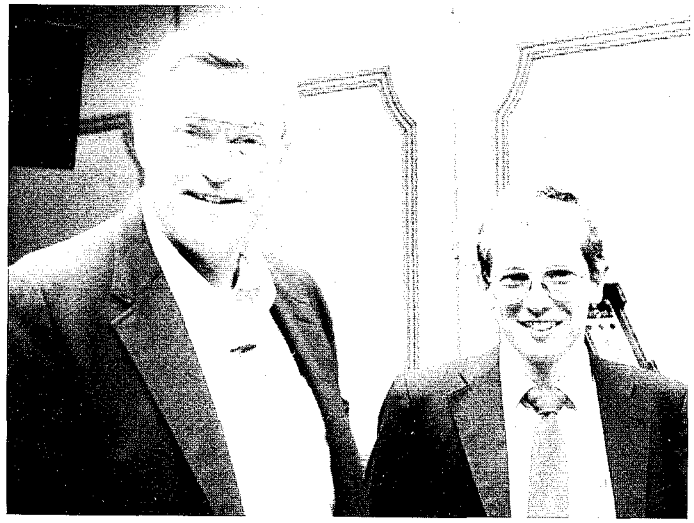
There is engineering data on normal cone speakers, Q, C∠, isobars, accurate sensitivities, the works! University has a lot going for it now: Doug, who really cares; two major competive lines harmonized and maximized; and real engineering data published in useful spec sheets. It must seem like an overwhelming avalanche to whomever thought they were still in the game as competition.

KLAUS HOYBJERG & THE B&K RASTI

During our discussion of speech intelligibility in our New Orleans class we invited Klaus Hoybjerg to address the class and found that he is articualte, well informed, humorous and all in all a delightful person. It's not easy to consider complex new ideas in a strange language and we admired Klaus rapid grasp of questions from the class and ourselves.

We believe the RASTI measurement may well be based on a faulty theory -- that of Houtgast and Steencken -- and that the B&K instrument serendipitously measures SNR ala Lockner and Burger in a new and unexpected way. We are convinced as a result of our experience with Craig Allen's speech compressor for the Navy that modulation has nothing to do with speech intelligibility (also see *Licklider and Pollack's Effects of Differentiation, Integration and Infinite Peak Clipping Upon the Intelligibility of Speech,* JASA 18(2): 418-4524 (1946).

In any case, the B&K Rasti works well and is a useful device especially where noise is the primary interfering factor. As Klaus points out, the theory is not B&K's, but the instrument is.



During our class in New Orleans we had the pleasure of having Klaus Hoybjerg of B&K sit in. He is in the United States to promote their RASTI instrument

OXMOOR DIGITAL CONTROL 1/3-OCTAVE EQUALIZER

Here's a really creative computer program for the Macintosh. After seeing Macintosh acoustic programs that were technological flops, this one really caught our attention. Using the mouse to move the visualized controls allows anyone who has ever used even the simplest graphic equalizer to immediately start right in on this one.

The beauty of this approach is that it allows the retention of good curves while continuing to play with their modification. It removes the ability of the end user to re-equalize a critically tuned system. And most important, *it restores accurate calibrated steps to equalization.*

Oxmoor's specification sheets contain accurate and reliable information. Write Oxmoor for more information. Oxmoor Corp., 237 Oxmoor Circle, Birmingham, AL 35209, Ph (205) 942-6779.

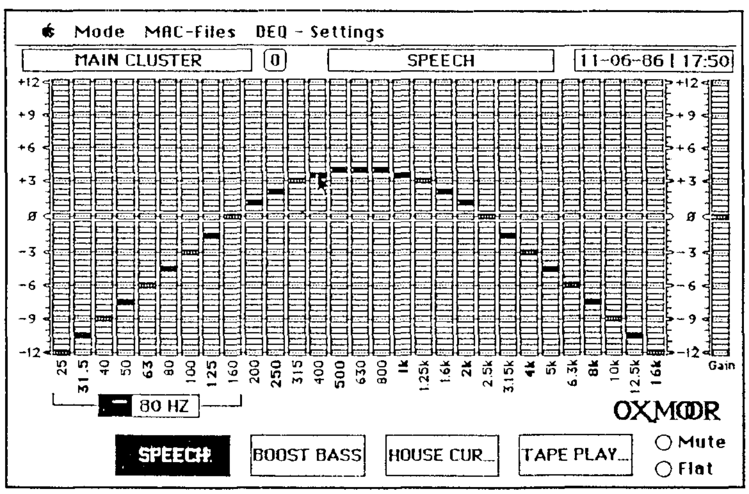
These are the people (Sonics) who give us the exceptional quality sound at many of the OmniMax theaters around the country. This sound contractor got into manufacturing after they had to deign the products to do what they wanted.

New Product Announcement

Oxmoor DEQ-29 Digital Control 1/3 Octave Equalizer

Features:

- Parameters programmed with a personal computer and Oxmoor TWEEQ® software (for Apple Macintosh™ or IBM PC™/compatibles)
- Personal computer only required during tuning
- On board non-volatile storage of over 100 complete equalizations (8 equalizations for cut-only version)
- Boost/cut and cut-only versions
- 29 one-third octave filters on ISO centers, 25 Hz thru 16kHz
- Programmable input/output gain, & 18 dB/octave high-pass filter
- ± 12 dB filter and gain control range, 0.5 dB step size
- Electronically balanced input, optional output transformer
- Hardware and software curve security No "front panel" controls
- Occupies only one EIA rack space



A Typical TWEEQ Screen

ALTEC MEASUREMENTS

Altec has employed their TEF analyzer to generate data for their specifications. While the data certainly shows some problems most manufacturers would choose to "cover up" the end result, when viewed by persons with practical field experience, is that this is believable data and the parts I need (Q and C∠) allow me to accurately plan performance.

Showing data, warts and all, is something most manufacturers won't do. The totality of their specification fits many requirements exceptionally well. Yes, we can easily find units that exceed each spec shown in their new 9872-8 loudspeaker system literature, but not many that exceed the balance of parameters for a high level packaged system.

Our congratulations to Altec for their honesty and integrity in these specs.

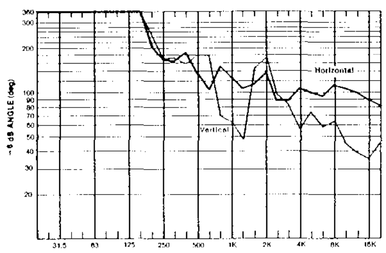


Figure 8. Coverage Angle

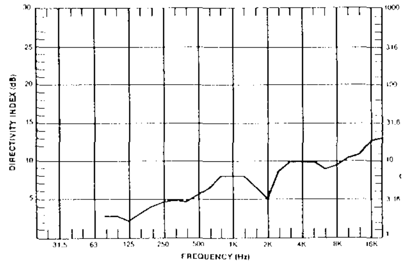


Figure 9. Q and DI

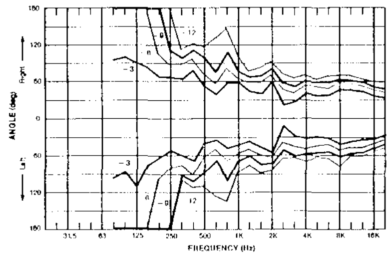


Figure 10. Horizontal Off-Axis Response Contours

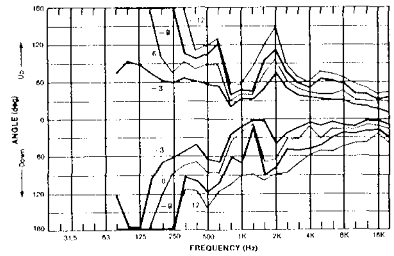


Figure 11. Vertical Off-Axis Response Contours

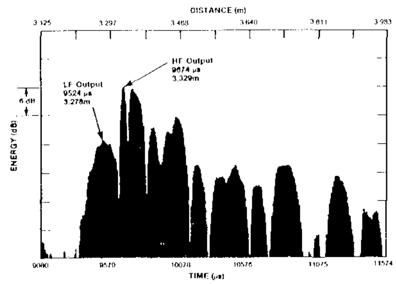


Figure 12. Energy Time Curve (See Note 9)

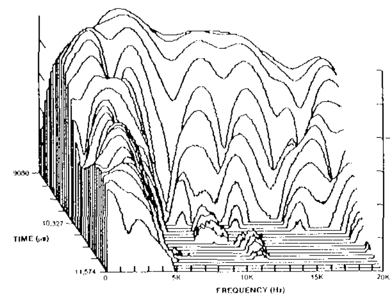


Figure 13. Time Energy Frequency Curve (See Note 10)

PASSIVE NETWORKS

Passive networks may have zeros in either the right half of the s plane (non-minimum phase shift networks) or the left half of the s plane (minimum phase shift networks) but they will never have poles in the right half of the s plane. Active networks with poles in the right half of the s plane are unstable.

Any ladder network is a minimum phase-shift network. Those networks which, in some instances, may be non-minimum phase-shift networks are those in which there are multiple signal paths between the input and the output of the network. Examples of networks which may be non-minimum phase-shift networks are lattice networks (all pass filters), bridged networks, and those having distributed constants.

A network having a "pole" on the omega (vertical) axis is an oscillator having infinite gain at a given frequency. In a similar manner, a filter having a "zero" on the omega axis is a notch network having no response to a given input signal.

2ND EDITION OF HOW TO BUILD SPEAKER ENCLOSURES

With the last issue of the Newsletter we included a form inviting anyone who wished to send us questions to be included in the second edition of **How to Build Speaker Enclosures.** We are very pleased with the response. The questions and the number of returns have been excellent.

The second edition will take both the very practical applications approach (Don Davis) an the theoretical mathematical approach (Dr. Patronis).

Anyone who sends a question that is used in the book will receive credit in the book plus a free autographed copy of the book. We would like to have more questions so that we can be sure that our book will be a useful edition to your library. Send your questions along soon as we hope to have the book written by the end of summer.

