SYNERGETIC
SYN AUD CON
AUDIO CONCEPTS

newsletter

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Spring 1992

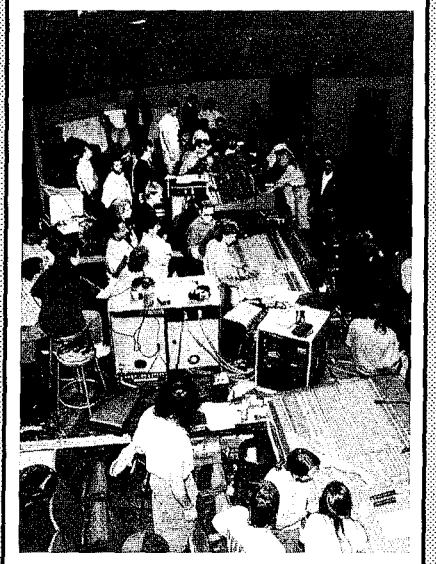
RON BORTHWICK - MICK WHELAN

ALBERT LECCESE RON BORTHWICK

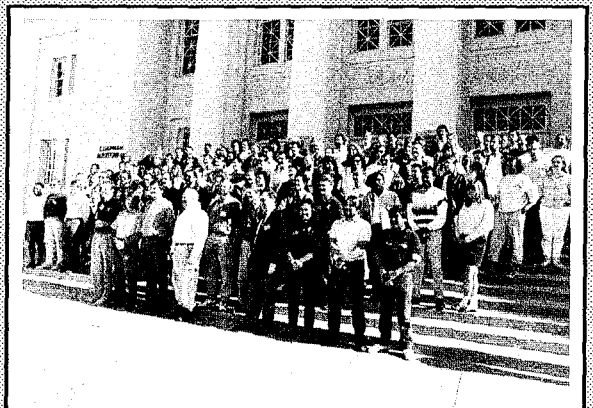
DAVID SCHEIRMAM MICK WHELAN

Concert Sound Reinforcement Workshop

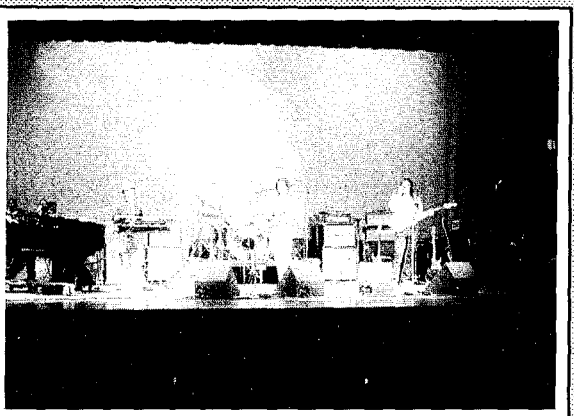
The Staff



The Workshop



The Members of the Workshop



The Band

ALBERT LECCESE - WILL PARRY - ML PROCISE

SYNERGETIC

SYN AUD CON

AUDIO CONCEPTS

EXCHANGE OF IDEAS

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

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

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

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

Editors: Don Davis
Carolyn Davis

Design & Layout: Dashia Meadows

The information conveyed in this NEWSLETTER has been carefully reviewed and believed to be accurate and reliable; however, no responsibility is assumed for inaccuracies in calculations or statements.

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For additional information contact:
Synergetic Audio Concepts
12370 W. Co. Rd. 100 N
Norman, IN 47264
Ph:(812) 995-8212
FAX: (812) 995-2110

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When Do I Renew?

You can check to see when your subscription will expire by checking the mailing label on the envelope in which your newsletter was mailed. In the upper righthand corner, beside the name, a date will appear (i.e. 4-90). This means that you will receive this issue and it will be the last issue sent unless you renew. Renewal notices will be sent at this time. You must renew before the next quarter's newsletter is mailed or your subscription will become inactive.

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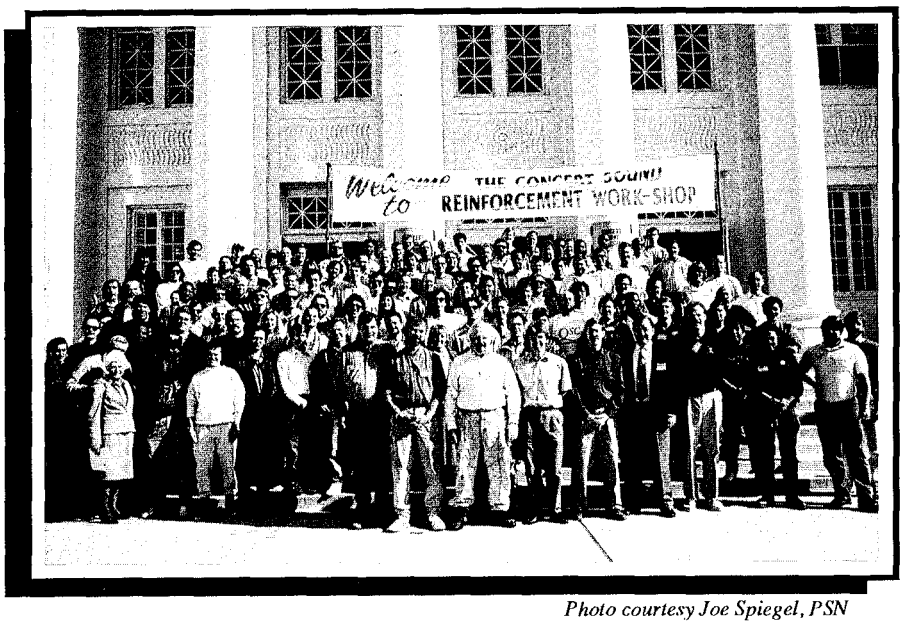


Photo courtesy Joe Spiegel, PSN

Syn-Aud-Con Sponsored Workshops

Our original thought with regard to workshops was to offer them as a "thank you" to grads of our Syn-Aud-Con classes. The very first one featured Dr. John Hilliard, VMA Peutz, James Moir and Dick Heyser. Hilliard and Moir represented the best of the past in the motion picture industry and the radar and sonar work of WWII. Heyser and Peutz were yet to bring forth TEF, speech intelligibility measurements, great concert halls, and inspiration to literally thousands of Syn-Aud-Con grads. One hundred Syn-Aud-Con grads attended that meeting.