NEW ACOUSTICAL CONSULTING FIRM

The well-known troika at BBN Los Angeles has left to start their own acoustical consulting firm: McKay, Conant, Brook, Inc. The Principals are Ron McKay, David Conant and Rolly Brook, 5811 Kentland Ave., Woodland Hills, California 91367. Phone (818) 713-2060.

These highly competent men are capable of handling any aspect of a job and jobs of any size. Ron McKay is a talented concert hall designer with one of the finest concert halls in the United States to his credit, Ambassador Auditorium.

Ron, Rolly and Dave are all contributors to the Syn-Aud-Con family and we are very pleased to be able to recommend such clear cut competence to our grads who need to suggest a first class consultant to the architects and engineers with whom they work.

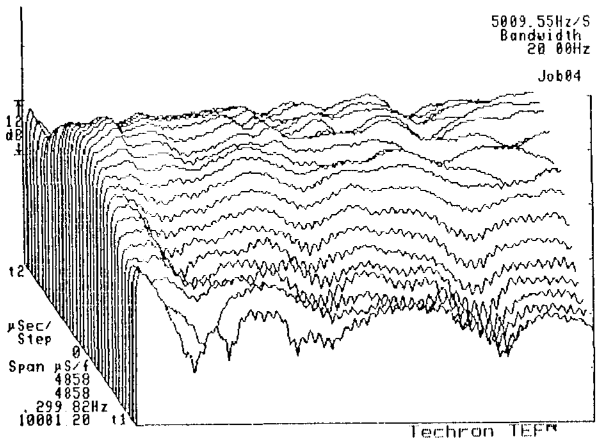
NEW PATENT ON SIGNAL ALIGNMENT!?

We were interested to see in the patent reviews in the ASA Journal that someone recently received a patent on the idea of temporal alignment of alike loudspeaker devices behind a movie screen along with having absorption near the loudspeaker. Since alignment dates back to 1937 and absorption near the loudspeaker to 1967, we would hesitate to license under such a patent.

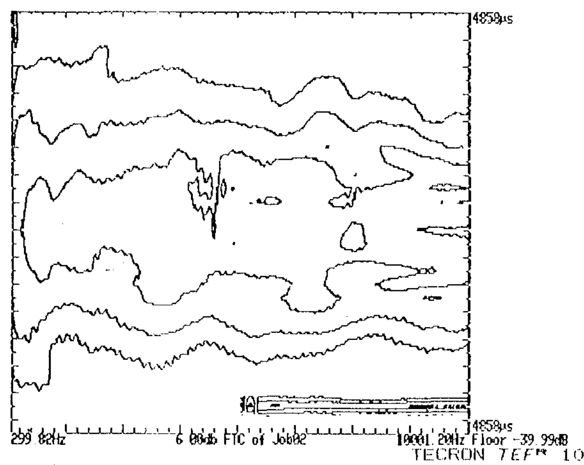
It is increasingly evident that the ideas are worthwhile. Here are some more ways of viewing in and out of alignment loudspeakers:

A. 3D of two in alignment loudspeakers
B. FTC of two speakers in alignment
C. 3D of two speakers out of alignment
D. FTC of two speakers out of alignment

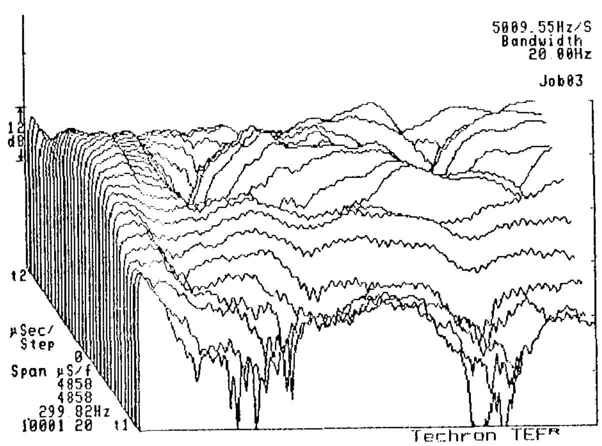
This kind of polar data is vital when working in control rooms.



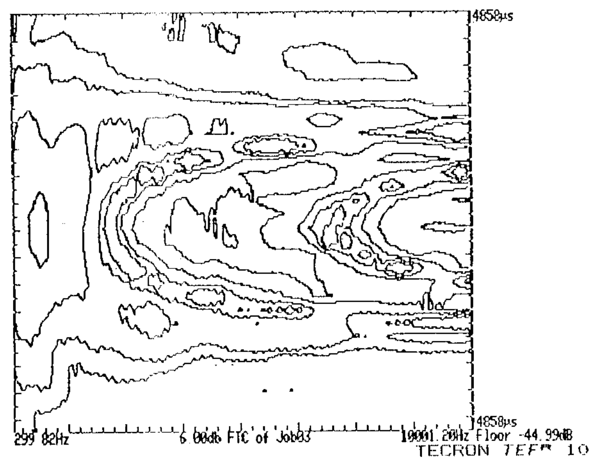
A. 3-D of two aligned loudspeakers



B. 6.00dB FTC of two aligned loudspeakers



C. 3-D of two unaligned loudspeakers



D. 6.00dB FTC of two unaligned loudspeakers

NEW ROOMODE™ PROGRAM

David Conant, principal at the new West Coast firm of McKay, Conant, Brook, Inc. in Woodland Hills has written a Roomodes program with some interesting features such as his table for common resonant panels.

The Roomodes portion of the disk is for rectangular rooms. The eingenmodes of a non-rectangular room cannot be calculated analytically. Numerical calculation of the acoustic eigenvalues and eigenfunctions of nonrectangular rooms is possible with the finite element method. The required computer storage, according to Nieuwland and Weber, *Eigenmodes in Non-Rectangular Reverberation Rooms* is 436 kilobytes of vertical storage. On an old IBM 370/168, it took 42 minutes of CPU time and 62,000 input/output operations to the disc storage. Even with that capacity it was stated that only the lowest seventy eigenvalues were accurate enough to be useful.

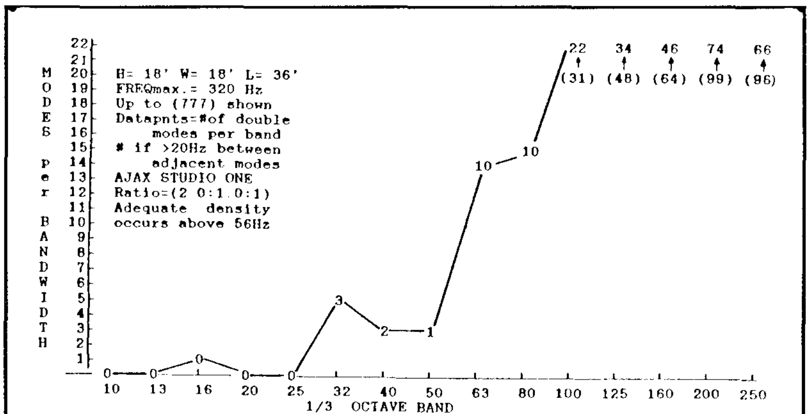
What's important to remember about all this is that in the lower modal frequencies, many of the control rooms look rectangular acoustically and the main deviation to be expected between calculation and measurement is the level of the mode rather than then spacing or frequencies.

The resonant panel information will be used often by control room designers.

Contact David Conant for more information at McKay, Conant, Brook, Inc., 5811 Kentland Ave., Woodland Hills, CA 91367. Phone (818) 713-2060.

ROOMODE™

A program for IBM PC computers and clones is available that quickly graphs the distribution of normal acoustic modes of rectangular rooms (10 Hz to 1.25 kHz & up to 777 mode, selectable) as a function of 1/3-octaves as well as their distribution across the room itself. Eigenwavelength within 1 Hz of each other are identified as welll as 20 Hz-wide gaps between adjacent eigenwavelength These data are presented in a format for easy aplication of Bonello's criteria for 'good' rooms (J.A.E.S. Sept. 1981). Options include viewing normalized rms pressure distribution across any plane orthogonal to the room coordinates for any mode as well as for the composite of all modes within any 1/3-octave band. Resonant panel absorption data are included for removing problem resonances revealed in the modal density graph as well as the pressure distribution point showing 'hot' and 'dead' spots in frequency and space. Program requires 512 RAM under MSDOS 2.0 or higher.



(sample of one of the displays)

Price: $49.00 for 5.25" or 3.5" diskette. Please specify

ABSORBENT AIRSPACE DEPTH BEHIND PLYWOOD RESONANT PANELS

1/3 Octave Center (Fo,HZ)	1/16"	1/8"	3/16"	1/4"	5/16" ← Plywood thickness
31.5	-	-	-	45"(B)*	38"(B)*
40	-	50"(A)	35"(B)	26"(B)*	21"(C)*
50	-	33"(A)	22"(B)	17"(C)	13"(C)*
63	40"(A)	20"(B)	13"(C)	10"(D)	8"(D)
80	26"(A)	13"(B)	9"(C)	6.5"(D)	-
100	16"(A)	8"(C)	5.5"(C)		
125	11"(B)	5.5"(C)	3.7"(D)		
160	6.1"(B)	3"(D)	-		
200	4.1"(C)	-	-		
250	2.7"(C)	-	-		

SABINE COEFFICIENT, α

	@ Fo	@ 2xFo & Fo/2
(A):	1.1	0.70
(B):	1.0	0.57
(C):	0.9	0.40
(D):	0.8	0.22

Sabines = α x Area (ft²)

NOTES: Fo = Panel resonant frequency, Hz

1. Letter A-D after air depth refers to absorption characteristic (see box).
2. 16" wood or solid steel stud spacing except '*' requires 24". No bracing!
3. Use 2" min. glass fiber or mineral wool in cavity. Must not touch panel!
4. Nail or screw the panels to studs @ 12" on centers. Caulk full enclosure.
5. If panels are denser than light or average plywood, multiply Fo by 0.85.
6. Airspaces deeper than 6" require 'boxing-in' rather than studs at edges.