Each of our three Concert Sound Reinforcement Workshops have closely approached the attendance record of that historical first workshop.

Have these workshops lived up to our expectations? You bet! They have all shared in common our philosophy.

1. The leaders of the workshop should be the most knowledgeable persons in their field of endeavor in the world;
2. The leaders of these workshops must be capable of communicating their knowledge to those of us standing on lower rungs on the ladder;
3. The leaders of these seminars must be willing to share, without reservation, their hard-won knowledge with those who attend the workshop.

Fulfilling those three requirements doesn't allow a steady flow of superficial workshops but a steady adherence to principle. The remarkably whole hearted approach taken by the principals of the Concert Sound Workshop is evidenced by the repeated enthusiastic audiences that attend. The three CSR workshops have given a truthful, realistic view of what experts do to satisfy sound reinforcement and monitoring needs of leading popular artists.

In the future, Syn-Aud-Con will no longer be one of the sponsors of this particular workshop. That it will continue is a source of pride and pleasure to us. We leave it in good hands and with our best wishes.

Carolyn says that when you're 20, you want to explore the whole world for new experiences. When you're 40 you want to do those things you're aware of not having done yet. Finally, when you're 60 you say, what is it I'm doing that I don't want to do.

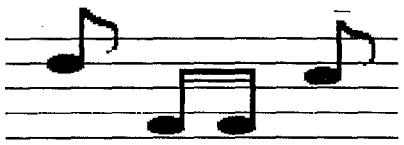
The most important lesson you can learn, if willing, between the ages of 20 and infinity is to listen to that inner voice that all of us possess if we don't mask it with the world's bad habits.

I wake up every morning with the clear realization that had God said to me at 20, "Plan your life anyway you wish" I'd have badly botched the job because no one can imagine the potential for good available to them, they can only experience it.

Taking a very finite example, the last 20 years of Syn-Aud-Con, who could have imagined where such a basically simple idea would lead.

Like the Quakers "who came to do good and ended up going well." we started out to teach and learned to share. Each early class taught us that such classes attract the bright, and offend the dull. Those that came were the alert, thinking, core of the future of our industry. We further learned to share their clear thinking with others and found that Synergy was not just a word but a dynamic *mental* catalyst to everyone not mesmerized by someone else doing their thinking for them. By the fifth year, Richard Heyser, Victor Peutz, James Moir, and John Hilliard recognized that a new peer group had reached critical mass in our industry and graced our first grad seminar. The wonderful Heyser years culminating in the TEF analyzer, the development of the LEDE idea into a whole new approach to small room acoustics through the likes of Peter D'Antonio, Russ Berger, Chips Davis and many, many others; Victor Peutz, a true intellectual giant who chose to share his speech intelligibility insights with the pioneer TEF users; and on into the Patronis years that are every day exploding in new directions.

To paraphrase Voltaire, "We live in the most exciting of all worlds." The only entrance fee is to be awake and able to think for yourself. Between now and the year 2000AD we believe the pendulum will again swing towards remarkable technological discoveries that will sweep away the entropy limiting so many today and causing them to fear progress. Mankind, for the first time, has within their grasp a new sense of universal freedom that grew, not out of political or other social causes, but out of man's ability to communicate with each other. Technology has in the past created both bullies and the bullies' eventual downfall. All that's needed is more widespread Synergy of the kind we have all experienced in the special case called Syn-Aud-Con.



The Musician's Business & Legal Guide

Remember the book, How to Make and Sell Your Own Record by Diane Rapaport of Jerome Headlands Press? A brand new edition is due in September from Prentice Hall.

Jerome Headlands Press has a new important book, The Musicians Business and Legal Guide.

The book represents a continuation of 15 years of effort in providing coherent and practical information for musicians that enables them to make a living at every stage of their careers. It's the only book that represents current legal thinking on all the critical issues in the business, including clause by clause analysis of major industry contracts.

Compiled and edited by Los Angeles music attorney Mark Halloran, this book is filled with easily understandable information about legal and business issues in the music industry today. In his introduction to the book, Halloran said, "The purpose of this book is to impart knowledge. To demystify this seemingly monolithic business and the indecipherable body of law which shapes it."

Key subjects include the selection and protection of names; copyrights and infringements; live performance; managers and agents; recording and production agreements; publishing contracts; music licensing for films, video and television; and music merchandising.

As I read through the book it seemed to me that The Musician's Business and Legal Guide should be on the shelf of anyone who works with a performing musician.

Diane, along with her husband, Walter, live in Jerome AZ - an exotic former ghost town. Buy your copy of the book and when you are in Arizona plan a trip to Jerome to personally meet the very talented Diane and Walter Rapaport. You won't be sorry you did.

Only a few years ago Jerome was totally a ghost town. Then talented "hippies" started to move into the vacant properties and fix up and restore the old buildings that have a toe-hold on the side of a mountain once filled with copper, silver and gold. (You rarely see a truck or a motorhome on the road because of the steepness of the grade and the sharp turns.) Most of the 400 residents of Jerome are artists which adds unique color to this remarkable town.

Getting back to The Musician's Business and Legal Guide, we have included an order form with your Newsletter.

President Bush Honors Peavey

Hartley Peavey is an American original. Every contact I have with him reminds me of another American original, also from Mississippi, Nathan Bedford Forrest. It was said of Forrest "No other high commander on either side overcame obstacles of poor education, military inexperience, and lack of social standing, as he did, to climb the long way from Private to Lieutenant General.....One reason for his greatness was his individuality and color. He made his own rules."

And, "His tactics were in large measure instinctive. His basic formula, as expressed by a not too erudite soldier in his army was "Git thar fustest with the mostest."

Having seen Hartley's dart board in his office, I know that he possesses other of Forrest's traits.

When the President of the United States quoted Hartley, "Fat cats don't hunt" and came to Meridian, Mississippi to do it, you know that another son of Mississippi has brought honor to his state.

Peavey's "People" are treated as one large family. And President Bush responded to that feeling by saying, "quality people do mean quality products." He went on to say to the cheering Peavey workers, "With a level playing field, I am absolutely convinced that American workers can outinnovate, out-perform, and outproduce any competition on earth." We agree.

Peavey sells 40% of his products overseas in 103 different countries. Peavey wrote recently in a letter to us, "I'm sure you are aware that products destined for export usually require special handling, special transformers, special wiring, color codes, etc., and sometimes this is a large pain in the butt for all concerned. Nevertheless *it is necessary*.. If we are going to sell in foreign countries we must comply with their standards....The President's visit and personal congratulations to them (the Peavey workers) vindicated a lot of policies and procedures we have mandated over the years."

We wish Hartley Peavey ran General Motors, Ford and Chrysler. We'd hear a lot less whining and witness a Congress besieged by other nations seeking protection from the U.S. And, I would like to see the U.A.W. addressed as "People".

Kudos for the Audio System Designer Technical Reference

DEC 14 RECD

Cox & Associates
Acoustical Analysis

Suite 365, 54 Danbury Road
Ridgefield, CT 06877
Phone: (203) 438-1398

December 9, 1991

Mrs. Carolyn Davis
Synergetic Audio Concepts
RR 1, Box 267
Norman, IN 47264

Dear Carolyn:

The Audio System Designer is the most useful and comprehensive compact package of audio data that I have seen. Would you please send another copy of the Klark Teknik Audio System Designer Technical Reference to the above address. Enclosed is a check for $27.50 to cover the cost of the manual and handling.

Thanks for your help.

Best regards,

T. E. Cox, P.E.
Principal

Accurately Controlled Equalization, ACE, & Source Dependent Measurement, SDM

The first commercial application of ACE-SDM technology is the Altec Acousta-EQ proprietary system comprised of software and their precision equalizer products

Accurately Controlled Equalization, ACE, and Source Dependent Measurement, SDM, are the basis for an advanced method of adjusting signal processing equalizers and precision signal delays plus monitoring their adjustment from program sources.

The ACE technique is predicated on careful equalization of a sound system prior to its use by the performer.

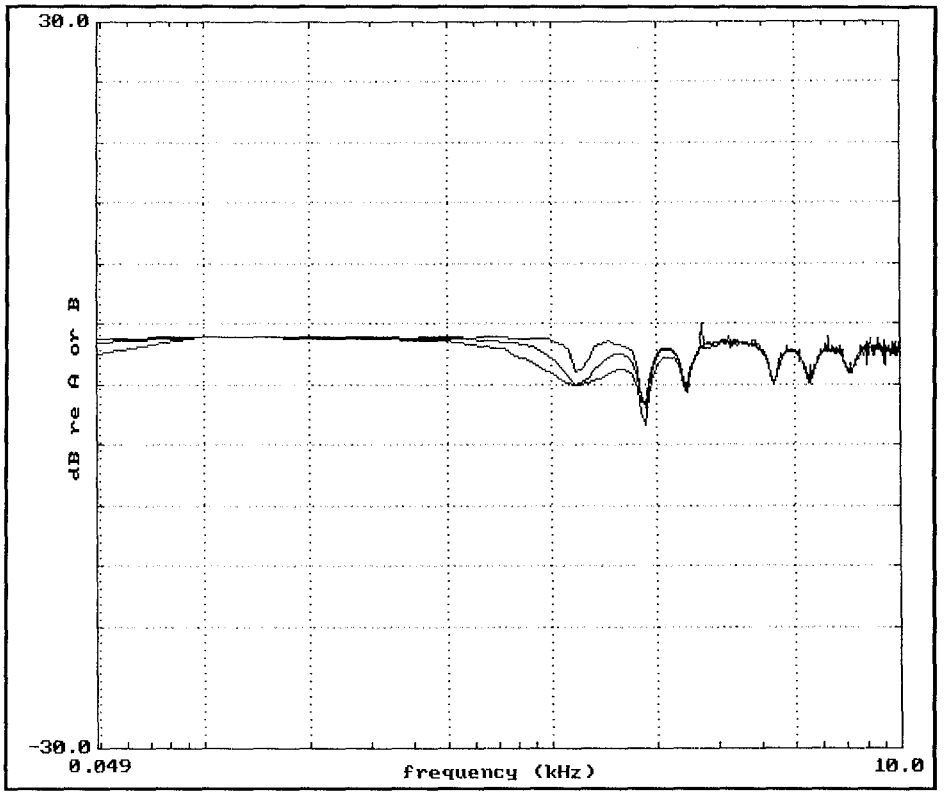
The SDM technique is based on the use of the performance as the source for a measurement of the transfer function of a sound system. That is, the measurement depends upon the chosen source in terms of its ability to supply the necessary energy at all frequencies of interest to the measurer whether it be speech, noise or music - and they are taken as a difference measurement. While obvious, it should be again pointed out that you can't make measurements without a source - either a test signal source or a performance source.

The ACE measurements are normally made using a known test signal tailored to the situation at hand. ACE measurements can be accurately made in the SDM mode when careful selection of program material is possible. In the example shown here we have measured the difference between the input and the output of the electronic equalizer. Such measurements are often called transfer functions, but are perhaps more properly referred to as the positive frequencies of the $j\,\omega$ axis of the transfer function. See Figure 1.

What is of interest to us is that a reasonable idea of the frequency response can be gained by such means by depending on the program source for the test excitation rather than on a calibrated test source such as an oscillator, noise generator or other restrictive test source. Note that we are able to easily look at details of amplitude, resonant Q and frequency using music as the source.

Why?

The question should naturally arise in the reader's mind as to why would you want to do this. Claims have been made that you might want to readjust a sound system's equalizer after the audience is present. That has been proven to be nonsense because the only thing an equalizer can equalize is the direct sound level generated by the loudspeaker. An audience has no effect on that.



Electrical response of an equalizer with one filter measured at 3 different amplitude settings. The test source is music.

If you have done proper precision equalization of the system prior to the arrival of the audience you might decide, for artistic reasons, to vary in slight detail the depth or bandwidth of one or two of your filters. The actual variation would be done by ear, since a live performance is under way, and SDM would allow you to see what you actually did to the electrical response of the system.

Artistie

Hang around entertainment sound systems and you quickly find out that those who are carrying the bags of money to the bank have learned to creatively distort any original sounds presented by the artist. If reinforcement were the only goal, life would be dramatically simplier. The artist wants to be made to "sound better", or different, or "not amplified, just transported to the listener's ears."