COMPUTER SOUND SYSTEM DESIGN PROGRAMS

Having been the very first to ever generate a sound system design program for the computer some 20 years ago, it saddens me to see the basic concepts twisted into sales tools full of product hype. The audio industry truly needs a good design program, one that uses the newest of VMA Peutz's work, correctly uses the statistical equations along with all the modifiers that have been developed, and employs an accurate loudspeaker mapping technique. What's not needed are flashy graphics driven by over smoothed data. We don't need ray tracing programs based on "wishful assumptions."

We do need menu driven programs that call the attention of the user to the natural sub-divisions that occur in real design situations.

Today's well equipped sound contractor can quickly and accurately measure:

1. Speech intelligibility
2. Acoustic gain
3. Loudspeaker coverage

Many have found that the program that most accurately *predicts* what they measure is the Prohs-Harris Design (PHD).

The tragedy, as Syn-Aud-Con sees it, is that each manufacturer seems driven to produce his own version of a design program. The result is a confusion of programs that bewilders the architect-engineer community with their conflicting claims. It costs a great deal of money on the part of the manufacturer to appear like a new "computer game" salesman to the end user and customer.

Some clever graphic sub-routines have been developed, but a clever three dimensional representation of incorrectly manipulated data is still in the plainest terms possible, a lie.

Industry Supported Sound System Design Program Needed.

Syn-Aud-Con believes that what is needed is an audio industry *design* program managed by some agency not subject to the influence of the marketplace. That eliminates NSCA, the AES and other trade show groups. Ambassador College would be a logical agency for the collection and utilization of the better sub-routines. Such sharing incidentally would have its biggest payback in the mutual education of all the contributors as to what the real world can and will utilize.

We realize that certain large firms rely on misdirection as a basic marketing tool but we truly feel that a design program administered by John Prohs at Ambassador and supported by Altec, Community, Crown/Techron, EV, Shure and JBL.

They would quickly generate a super program with authority that would gain and maintain the respect of the entire architectural planning community.

Panel of Industry Authorities

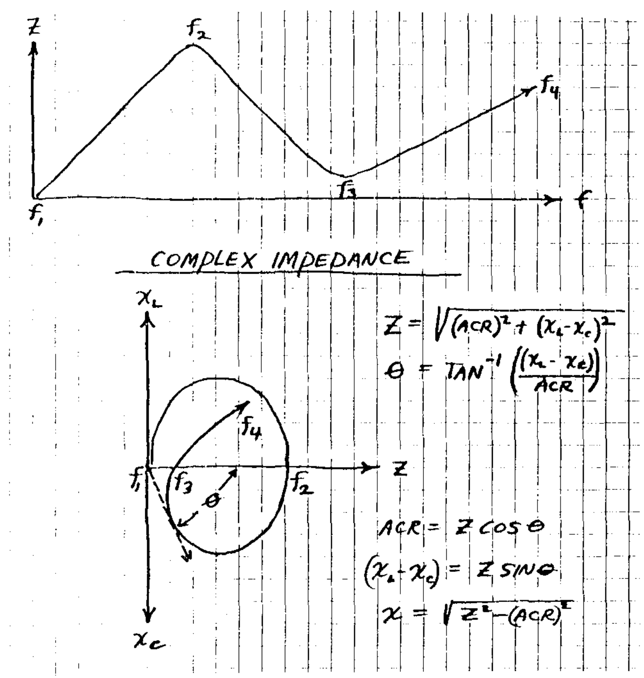
While we acknowledge the clever graphics several manufacturers have developed, the key question is "Where do the guts of the program come from?" The answer here, in our opinion, would be a meeting between the engineers of the manufacturers and VMA Peutz, Dr. Patronis, Ron McKay, Dave Klepper, Don Davis and similarly qualified persons involved in design problems but not in the equipment marketplace. If any of this makes sense to you, write your manufacturers and tell them so. Otherwise, the tragedy will continue at an ever accelerating pace.

There is plenty of room for proprietary programs for those with surplus cash to support them:

1. How to bid
2. Inventory control for sound contractors
3. CAD programs for shop drawings, etc

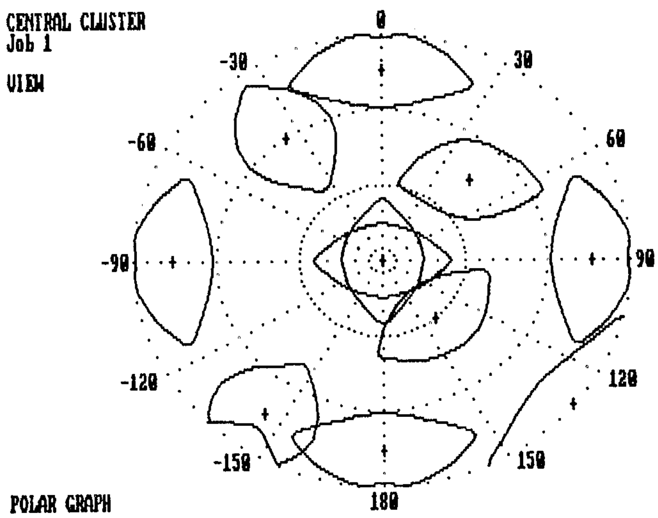
These types of programs are rightfully considered as useful to a manufacturer's closely held group of outlets. We simply don't believe the basic acoustic design program is or should be.

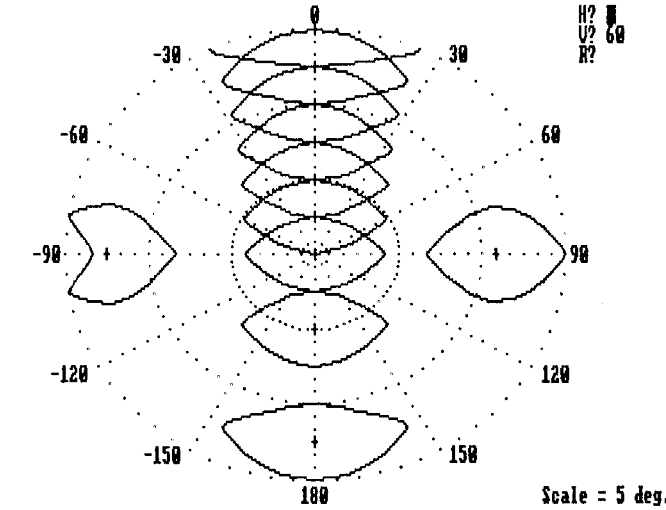
MAGNITUDE OF THE IMPEDANCE



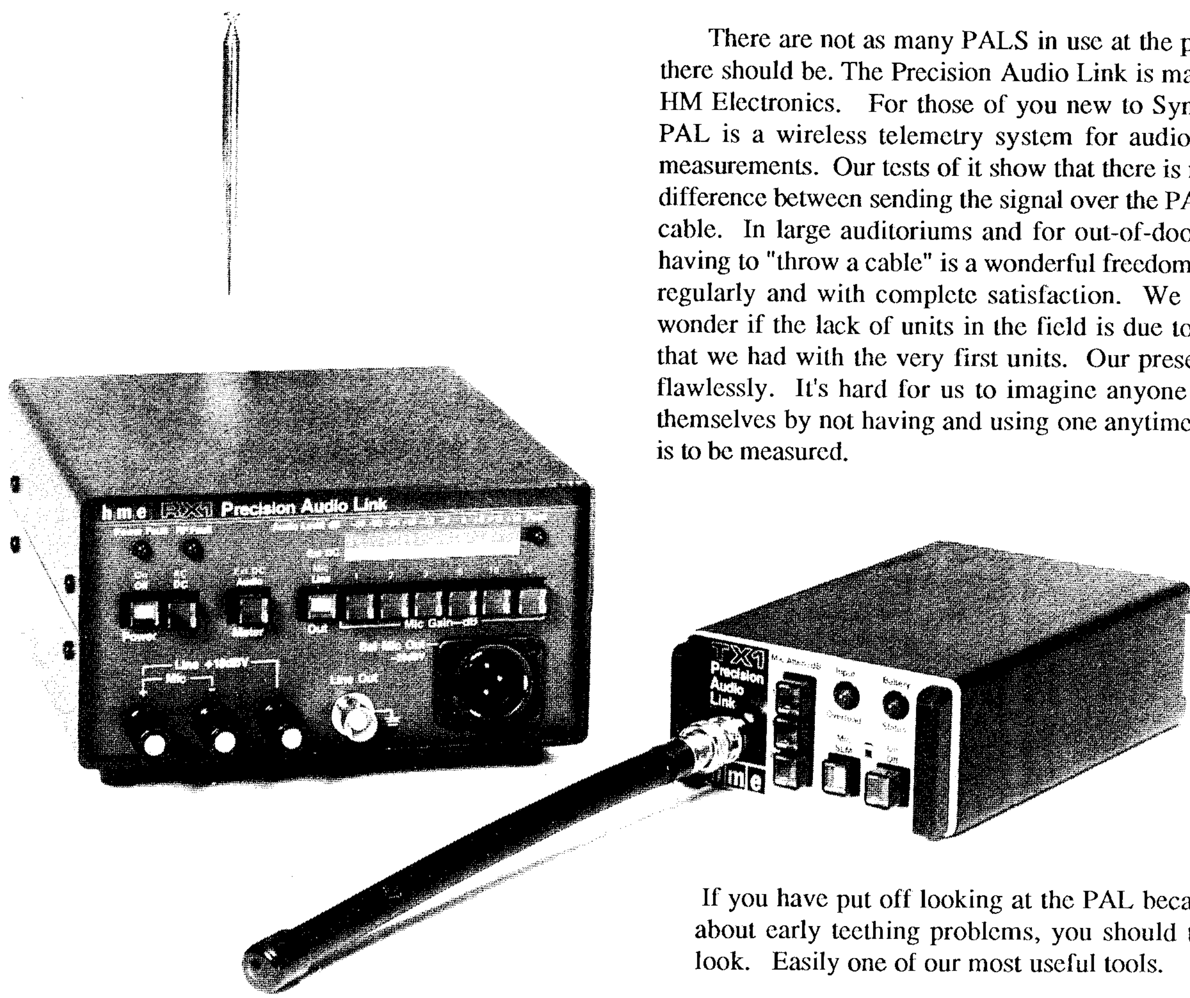
FUTURE PHD PROGRAMS

John Prohs and David Harris have sent us some printouts from their latest improvements in their program. They can now move loudspeaker patterns around on their spherical map of the room as is evidenced in these printouts. This feature, in our opinion, may well turn out to be the avalanche factor in the use of the PHd program. Accurate visualization of loudspeaker coverage is a must for tomorrow's designers.