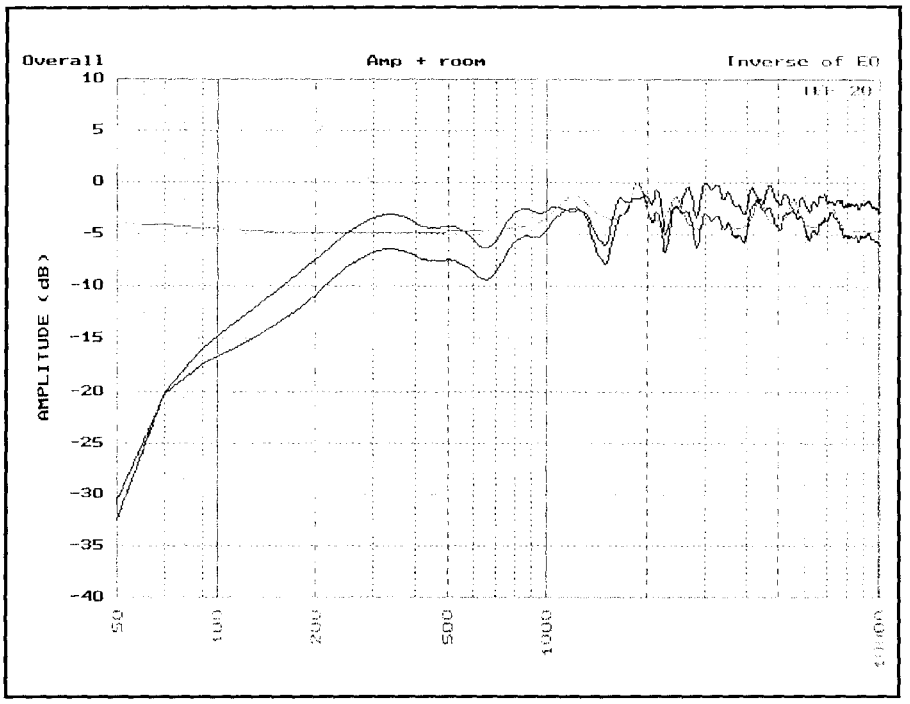
It is in this realm of program equalization that cause and effect take a back seat to artist preference.

Instrumentation

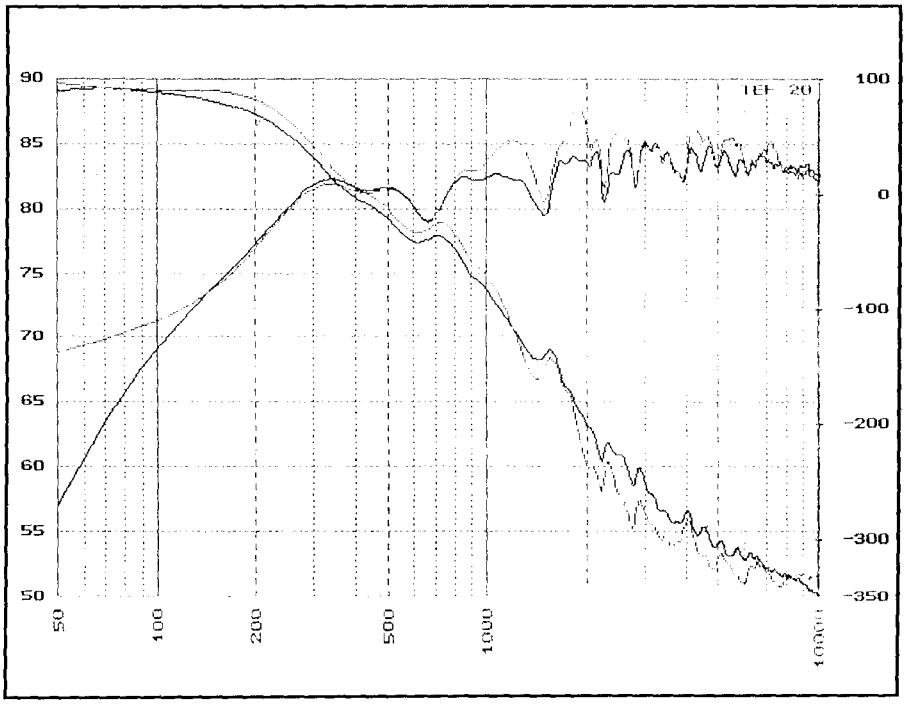
The analytic tools are the Techron TEF 20HI and the Ariel SYSid computer-based systems. These, in conjunction with special software, allows a hitherto unprecedented ease and accuracy of system adjustment.

The basic ACE program provides a display of:

1. The original raw house curve
2. The inverse response of the equalizers overlaying the raw house curve
3. The resultant house curve



ACE measurement, three curves:
(1) inverse equalizer curve, (2) equalized system response, and
(3) the system response minus equalizer response.



The corrections made in the magnitude response also show up in the phase response when both the system and the equalizer are minimum phase response

Each time a measurement is made, three sweeps occur generating the transfer function of the total system curve, the inverse curve of the equalizers, and the response of the total system minus the response of the equalizers. See Figure 2.

The SDM technique utilizes the SYSid dual channel FFT to take 200 averages of the energy generated by the source the system is dependent upon for excitation. The transfer function of the desired system, or part of the system, is obtained.

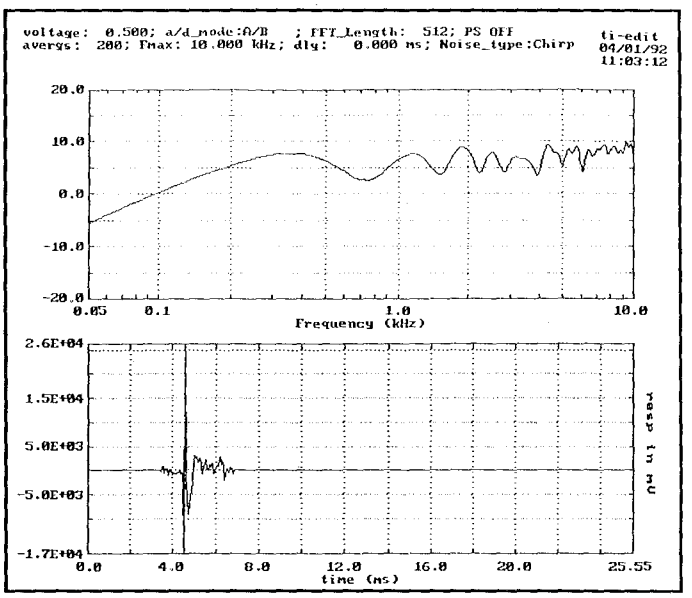
After completing the equalization process the before and after results for both amplitude and phase can be made using normal TDS. Both amplitude and phase are smoothed (darker curves) as a result of both the system and the equalization being minimum phase response. See Figure 3.

SDM Source Dependent Acoustic Measurements

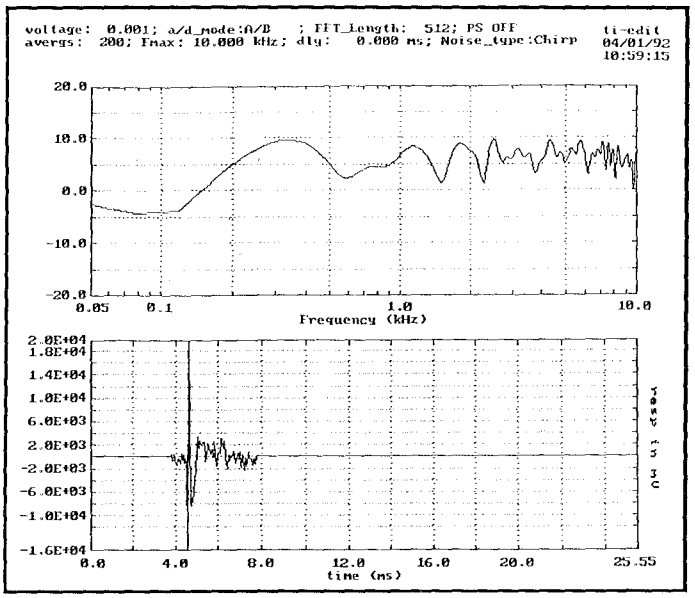
To investigate the accuracy of SDM (Source Dependent Measurements) with a loudspeaker in a room using a CD player as a music *source* (i.e., the measurement is now *dependent* upon the source as the test signal) we used our Ariel SYSid in our new 486-33 "lunchbox" computer.

One feature of SYSid that we really like in a dual channel FFT is its *edit* ability. The line spacing of an FFT is determined by the useful frequency range divided by the number of display lines. (In this case, the line spacing was about 20 Hz (10,000 Hz/512 lines.) What we would have liked to have was a frequency resolution of about 200 Hz.

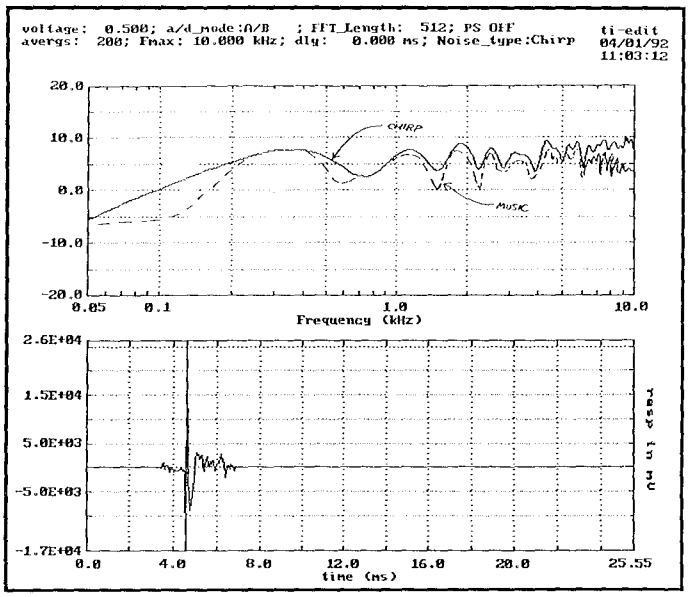
Enter Editing. What SYSid offers with editing is a cursor selected choice of time interval (T), therefore, frequency resolution (F_R) because $f_r = 1/T$. In the case shown here, 1/0.005 sec equals a F_r = 200 Hz. This very practical method of "smoothing" data to a more useable resolution allows rapid viewing of a loudspeaker's performance when driven by a music test signal.



*Measurements made using 200 swept chirps. The detailed frequency response is then edited by choosing the time interval shown (bottom curve) by means of two cursors which results in the upper curve (frequency domain) having a freqeuncy resolu*tion of 1/T



The same measurement as first shown with the exception that it is 200 samples of music. Note the additional high frequency noise in the impulse response (lower curve) and its manifestation as noise in the frequency response curve (upper curve.)



Same two curves overlaid. Where the music level is high and the spectral content is wide it is possible to obtain a reasonably accurate view of the important 500 to 5,000 Hz region.

Major Armstrong

Few American tragedies have exceeded the destruction of Edwin Howard Armstrong by RCA and AT&T.

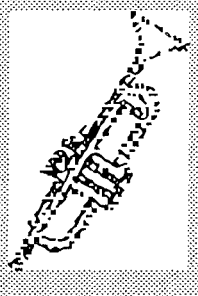
The man, Edwin Howard Armstrong, invented the regenerative, super-regenerative, and Super-hetrodyne radio circuits and received a fortune for doing so. He then invented FM radio and had to spend his personal fortune and watch his reputation be destroyed by ignorant and corrupt courts and powerful corporate propaganda machines. Armstrong died of suicide defeated by one of the most vicious men ever to head a large corporation using a clown as a foil.

Now over fifty years too late comes a book and a documentary video revealing the devastating truth including the moronic decision by Justice Cardoza of the Supreme court who decided he was capable of understanding radio circuits and got it all backwards but refused to correct the error when the entire world of competent engineers pointed it out.

The book "Empire of the Air" by Tom Lewis and the PBS video by Ken Burns (same man who did "The Civil War") documents thoroughly the genius of Armstrong, the idiocy of DeForest, and the venality of Sarnoff and it does it out of their own mouths. A VHS Video of this remarkable program can be obtained for $19.95 plus shipping by calling 1-800-282-8765.

You can miss this story if you want but you'll be poorer for it.

Those of us who knew this story well over the intervening years heard it from men like Paul Klipsch who supplied Armstrong Klipschorns for his post war FM demonstrations and from the equally excellent but less well known book, "A Man of High Fidelity" by Lawrence Lessing back in 1956.



"In Tune With Power Harmonics"

Ed Lethert writes that he has received a Fluke 97 ScopeMeter with interface cable and have same communicating with his computer. "What a remarkable instrument! Fluke indicates that there are more than 9000 on back-order and an 8 month wait is in store for those ordering them."