PRECISION AUDIO LINK (PAL)



There are not as many PALS in use at the present time as there should be. The Precision Audio Link is manufactured by HM Electronics. For those of you new to Syn-Aud-Con the PAL is a wireless telemetry system for audio and acoustic measurements. Our tests of it show that there is no measurable difference between sending the signal over the PAL and using a cable. In large auditoriums and for out-of-door systems not having to "throw a cable" is a wonderful freedom. We use ours regularly and with complete satisfaction. We can't help but wonder if the lack of units in the field is due to the problems that we had with the very first units. Our present unit works flawlessly. It's hard for us to imagine anyone handicapping themselves by not having and using one anytime a large space is to be measured.

If you have put off looking at the PAL because of stories about early teething problems, you should take a second look. Easily one of our most useful tools.

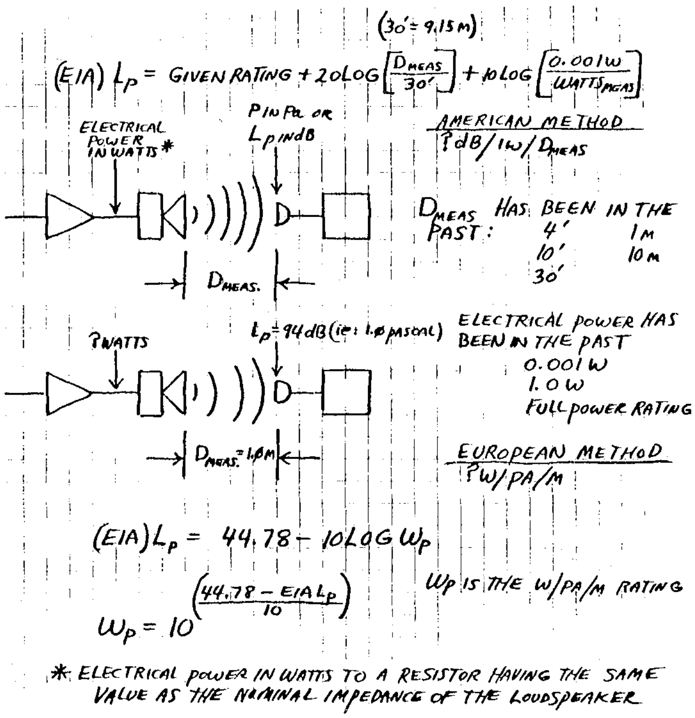
FREE COPY OF SOUND SYSTEM ENGINEERING

J. W. Davis & Company
214-651-7341 (Dallas)
1-800-442-1564 (Texas)
1-800-527-5705 (Outside Texas)

J. W. Davis has a special offer to people who place an order for their products of $1,000 or more that we like very much. They will send you a free copy of the 2nd edition of **Sound System Engineering**. For an order of $500, they will let you have the book for $19.95.

You can also get a copy of **Handbook for Sound Engineers, the new Audio Cyclopedia** by ordering J. W. Davis products. It's worth calling J. W. Davis: The J. W. Davis people are good people with good products. They are long on **SERVICE**, spelled with bold capital letters.

LOUDSPEAKER SENSITIVITY RATINGS



SIGNAL ALIGN, SIG CONVERGE OR SIG SYNCH

Industrial Research has a new video tape on their excellent line of products. They used a term in conjunction with their signal delay devices that we found highly descriptive: Sychronization (incidentally, they have always used the correct term "signal delay.")

Our mind scan instantly settled on Sig Synch for "Signal Synchronization" as a term for what we are trying to do to signals out of loudspeakers arriving at our listeners ears.

One friend of mine used to say just before zero hour "simonize your watches." Now we can say, "Gentlemen, Synchronize your loudspeakers"?

Is it easier to say, "Synching your loudspeakers" than it is to say, "Converging your loudspeakers" as suggested by Charles Baxley?

Alignment	Convergence	Synchronization
Aligned	Converged	Synched
Aligning	Converging	Synching

What shall it be?

LOSS IN SPEAKER LINES

A recent telephone conversation with a young man from Florida who is new to the audio business led to me digging in the files for some old Altec data from their original national seminar in 1958.

David Marsh in Tech Topic Vol. 14, No. 5, spring 1987 **An Electronic Spreadsheet Calculating Speaker Line Losses** has provided a neat elegant solution for those with M-DOS computers and Lotus 1,2,3. We expect that seasoned audio contractors welcome its availability.

This reproduction from that original seminar's manual is a quick reference guide for those new to the business. When using long volt or 25 volt lines it is necesssary to consider

1. Resistance of the total line (the IR loss)

2. The current carrying capacity for a given wire size and hence the power limit that implies:

$$W = I^2R$$

3. The chosen amplifier power and its impedance:

$$R = E^2/W$$

We are grateful to the young man that called and regret we failed to write his name down in our hurry to try to find data useful to him over the telephone. We hope he sees this reproduced article.

LOSS IN SPEAKER LINES

The choice of wire size for loudspeaker lines is determined by an economic balance of the cost of copper against the cost of power lost in the line. The following table gives a considerable amount of information to help solve this problem. Examples are provided to illustrate the use of the tabulation, including the method for determination of cross-talk level when one wire is common to two circuits feeding separate zones.

Length of 2-wire Line for Various Values of Power (70 volt line, 0.5 dB loss)

Wire Size AWG	Resistance per 1000ft. Wire pair	Max. Safe Current	Max. Safe Power	Power in the Load 10W	15W	20W	30W	40W	60W	100W	200W	400W	1000W
#6	.8ohms	50 Amp	3500W					9100	6200	3640	1820	910	360ft
#8	1.28	35	2450				7800	5700	3900	2280	1140	570	230ft
#10	2.0	25	1750		9900	7300	5000	3700	2500	1450	730	370	150ft
#12	3.2	20	1400	9100	6200	4600	3100	2300	1600	910	460	230	90ft
#14	5.2	15	1000	5600	3800	2800	1900	1400	950	560	280	140	56ft
#16	8.0	6	420	3600	2400	1800	1200	900	600	370	180	90	ft
#18	13.0	3	210	2300	1500	1100	750	560	370	230	110	ft	
#20	20.6	1	70	1400	960	710	480	350	240	ft			
#22	32.6	.5	35	900	600	450	300	ft					
		Load Impedance		490	327	245	163	122	81	49	24.5	12.2	4.9ohms

For 1 dB loss, double all lengths. For 25 volt line: divide all lengths by 8, Max. safe power by 2.8 and load impedance by 8.

EXAMPLES:

1. A line composed of two #14 wires 5600 ft. long can supply 10 watts to the load at 70 v with 0.5 dB loss. For a line double this length or double this resistance per 1000ft., the loss is 1 dB.

2. A line composed of two #14 wires has a resistance of 5.2Ω per 1000 ft. of line, and is allowed to carry up to 15 amperes (N.E.C.) or, at 70 volts, a power of 1000 watts.

3. The impedance of a load drawing 10 watts from a 70-volt line is 490Ω.

4. A 1000–foot 70-volt line is required for a load of 30 watts. Use #16 wire for a loss slightly less than 0.5 dB or #18 for approximately 0.6 dB loss.

5. 100 watts is to be supplied to a load by a 100-foot line. #22 wire would have little loss, but the Code limits the current in #22 to 0.5 ampere or 35 watts.

6. A pair of #18 wires can supply 200 watts at 70 volts (impedance 24.5Ω) a distance of 110 feet with 0.5 dB loss. The same line at 25 volts (impedance 200Ω) may be only 14 feet long for 0.5 dB loss, but, on safe power basis, the conductors would be overloaded 2.8 times.

7. A 1000-foot, 70-volt line consisting of 3 #16 wires (1 common) supplies power to two 15-watt loads in different zones. The voltage drop in the common due to one load is 4/327 (roughly .01) of the load voltage. The resulting cross-talk voltage ratio is approximately .01 or -40 dB (inaudible).

8. Note that the length of line for 0.5 dB loss, in a given conductor size, is inversely proportional to the power. Thus, for #14 wire pair and 100 watts, read 560 ft. from the Table; for 150 watts, divide this by 1.5 to obtain 374 ft.

NEW PRODUCTS FROM SHURE

We recently received a letter from Shure announcing ten new products. Two of them immediately caught our attention. The first is called the Audiomaster 1200MX. It is a monophonic powered mixer with 6 inputs expandable to 10 and with 200 watt electrical output power into a 4 ohm load.

The second is a new two-way loudspeaker system (rumored to have had Ed Long's magic touch applied -- called here Time-Synch). It is rated at 120 watts, 50.8 dBm input power and with an EIA sensitivity of 48.78dB, thus the maximum audience level, LP at 30' would be 99.6dB. Not bad from a packaged constant directivity system powered from a small portable mixer-amplifier.

We have always had total satisfaction from Shure electronics and the loudspeaker looks promising. For those of you needing small powerful systems to rent out, this looks like a Shure thing.

We're also pleased to see that the Shure spec sheet has their polarity information listed as Phase (polarity). It will soon be just polarity.

On the amplifier they are describing signal parts as dBV, which we fully concur with as a 1.0 volt reference does proceed from an agreed upon standard. They also are consistent in giving output amplitude in voltages as well. Excellent spec sheets that can serve as examples to the industry.

A NEW SYN-AUD-CON LABORATORY

June 1987 saw the construction of a new Syn-Aud-Con laboratory at the farm in Indiana. A 1350 sq. ft. facility houses the book collection gathered over the years by Don and Carolyn, a full acoustic measurement space for transducers of all types, and a video film work area. The first use of this new laboratory will be to support the illustration efforts for a second edition of **How to Build Loudspeaker Enclosures.**

A primary need in such a laboratory is sufficient physical space to allow polar responses of loudspeakers to be taken with adequate frequency resolution. 250 acres should suffice.

Future issues will feature some of the unique antique test equipment gathered together in this lab, as well as some listings of the library's resources.

Our office in Bedford is open Monday through Friday 8:30 a.m. to 5:00 p.m. EST. Our lab phone number is (812) 995-2101. When we are at the farm we will answer, so this means that during July and August you'll have a better than average chance of Don or Carolyn answering the telephone.

A MISTAKE REPEATED

It's always interesting to see a mistake you've made in the past show up in the present as someone else's problem. To quote from a speaker review in **Audio**:

"This is the tweeter's rear radiation reflecting off the inside rear of the cabinet and **passing out through** *the electrostatic panels."*

This energy does not "pass out through", but causes a standing wave condition that results in the radiating surface changing its acoustic impedance, thus creating a comb filter effect that looks the same as would have been caused by a second signal passing through the diaphragm, but in physical fact did not. We have Dr. Patronis to thank for the correct explanation for this phenomenon.

I remember Paul Klipsch's admonition, "I'm an expert because I already made that mistake". Those of us who make frequent mistakes but learn from them prosper. Those who make frequent mistakes but don't know it, pontificate.

HELP from THOSE WHO LIVE OUTSIDE U. S.

We have a problem at Syn-Aud-Con now that we have moved to a small town in the middle west. Our local bank charges us as much as $40 to process an out-of-the country check.

Our Newsletter subscription forms ask for payment by Visa or MasterCard but there are a lot of Order Forms out there which are being used without knowledge of our problem. Please. Will our friends from out of the U.S. please make payment by Visa or MasterCard?

IRPI TRANSVERSAL EQUALIZER

If you haven't seen Industrial Research Product's new specification sheet on their DG 4021, 4022 and 4023 transversal equalizers, send for it now. It is the best we've seen to date. Better yet, it is describing new versions of the best equalizer available today.

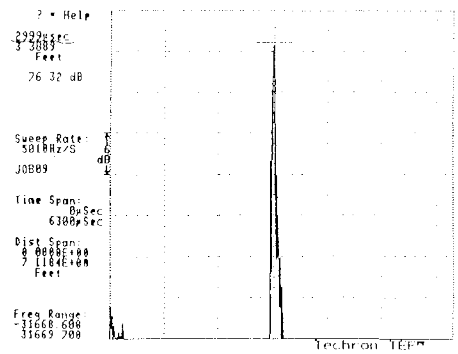
I particularly like the DG 4021 with its screwdriver slot adjustments. The other two versions utilize rotary knobs and graphic slider controls. These two versions also are full 29 filter equalizers (spaced on ISO 1/3-octave centers).

We have used the older version DG 4017 (16 filter unit) for over a year in our classes and found it to be a remarkable unit. We also have been using the IRPI 100 watt dual channel power amplifier as our auxiliary test amplifier (for most of our live listening tests) and believe it truly lives up to Industrial Research's statement, "state-of-the-art, small, light weight, extremely reliable."

Again, if you haven't seen it yet, get their new spec sheet. It's what we think a spec sheet on an equalizer should look like.

SIGNAL DELAY INVERTS POLARITY

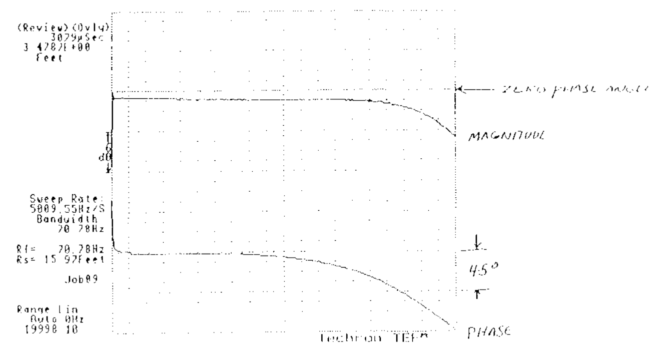
Be sure that you check all signal processing equipment for polarity in and out. To date every signal delay we have encountered needs to have its output flopped -- fortunately they have all been balanced circuitry. To illustrate the problem I'll use the tests we recently made of the ADD-3 digital processor.



PROCESSOR SET TO 3000 MICROSECONDS

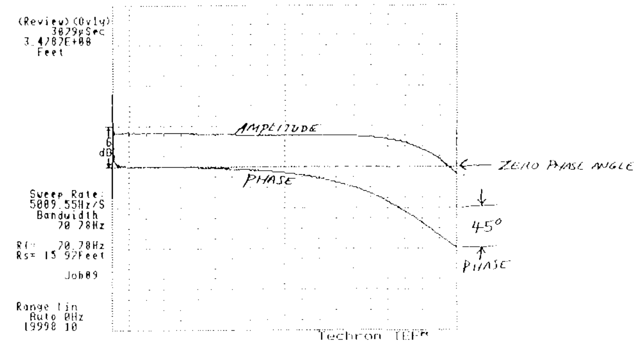
Audio Digital is an excellent delay device for alignment work with steps of 15 usecs out to 9.99 msec (the other mode is 0 msecs to 490 msecs). Jensen transformers are used for the balanced configuration.

Since the resolution of the TEF analyzer was 15 usecs, we could easily misjudge relative time by ±15 usecs. In order to adjust the unit precisely to 3000 usecs, I found I had to set it to 2910 usecs on its internal indicator (i.e. 194 steps of 15 usecs each) the difference between the 2999 usecs indicated by the cursor on the TEF analyzer (see Fig. 1) and 2910 usecs is the signal lag caused by the A-D and D-A procesers in the delay device (i.e. 89 usecs ± 15 usecs - 104 or 74 or somewhere inbetween).



When we ran the magnitude and phase responses, (see Fig. 2) we found the phase response to be 180° below the zero phase angle reference point. When we flopped the polarity, we obtained the desired phase response (see Fig. 3).

In examining the transient behavior of the high frequency response of the unit, we found just beyond 20K Hz an interesting frequency ringing. We don't tend to believe this is of any consequence, but it was a behavior we had only observed before in too narrow bandwidth simple filter circuits.



We liked the ADD-3 and felt its programable features were a definite asset in a device that has to be left where prying hands might try to fool with it (they can't). Its well behaved frequency, phase, and transient response along with its accuracy of calibration belies its very low price. (Full list $849 with usual trade discounts.)

OHMS LAW

The letter "E" stands for electromotive force and is measured in volts. The letter "I" stands for the current flowing in a circuit and is measured in amperes. The letter "R" stands for resistance and is measured in ohms. The letter "W" stands for the power developed and is measured in watts. These four letters spell WIRE and the familiar wire wheel is shown in Figure 1.

The letter P.F. stand for power factor and are dimensionless. For our preliminary discussions we'll make P.F. 1.0.

All of the equations in the WIRE wheel are derived from

$$E = IR \quad \text{and} \quad W = EI$$

$$I = \frac{E}{R} \quad \text{and} \quad R = \frac{E}{I}$$

because

$$\frac{E}{R} = \frac{IR}{R} \quad \text{and} \quad \frac{E}{I} = \frac{IR}{I}$$

We can do exactly the same with
$W = EI$

$$E = \frac{W}{I} \quad \text{and} \quad I = \frac{W}{E}$$

If we gather like expressions together we find

$$W = EI \qquad I = \frac{E}{R} \qquad R = \frac{E}{I} \qquad E = IR$$

$$I = \frac{W}{E} \qquad E = \frac{W}{I}$$

If we now use substitutions we can write

$$\frac{W}{I^2} \quad \text{and} \quad R = \frac{E}{\frac{W}{E}} = \frac{E^2}{W}$$

Further manipulation leads to

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

$$E = \sqrt{WR}$$

More manipulations would be

$$R = \frac{W}{I^2} \qquad I^2 R = \frac{WI^2}{I^2} \qquad W = I^2 R$$

Again let's gather like expressions together

$$W = EI \qquad I = \frac{E}{R} \qquad R = \frac{E}{I} \qquad E = IR$$

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

$$E \sqrt{WR}$$

Looking at our collection we can now find by substitution

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

and

$$I = \frac{W}{E} = \sqrt{\frac{W}{WR}}$$

$$I^2 = \frac{W^2}{WR} = \frac{W}{R}$$

$$I = \sqrt{WR}$$

and further

$$R = \frac{E^2}{W} = \frac{W^2/I^2}{W} = \frac{W^2}{WI^2} = \frac{W}{I^2}$$

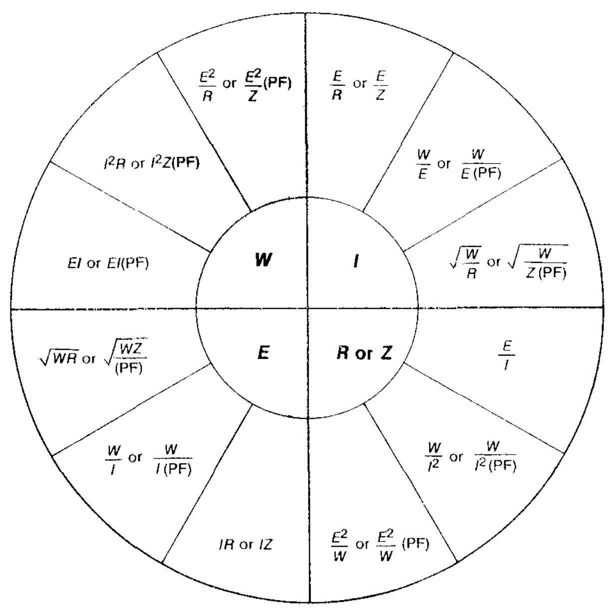
Our final list of equations is:

$$W = EI \qquad I = \frac{E}{R} \qquad R = \frac{E}{I} \qquad E = IR$$

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

$$W = \frac{E^2}{R} \qquad I = \sqrt{\frac{W}{R}} \qquad R = \frac{W}{I^2} \qquad E = \sqrt{WF}$$

And that's a good beginning into ohms law! (the exclamation is supplied by the typist doing her first equations



Ohm's law nomograph for ac or dc.