As you know, Ed strongly urges people involved with electronic equipment, especially that powered from three phase feeders and that connect to voltage regulators pay serious heed to the harmonic issue.

For further education on the subject, call Fluke for their literature on the subject: U.S. 800-443-5853, Canada 416-890-7600. And Ed Lethert is holding seminars on the subject. Write Ed Lethert Associates, Inc 3656 Ensign Ave, N., Minneapolis, MN 55427, or call 612-545-0030.

The "Polish Dimple" Award

Tom Danley of Intersonics has had patent #4,757,547 issued to him for an air cooled loudspeaker .

Quoting from George Augspurger's review in the ASA Journal,

"Cone loudspeakers with large diameter voice coils often have a vent in the center pole piece. The advantages cited by loudspeaker designers include relieving back pressure behind the relatively large center dome and cooling the magnetic assembly as air passes through the vent in response to motion of the cone. It follows that additional cooling can be accomplished by adding a forced air blower. The novelty lies in the fact that the blower motor is connected in parallel with the loudspeaker voice coil, thus providing greater cooling at higher drive levels."

The dent in the forehead after someone shows you something perfectly obvious that no one has ever awakened to previously is called a Polish Dimple.

Frequency Response and Transfer Function

One effort to employ dual channel FFT analyzers in the adjustment of parametric equalizers has led to some writers becoming confused over what is and what is not possible via electronic adjustment of a sound system.

It is legitimate to use a dual channel FFT analyzer in the acquisition of the "transfer function" of a device or a system using a program source rather than a test source. We call this a source dependent measurement, SDM. (We have never encountered a measurement independent of any source. There has to be a cause to have an effect.)

The accuracy of the measured "transfer function" when program material is the source depends upon

1. The frequency dependent nature of the energy generated by the program material
2. The number of averages taken
3. The ability of the observer to detect legitimate displays from spurious displays

Frequency Response and Transfer Function

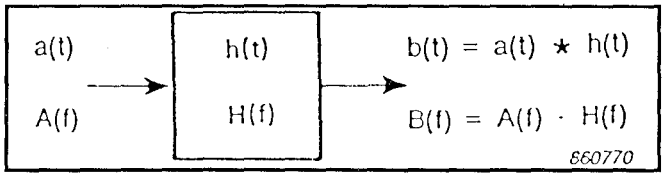


Fig. 1a—Input-Output relations for a linear system

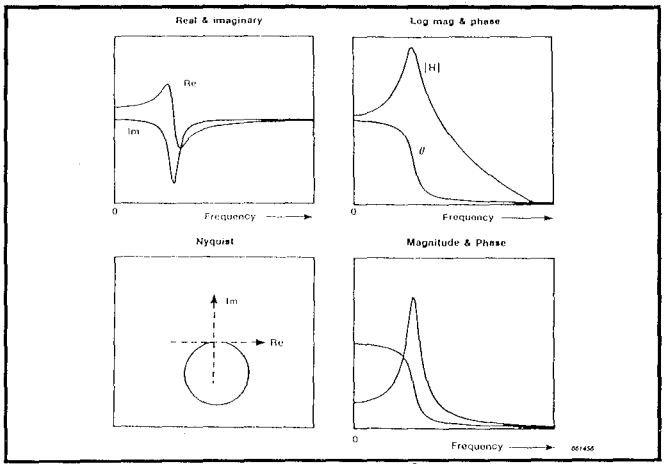


Fig. 1b—Various representations of the frequency response function of a single degree-of-freedom system.

The transfer function, strictly speaking, applies to the complete description in the Laplace domain of a stable, linear, time invariant physical system.

The frequency response functions represent a special case (the values along the imaginary axis of the Laplace plane.)

Properly made frequency responses are characterized by Figures 1a and 1b. They are the difference between the input to a device and its output. The advantage of the "difference" measurement is that the input signal can vary and not affect

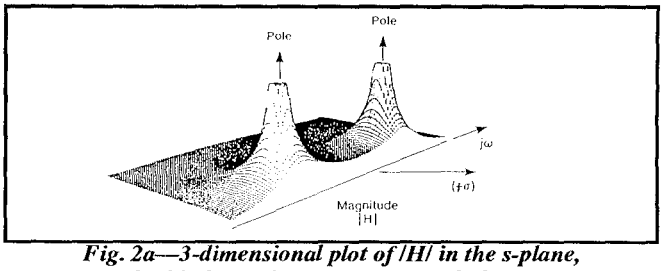


Fig. 2a—3-dimensional plot of /H/ in the s-plane, highlighting the intersection with the jω

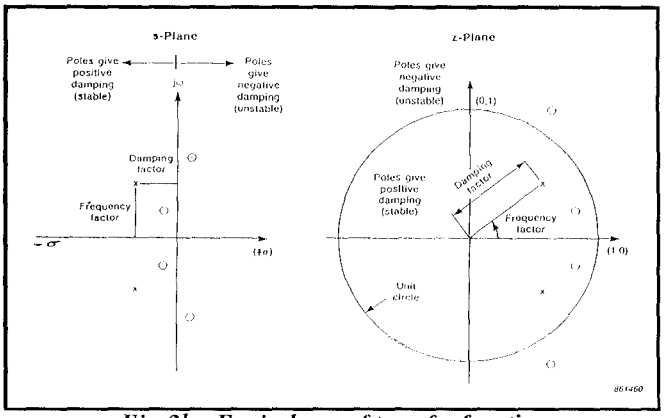


Fig. 2b—Equivalence of transfer function characteristics in the s-plane and z-plane.

the result. For example, if using pink noise and a conventional analog real time analyzer, the accuracy of your measurement depends upon the accuracy of your input signal. With a dual channel system the measurement is of the difference caused by the system. (Note: A TEF analyzer is a dual channel system inasmuch as it compares the input to the output of a system and measures the difference.)

The Laplace plane, called the complex S plane, com-

pletely describes the transfer function of a system as above defined. (See Figure 2.)

The use of the LaPlace transform in the solution of network problems may be compared with the use of logarithms to simplify the solution of mathematical computations.

Laplace transforms are used to reduce solving integro-differential equations to a purely algebraic process, and in addition, allows complex excitations such as square waves, etc., to be analyzed by the same algebraic procedures.