HANDBOOK FOR RIGGERS

We had several phone calls from people asking where they could buy the **Handbook for Riggers.** Mark Miceli of Tucson had given us a copy. He helped us find the publisher. The price is very reasonable for such an important manual.

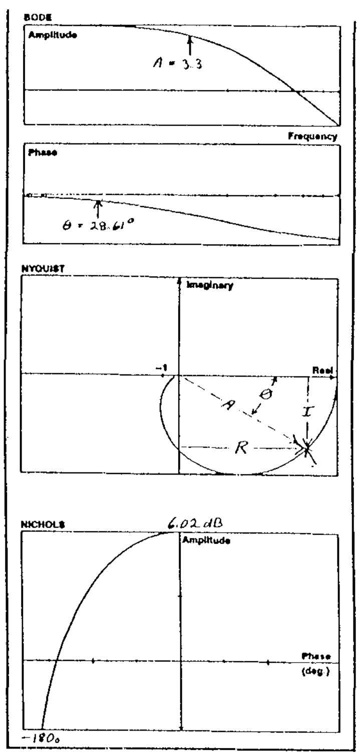
PHASE BASICS

As we have promised, these short tutorials will appear from time to time in our newsletters.

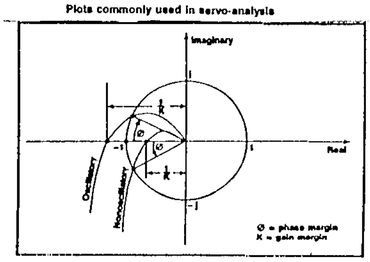
Phase response is not as familiar to many as is amplitude response (i.e. often called frequency response).

Let's start with the familiar - an amplitude vs. frequency plot (top of illustration). We are looking at a signal that as it increases frequency (log scale) it drops off in level.

Plotted just below (see illustration) is the phase response which starts at zero degrees and rolls off to minus one hundred and eighty degrees.



Plots commonly used in servo-analysis



Stable and unstable systems: Nyquist plots showing gain margins and phase margins

The next two illustrations are called a Nyquist plots and are related to the amplitude and phase in the following way.

The line labelled 'R' is the magnitude of the real axis and the line labelled 'I' is the magnitude of the imaginary axis for the point indicated by the arrows. If we assign a value of 4.0 to the distance from the crossing of the axis to the end of the arrow labelled "Real" and 2.5 to the arrow proceeding from the axis to the label "imaginary", then we find that R is 3.3 and I is 1.8. Using the ancient Pythogorian theorem

$$A = \sqrt{R^2 + I^2} = \sqrt{(3.3)^2 + (1.8)^2} = 3.76$$

The next plot is called a Nichols plot. It is the log magnitude vs. phase.

Log Mag = 1OLOG A

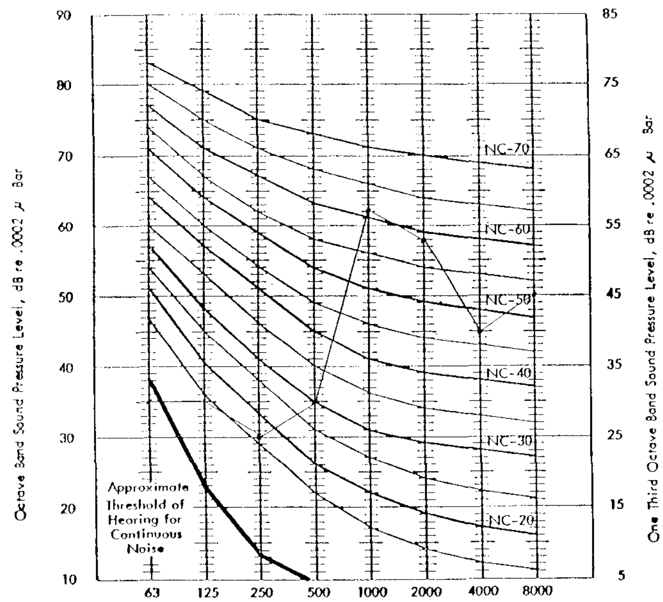
Each of these displays tell much the same story but in different ways.

The final plot is a Nyquist plot, indicating the difference between a stable and an unstable system (could be an amplifier, a servo mechanism or an acoustic feedback loop).

Phase plots are often easier for finding the natural frequency of a filter as it passes through zero phase at that point. Learn the definition given here and you'll soon find that phase no longer phases you. More on phase will follow in other issues.

WRITE A NOISE CODE FOR THIS

Here is a plot of the 17 year locusts at our farm in Indiana during early June. These readings were taken about 100 yards from the woods. The ground suddenly was full of holes where they had emerged and the acoustic level was relatively steady all over the farm. They got louder as it got hotter. They lasted for approximately three weeks. We'll do a repeat measurement in the year 2004.



NOISE CRITERIA (NC) CURVES
Jackson County Indiana "Locusts" June 4, 1987 (70°F)

VOLTMETER PRECISION

Digital voltmeters quickly lead to questions about precision. Suppose, for example, that you have a new digital voltmeter with an accuracy of ± 5%. To what precision should you read voltages if the ultimate use of the reading is to compute audio levels.

Suppose that you obtain the following readings across a 600Ω circuit

1.23 volts (actually read)
1.15 volts -5%
1.29 volts +5%

$10 \text{ LOG } (1.23)^2/(0.001)(600) = 4.02 \text{ dBm}$

$10 \text{ LOG } (1.15)/(0.001)(600) = 3.43 \text{ dBm}$

$10 \text{ LOG } (1.29)^2/(0.001)(600) = 4.43 \text{ dBm}$

Now let's suppose that you misread the voltage by the following margins

1.2 read
1.1 -5%
1.3 +5%

These values would compute as:

3.8 dBm
3.0 dBm
4.5 dBm

We might easily draw the conclusion that we would know the actual level to within one decibel with this voltmeter.

SMILE

Jerry Hubbard, chief acoustic engineer at Altec, introduced Richard Schmidt, TEF operator at Altec, as a member of The TEF POUNDERS. We like that name.

HOW TO FOOL B&K RASTI

We have just returned (June 3, 1987) from an Intelligibility measurement session on the flight deck of the USS Ranger (an aircraft carrier). During the course of these tests we had the opportunity to measure a highly audible speech system with no modulation.

The Bruel and Kjaer RASTI system measured this highly audible speech signal as "too much noise to allow a measurement." The TEF %ALcons and the TEF-RASTI measured the system as if the speech processor was not being used (a speech clipping device) i.e. a 6dB error. The reason the TEF-RASTI still measured it as a speech rather than a noise signal is due to its ability to distinguish between L_D and L_N on the ETC portion of the measurement.

WORDS OF WISDOM

Doubt is the dark room where negatives are developed.

WE'RE SORRY FOR OUR MISTAKES

It is very embarrassing to make mistakes and we are sorry when we do. Fred Ampel, editor of **Sound & Video Conractor** let us know that we were in error in Newsletter V14N3, page 6, when we said "The March issue of S&VC included an article by John Linde and Mel Smith on the Marriott's Orlando World Resort and Convention Center Ballroom Combining System."

The article **did not** appear in **S&VC** but in **Sound and Communications.** We regret such mistakes.

MELTDOWN AT COMMUNITY

We're never sure where Community may lead us next but here's something to consider when you feed high electrical powers to devices that can handle them.

Dear Carolyn and Don,

Something happened here at Community the other day that I thought might tickle you.

We have recently started to manufacture a 1000 Watt siren driver that is used exclusively in the new Whelen Engineering 360° and 45° (H) horns. The horns and driver were all designed and developed by Bruce Howze. To give you a little perspective on the capabilities of the 360° horn with five drivers, it was placed on a fifty foot pole and measured at 100 feet. The SPL was a nice even 117dB at that distance, no problems, no surprises. Back at the shop, however, we needed a nice, quiet method of power testing each driver. Bruce built a wooden box lined with fiberglas insulation that is coupled to an injection molded throat to mount the driver on. The acoustical impedance of the chamber was about the same as the 360° horn, to provide similar excursion characteristics. When the driver was power tested with 400-1000 Watts for about twenty minutes the box began to really stink! Bruce removed the driver (which was cooking hot at this point) and peered into the throat of the test box. The entire throat had melted down into the box covering the insulation inside - a demonstrable example of adiabatic energy conversion! Put that into your plane wave tube and smoke it.

Best Regards,
COMMUNITY LIGHT & SOUND, INC.

John T. Wiggins
Executive Vice President

Community

HOROWITZ

Those of you fortunate enough to have seen and heard Horowitz on the national public television special have some appreciation for the immense talent of this remarkable man. Therefore, we were genuinely interested to see his "acoustical observations" as recorded in the **Washington Post**.

I'd really have enjoyed watching how and where he decided to put the piano in the East Room.

Ear, Ear: Acoustical Observations

Get Vladimir Horowitz on the subject of acoustics, and he could go on all night. It has always been a sort of fetish with him—partly because of his superlative ear, and partly because the awesome range of his tonal palette is a supreme test of acoustics.