Very useful tables of Laplace transform pairs exist for taking the Real function (f(t)) and finding the complex function (F(s)). For example:

$$e^{-xt} \text{ becomes } \frac{1}{s + \alpha}$$

Translated from a formula into words, one over S + Sigma.

ABC's of the S-plane

Those using equalizers are interested in a system's "minimum phase" response because an amplitude equalizer that is minimum phase needs a system transfer function that is minimum phase if they are to be the conjugate of one another (i.e., correct both the amplitude and the phase of the system with the equalizer.)

I. An 'S' plane with all the poles and zeros in the left half plane is the transfer function of a minimum phase system. In real life most practical cases include non-minimum phase areas in their transfer functions; therefore, we need to be able to identify them as well. (See Figures 3a and 4a.)

II. An S-plane with poles in the left half plane and the zeroes all in the right half plane is the transfer function of an "all pass" system.

Precision signal delay used to synchronize loudspeaker systems have, in recent years, been increasingly recognized as essential prior to attempting equalization. (See Figure 3B)

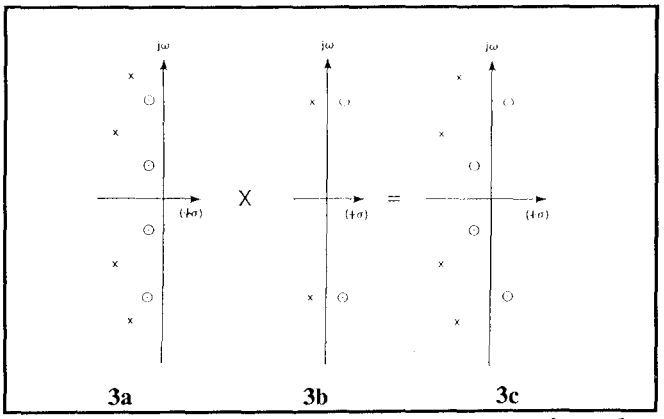


Fig. 3—Representation of a mixed phase function as the product of a minimum phase and an allpass function.

III. An S plane with all poles in the left half plane and some zeroes in the left half plane and some zeroes in the right half plane is the transfer function of a mixed phase system, i.e., synchronization is required prior to equalization. (See Figure 3c.)

IV. Poles on the imaginary axis are oscillators. (See Figure 4b).

V. Poles in the right half plane are unstable systems. (See Figure 4c.)

VI. Placing a pole on a zero and re-locating a new zero in the left half plane is an equalizer.

VII. Placing a pole on a zero in the right half plane is an non-causal event which is not physically possible.

Physics Tells Us What's Impossible

Physics does not tell us what's possible but what's impossible.

The physics of the true transfer function, thanks to Laplace, tells us that it is impossible to place a pole on a zero in the right half plane. Translated, that means that **an electronic equalizer cannot adjust a reflection, echo, or reverberation.**

The subject, is of course, much more complex than depicted here, but ascertaining what the complex S-plane plot is for a given system allows you to understand a great deal about how it is likely to operate, certainly more so than just that of the frequency response.

We will be writing more on this subject as time goes on because more and more people are using the words "transfer function" when they mean "frequency response."

The illustrations used here are from Frequency Analysis by R. B. Randall and published by Bruel and Kjaer.

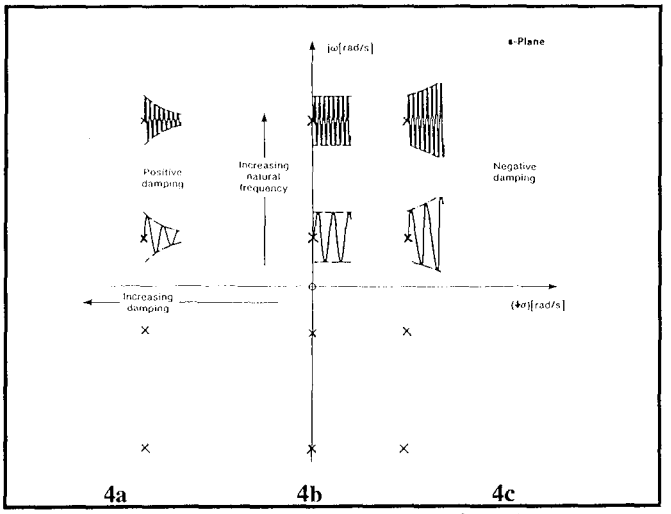


Fig. 4—How the position of a pole (pair) affects the impulse response.

"I Have Reached the Age of 16 dB. How Old Am I?"

Letters from Peter Mapp, consultant in Great Britain, can be compared to Ted Uzzle (circa pre Altec) - erudite, to the point, and devastating to the pompous and partially informed.

Peter Mapp at a recent symposium in Great Britain entertained his listeners with a real life story of a universally condemned sound system that the public considered just plain bad. It was replaced by a new sound system judged by the public as "very good". As Peter puts it, there was just one minor problem: both systems measured had virtually identical STI scores.

Peter also gave what was described in the press as a tongue-in-check talk entitled, "Chaos, or how to train your computer to give the right answers."

Peter announced he had reached the age of 32dB which he said put him 4.2 dB behind me.

I wrote,

"How like a European (and here I thought you were a Briton) - using voltage ratios with dBs. You are 16 dB and I am 18 dB for a 2 dB difference. Life is a powerful experience, not a pressure one."

Peter faxed back,

"Life may well be a 'powerful' experience but I am definitely feeling the pressure, or am I just feeling my dBs?"

How old are Don and Peter?

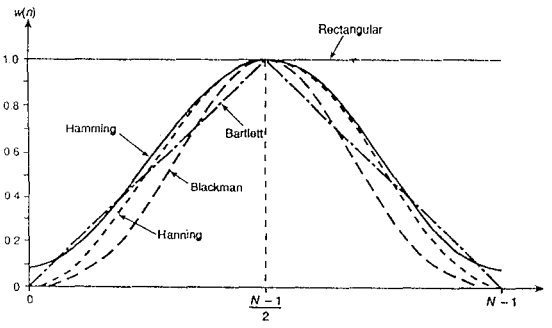
Why Equalizers Sound Different

From Studio Sound, December 1991, *EQ Empirically* - "Keith Andrews of Amazon Studios talks to Tim Smith about experiments to find an equalizer design that appeals.