Anyone who has witnessed the lengths to which he will go during a rehearsal to get his instrument into the optimal place on a stage knows how strongly he feels. He stations Wanda Toscanini Horowitz out in the empty hall, and has her shouting back her reactions as the piano is moved around on the stage. The very odd placing of the instrument off to the side at the one and only concert Horowitz has chosen to play in the Kennedy Center Concert Hall a few years ago resulted from such a session.

In an interview last week, he launched into a series of acoustical observations:

- Until he went back there and played last spring, Horowitz had forgotten that the Philharmonic in Leningrad is "the world's greatest hall." There is the "warm and wonderful" sound. And there is also its tradition—"after all, people like Verdi and Tchaikovsky were there."
- Last month, Horowitz played in the opening concert of the newly refurbished Carnegie Hall, where he has performed more concerts over the years than anywhere else. He is disappointed by the newly adjusted acoustics. He thinks that the new "hard surfaces" are probably the reasons for a new reverberation. "You hear it [the sound] twice, slightly," he says, and he finds that "disconcerting." But he thinks that time may soften the surfaces and solve the problem.
- Horowitz lamented the fact that many of the world's best concert halls have been destroyed by war. For instance, London's Queen's Hall was bombed out, and Horowitz thinks none of the subsequent halls there—or for that matter, the older Royal Albert Hall—are in the same class. The fact that Amsterdam was not bombed in World War II, he noted, may have saved the Concertgebouw, a "magnificent" hall.
- Constitution Hall is his favorite Washington hall, because of its "natural" sound. He also likes the sound in the East Room of the White House, where he has played two concerts in the last eight years.

—Lon Tuck

STANDARDS

There is tremendous force in a standard whether set by law or custom. The "QWER-TY" keyboard layout was designed a century ago to slow typists so the primitive machines of the day didn't jam. The the keyboard layout survives today on modern computers because it is a standard.

So much for standards. They entomb the dead.

MEASURING REVERBERATION

Reverberation time, decay rate, Schroeder integration of reverberation, early decay time, ratio of direct-to-reverberant, room time, initial time delay gap, direct sound, early sound and reverberant sound fields, density of reverberant sound field, non-exponential decay, room modes, diffuse sound, specular reflections, focused sound, echos, and many more terms are part of the vocabulary of reverberation.

Liveness and Deadness

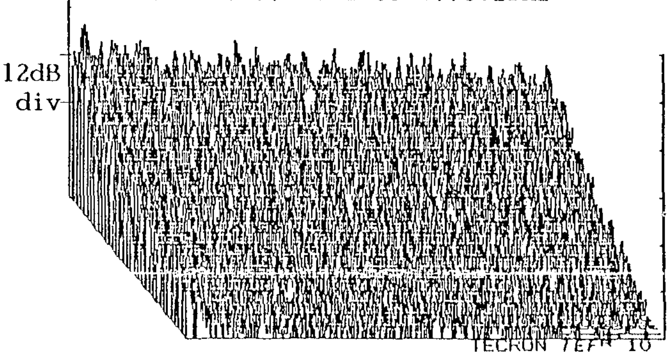
Liveness and deadness are two qualities that are almost never associated with the reverberant sound field but rather with the separation in level between the true direct sound and the first arrivals in the early sound reflections.

Measuring Reverberation

Incredible as it seems, we are able to measure all of the above quantities and qualities with the modern TEF analyzer. We can further obtain our measurements in the frequency domain as a sweep tone and use the inverse Fourier Transform to obtain the decay vs time behavior. Or we can use repeated sweeps in the frequency domain each one offset to a new time and obtain a full 3-D measurement of the decay. We can further perform a regression analysis on the 3-D and obtain the reverberation time for 60 dB of decay at any 1/N octave interval desired.

The Techron TEF analyzers have now been tested for reverberation measurements at the famous Riverbank Laboratories in Illinois. On 3-D measurements the correlation was exact with classic techniques.

Horizontal: 99.58Hz to 2998.22Hz



Resolution: 7.9406E+01 Feet & 1.4175E+01 Hz

These tests were done in conjunction with tests Peter D'Antonio was having done on his quadratic residue diffusors in the same facility.

With all this in mind the reverberation measurements that were made in St. Boniface were interesting but their usefulness would have been just as great if we had confined them to 500 to 2000Hz. A sampling is included below. Remember that increasing Q lowers early decay times.

BANDWIDTH 1/ 1 OCTAVE — 3-D MID CHURCH — Jobno 3

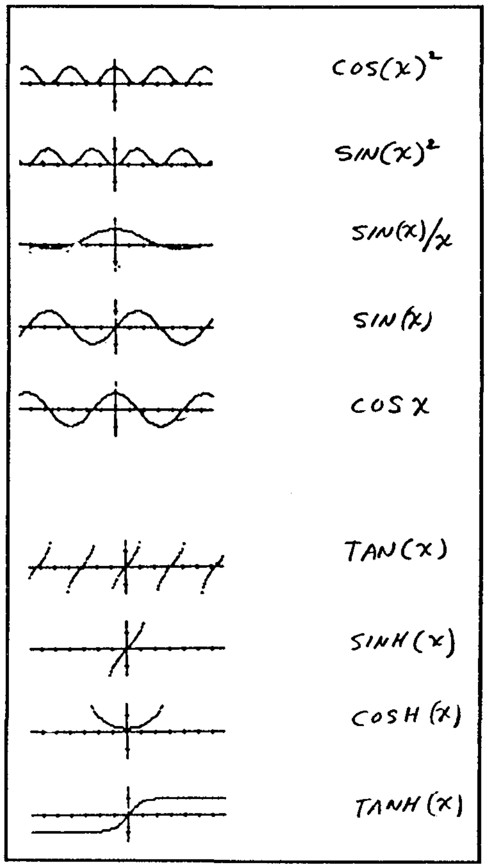
Ln	Time\Fc	125	250	500	1000	2000	4000
0	0	54.9	54.0	50.8	54.6	56.9	42.9
1	-39	55.1	52.5	53.4	55.9	57.2	43.4
2	-78	60.5	52.9	54.2	57.1	58.2	45.2
3	-117	57.8	54.6	54.2	57.6	58.2	45.3
4	-155	55.2	56.5	55.3	58.3	60.8	46.4
5	-194	58.2	57.5	56.2	58.6	60.6	46.1
6	-233	59.1	57.1	56.9	60.0	61.8	49.8
7	-272	58.8	58.6	57.0	60.1	62.5	49.9
8	-311	58.7	59.0	58.2	61.1	63.5	50.6
9	-350	61.1	58.9	59.5	61.5	64.5	51.4
10	-389	59.9	61.6	59.7	62.8	65.7	52.5
11	-428	62.5	62.8	60.2	64.3	66.5	53.6
12	-466	60.9	63.1	62.2	64.9	67.9	53.1
13	-505	61.5	63.6	62.7	66.2	69.4	55.3
14	-544	64.0	63.7	63.3	67.6	70.4	55.7
15	-583	66.3	64.6	64.9	68.2	70.3	56.9
16	-622	63.9	63.9	65.6	68.7	71.2	57.7
17	-661	62.6	65.0	65.8	70.5	72.3	58.6
18	-700	63.0	66.1	66.1	72.1	73.7	61.5
19	-739	63.3	67.0	68.3	73.7	75.5	62.0
20	-777	64.3	66.6	69.9	74.9	77.2	64.7
21	-816	67.2	68.0	69.7	75.2	77.5	64.6
22	-855	69.3	71.5	70.2	76.3	78.0	67.0
23	-894	70.3	72.6	72.1	77.0	79.6	68.6
24	-933	68.9	72.0	72.6	77.7	80.6	68.2
25	-972	68.9	74.7	74.7	79.7	81.8	69.8
26	-1011	70.5	75.8	78.1	81.2	83.4	72.8
27	-1050	73.2	75.8	79.3	82.1	84.7	72.3
28	-1088	77.1	79.9	81.9	84.4	85.3	71.2
29	-1127	80.4	80.5	81.9	84.7	85.3	71.0
30	-1166	83.0	82.7	82.4	85.3	86.3	73.2
31	-1205	80.1	83.0	84.7	85.8	87.0	74.9

REVERBERATION TIMES

RT(5/30)	2.93	2.47	2.19	2.11	2.19	2.11
RT(5/30)	2.93	2.47	2.19	2.11	2.19	2.11
RT(0/31)	3.16	2.51	2.29	2.23	2.26	2.17

THE HP 28C

The HP28C handheld calculator could easily be mistaken for a mathematical magic carpet. Just a few of its features are:



1. Algebraic manipulation. It expands, collects, or rearranges terms in an expression and you can **symbolically** solve an equation for a variable.

2. It does calculus derivatives, indefinite and definite integrals.

3. Plotting (see illustrations)

4. 120 built in unit conversions

5. statistics

6. Binary, octal, and hexadecimal numbers.

It can perform bit manipulations. It possesses the HP calculator user's dream in a stack that can be any height. A 128K RAM is another wonder for a unit this small. Menu driven it at first seems much easier but as the menus unfold infinitely you find yourself back at the math books.

This new calculator can be purchased for as little as $175 if you shop around. An excellent small printer comes with it the HP 8224OA. Just point the 28C at it and this battery operated printer reads the infra red signal and prints -- look Ma, no cords.

Our conclusion - the first calculator since the 41CVX to merit serious attention by audio engineers.

HOPKINS-STRYKER ACCORDING TO THE HPC28C

The Classic form of the Hopkins - Stryker equation is:

```
'10*LOG(Q/(4*π*r^2)+
4/(S*a))=dB'
```

and solving for r which the first time was tedious resulted in

```
's1*√(Q/(ALOG(dB/10)
-4/A)/(4*π))'
```

When we entered the Hopkins-Stryker into the HP 28C and asked it to "isolate" r followed by "colct" (collect terms) we got the following print out simply by pointing its infra red output at the printer. Low and behold a compact version

```
'√(0.25/(ALOG(0.10*
dB)-4*a^(-2))*Q/π)*
s1'
```

*SI stands for ±

These examples were obtained by entering the normal form of the expression and asking the HP 28C first to 'collect terms' and then to "isolate" a.

WHAT TO DO WHEN THE POWER FAILS

When the last battery has died and electricity in the home is but a distant memory, someone may come across my collection of slide rules and math books. My Bruhns seven-place and Vega ten-place logarithmics are still on the shelf next to Hof's powers, roots and reciprocals and Loomis's logarithmics. **The Handbook of Mathematical Functions** by Abramowitz and Stegun with its higher mathematics tables including Bessel functions is also close at hand.

These venerable tables along with my K&E log log duplex Dicitrig and my Post precision bamboo versalog slide rules are the tools that left me so receptive to scientific electronic calculators when they first arrived just 16 years ago in the form of the H.P. 35. Prior to the handheld calculators, I had been using the HP-9100 series and prior to that the books of tables with a large Frieden for extrapolation work.

Now I open up my HP 28C and have it solve equations for the unknown of my choice. I can't help but wonder if twenty years from now it will seem as slow as my old companions I've written about here.

SMILE

Editor's joking comment to us about a few sentences in an article we submitted to him: "Split infinitives up which I will not put."

COMMENTS ON MANAGEMENT

Managing a company is a complex unquantified task. Famous business schools are known for the magnitude of the mistakes their graduates make.

Some businesses are amenable to "professional management." Most audio industry businesses are not. The "professional manager" in audio always feels everything is going along splendidly until the very end. Not being able to forsee or even observe the technological changes occuring all around him. Grocery wholesalers and the like may be able to tolerate "professional management." One sure sign that "professionals" at the helm is that seven phases of a project--especially item VI.

SEVEN PHASES OF A PROJECT

I - ENTHUSIASM
II - DISILLUSIONMENT
III - PANIC
IV - SEARCH FOR THE GUILTY
V - PUNISHMENT OF THE INNOCENT
VI - DEPARTURE OF THE COMPETENT
VII - PRAISE AND HONORS FOR THE NON-PARTICIPANTS

While we realize that many of the younger generation have no idea what Fascism, Nazism, and New Dealism were (era: the 1930's-40's). The presence of the descriptors in Cows and Capitalism at least describe how they work. All these isms are still present in the world today and in modified forms often appear in state, county, city, and company politics.

In audio we've heard the division between loudspeaker manufacturers is the sensual, the psychoacoustic, and the technically competent. The first wants his body to "feel" that sound, the second can sit on a hot stove and say "what's burngin," and the third often wonders why the first two outsell him in what he had thought was a rational world.

COWS AND CAPITALISM

SOCIALISM:	"You have two cows and give one to your neighbor."
COMMUNISM:	"You have two cows. The government takes both and gives you the milk."
FASCISM:	"You have two cows. The government takes both of them and sells you the milk."
NAZISM:	"You have two cows. The government takes both of them, and shoots you.
NEW DEALISM:	"You have two cows. The government takes both; shoots one, milks the other, and throws the milk away."
CAPITALISM:	"You have two cows. You sell one and buy a bull."

--Courtesy of George Dahl

OBTAINING "IMPULSE" RESPONSE DIS-

1. Use digital oscilloscope to view impulse in time domain.

10LOG (impulse)^2 = impulse display (note: this display contains both real & imaginary components combined).

2. Acquire impulse in time domain. Do FFT to frequency domain and average many samples to obtain acceptable S/N. Do FFT^{-1} of real part back to time domain.

$$10\mathrm{LOG}\sqrt{(\mathrm{Realpart})^2 + (\text{Hilbert transform of Realpart})^2} = \text{impulse display}$$

3. Acquire magnitude and phase responses in frequency domain. Do FFT^{-1} to the time domain for both coincident and quadrature values resulting in impulse* and doublet.

$$10\mathrm{LOG}\sqrt{(\mathrm{Impulse})^2 + (\mathrm{doublet})^2} = \text{impulse display}$$

4. Acquire impulse* and doublet in time domain. Do FFT to frequency domain and average for S/N. Do FFT^{-1} to time domain for both real and imaginary parts.

$$10\mathrm{LOG}\sqrt{(\mathrm{Real})^2 + (\mathrm{Imag})^2} = \text{impulse display}$$

What Should Not Be Done

Acquire impulse response in time domain. Do FFT to frequency domain and process signal. Do FFT^{-1} back to time domain of real part only

$$10\mathrm{LOG}\sqrt{(\mathrm{Real})^2} = \text{impulse *}$$

(*Impulse defined here as the real part only. Note this impulse display is missing information removed as a part of the signal processing technique. It is often mistakenly identified as **the impulse response.** It is not!

AIR BAGS

Noise Control Engineering published an article in 1976 titled "The Noise of Automotive Safety Air Cushions" by R. Hickling of General Motors Research Laboratories. The article begins:

Coupled with the inherently loud noise of the inflator system is the sudden increase in pressure in a closed passenger compartment (called the overpressure), caused by the compression of the air in the compartment when the cushion is inflated. The inflator noise and the overpressure are components of the total air pulse to which the occupants of the automobile are subjected. Both are considered in the study presented here.....

TABLE II
Comparison of Inflated-Balloon and Breathing Air Cushions (Windows Closed)

	A-duration ms	A-peak dB (psi)	B-duration ms	B-peak dB (psi)
Inflated-balloon air cushion	300	167 (0.64)	60	159 (0.25)
Breathing air cushion	300	160 (0.30)	75	151 (0.10)

Some of the implications of the data with regard to risk criteria for damage to human hearing are discussed.....

The article is some 12 pages long (pp. 110-121). We have reproduced here a few excerpts from page 118:

This figure (160 dB) is somewhat arbitrary. There is a wide range of eardrum strengths in the general population and it is probably more appropriate to set the threshold for eardrum rupture at about 160 dB.

Below 300 Hz is the A-duration component and above is the B-duration. The charts for determining damage risk based on the BBN method are shown in Fig. 16.

We would be very interested in recent data. The figures shown here indicate the eardrum splits at around 160 dB and that in most instances the air bag exceeds that level. (Inflated balloon air cushion is 167 dB for 300 ms below 300 Hz and 159 dB for 60 ms above 300 Hz.) I'm sure that research and development has brought about progress. If anyone has more recent data, we would be interested in hearing from you.

LOUISVILLE MAY 19-20,1987

WHAT IS A DECIBEL?

It's been some time since we last wrote about the basic definition of a decibel. In audio and acoustics we deal with both electrical and acoustical powers and power ratios.

The power is one watt or we raised the power to twice its original power are commonly encountered statements. We also have electrical and acoustical power **levels.** When the word "level" is used it always should refer to a power ratio converted into a **decibel level** and **never** a voltage ratio converted into a voltage level.

THE CHOICE OF BASIC RATIO

The ratio was chosen in 1923 for the transmission unit (TU) used by Bell Telephone system and later internationally in 1929 as the decibel dB or one tenth of a Bel.

The Bel was defined as

$$\text{Log}_{10}\ 10 = 1.0 \text{ bel}$$

The decibel (1/10 of a Bel) was defined as

$$\text{Log}_{10}\ 10^{(1/10)} = 0.1 \text{ Bel}$$

The tenth root of ten, $\sqrt[10]{10}$, $10^{(1/10)}$, is a power ratio of 1.258925412...to 1.0. By this definition **any power** raised by a factor of 1.2589...(multiplied by that value) is said to have risen in level by 1.0 dB. The decibel is written as a small d for deci, the SI prefix for one tenth, capital B for Bel to honor Alexander Graham Bell.

THE BASIC EQUATIONS

Any ratio a/c can be made equal to some b^N (some base raised to some power) so that

$$a/c = b^N$$

It can also be written as a logarithmic expression

$$\text{Log}_b\ a/c = \log_b b(N)$$

and because $\text{Log}_b\ b = 1.0$

$$\text{Log}_b\ a/c = N$$

Using the base ten and the definition of the decibel we can write

$$\frac{1.28925...}{1} = \text{Log } 10^{(0.1)}\text{dB}$$

Then the logarithmic form becomes:

$$\text{Log}_{10} \frac{1.28925}{1} = \text{Log}_{10}\ 10(0.1)\text{dB}$$

or

$$\text{Log}_{10} \frac{\frac{1.28925...}{1}}{0.1} = 1.0\text{dB}$$

and finally

$$10 \text{ Log}_{10} \frac{1.28925...}{1} = 1.0\text{dB}$$

These basic equations further simplify into:

$$\text{MLog}_b\ a/c = \text{NM}$$

and

$$a/c = b^{\frac{NM}{M}}$$

or in terms of the base 10

$$10 \text{ Log}_{10} \frac{1.2892...}{1} = 1.0\text{dB}$$

and

$$\frac{1.28925...}{1} = 10^{(0.1)}$$

Mastery of these two basic equations is the key to real progress in the use of the decibel.

ETC RESOLUTION

Some users of TEF analysis use the negative sweep through to positive sweep technique in order to increase the on-screen resolution. It occurs to me that this is only useful if your microphone is relatively uniform in amplitude response up to 32,000Hz.

It is interesting to look at an ETC made with a 1/2" microphone compared to a 1/4" microphone. The resolution possible with a 200,000Hz bandwidth and a 1/8" microphone is indeed fun to contemplate.

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WANTED

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WANTED

IVIE 1/3-Octave analyzer and IVEI noise generator. **Contact Frank Huang, 3141 E. 62nd Ave, Vancouver, BC V5S 2G6, Canada. Ph 604-438-1355**

FOR SALE

Bruel & Kjaer Type 4165 1/2 inch freefield condenser microphone cartridge. Calibrated by Bruel & Kjaer in June 1987. $350.00 including UPS shipping. **Contact: Neil Thompson Shade, 6813 Glenmont St., Falls Church, VA 22042**

WANTED

Peerless K241-D
Peerless 4370 Bridge measurement. **Contact Ralph Townsly, 1020 Lindberg Ave., West Lafayette, IN 47906. Ph 317-463-5129**

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