"An article by Michael Gerzon on why equalizers sound different (Studio Sound July 1990) raised several points, including the idea some people have put forward that most of the subjective effect of equalizers is due to their phase response. Gerzon relates this to Phil Newell's observation in an article on monitors (Studio Sound August 1989) that a loudspeaker system with a very flat frequency response achieved at the cost of its phase response will not sound as clean as a system with good transient and phase response, even if this results in an audible dip at the crossover frequency."

Dr. Patronis agrees. Quoting from Newsletter Vol 15 N 2, P29, *"It is true that this technique produces an improvement in the combined amplitude response but it does so by changing the phase response."*

Windows



The responses of some commonly used windows

Using TEF, FFT and various simulation software leads to the user having to consider "Windows" and their use. (Hanning, Hamming, Blackman, Bartlett or Rectangular.) In a very practical sense, use of a Window can enhance the dynamic range view while smearing the frequency detail in an audio or acoustic measurement. While all of these Windows appear in every worthwhile digital signal processing texts such as the one by Oppenheim and Schafer - Prentice Hall - this overlay is a useful overview of their responses.

Guilt by Association With a Great Man

These are extremely fortunate young men in this group picture and what's most interesting about them is that they know it and are making the most of it. (L to R Bruce Marlin, Roy Delago, Jim Hunter, Terry Geist, Tom Gallagher and Paul Klipsch)

Just meeting Paul W. Klipsch is a special occasion, but coming back to Hope, Arkansas after a third of a century to spend the day with him and his disciples (and I use the word disciple with respect and care for I am one) was very special. "My cup runneth over."

When I complimented Mr. Klipsch on his excellent health and alertness and told him those were qualities I had hoped to see in one of my favorite father-images, he quickly responded with one of his famous yellow buttons.

Fame, fortune, and the good life are worn by Mr. Klipsch as if total success in life is compulsory.

In my sixties, I am better equipped to recognize the immense gulf between talent like that of Mr. Klipsch and merely competence gained through years of experience. Mr. Klipsch's gift is a form of "mind set" that causes the recipient to view every thing in the world from a different vantage point than other mortals.

In each of the pictures where Mr. Klipsch is present note the intensity and attention to whatever is at hand. His responses continue to remind us that he's one of the "great ones" at lateralizing from a non-productive hole over to a variation that is productive.

We also visited their excellent museum across the street from the plant and once again saw the EV Ionic tweeter we had worked with back in the 1950s.

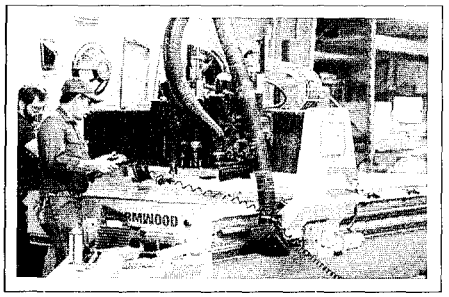
Mr. Klipsch has transferred his aircraft piloting expertise and his aircraft manifold gauge to his Mercedes Benz motor car.

Back when I worked at Klipsch & Associates, I drove a Porsche Speedster and Mr. Klipsch drove a Ford. Now, I drive a Ford-powered motorhome and he drives the German car - changes neither of us dreamed would occur. We shared the most recent story about the East German Trabant (Trabi), "How do you double the value of a Trabi? You fill it with gas!"

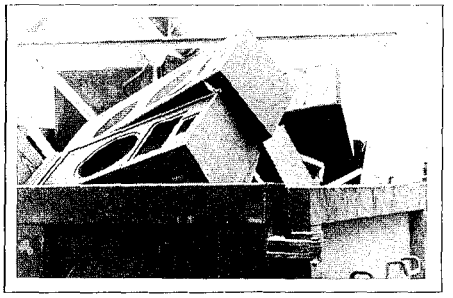
The High Futility market still accounts for a sizable portion of their $22,000,000 business (now owned by Mr. Klipsch's cousin, Fred Klipsch, and they continue to produce Fidelity music reproducers. It was, after all, Paul Klipsch who first pointed out to me that one wouldn't refer to his spouse as "highly faithful", they either are or they aren't.

The Klipsch plant, products and personnel represent the best of the American dream - superlative craftsmanship, design and engineering.

The famous King Klipschorn is still handbuilt.



The quality of wood working automation is impressive in this large plant.



Equally impressive is how they handle enclosures that aren't up to their standards.

Accounting for Intelligibility

Sound System Engineering (2nd edition) has a chart for the effect of S/N on %ALcons (Figure 10-4, Page 240). The question can also arise as to what effect on loudspeaker-to-listener distance, D_2, it has.

The formula in the book for the maximum D_2 is:

$$\text{MAX } D_2 \text{ for } x\%\,AL_{cons} \sqrt{\frac{x\%VQMa}{656\,RT_{60}^{\,2}N}}$$

which does not account for the effect of S/N on the calculated distance. It turns out that for most situations we can re-write the equation in this form:

$$\text{MAX } D_2 \text{ for } 15\%\,AL_{cons} = \sqrt{\frac{x\%(VQMa)}{656(RT_{60})^2 N}}\left(\frac{1}{10^{\left(\frac{25-15}{20}\right)}}\right)$$

The reasoning behind this equation is as follows: If the older version computed the maximum D2 for a 25 dB or greater S/N (this is the assumption behind the equation) and we found ourselves in a situation where we couldn't meet that demand, what we could do would be to move closer to the source until we once again achieved 25 dB S/N. Inverse square law allows us to compute the change in distance necessary to overcome the difference between 25 dB of S/N and the S/N we actually have. The new extension of the formula does just that.

Our sincere thanks to Herb Chaudiere of Towne, Richards and Chaudiere Inc, consultants in sound and vibation located in Seattle, for bringing this need to our attention with a real life example. He had found a solution using overlaid charts 10-4 and 10-5 from **Sound System Engineering.** Herb reports a real life situation where this concept worked remarkably well.

Herb states, "Intelligibility was deemed very marginal at 30' and acceptable around 25'."

$$\text{MAX } D_2 \text{ for } 15\%\,AL_{cons} = \sqrt{\frac{15\%(35{,}834{,}784)31}{656(5)^2\,193}}\left(\frac{1}{10^{\left(\frac{25-15}{20}\right)}}\right) = 22.9 \text{ ft}$$

"Sound Exposures and Hearing Thresholds of Symphony Orchestra Musicians"

Julie D Royster, Larry H. Royster and Mead Killion published an article in the June 1991 Journal of the Acoustical Society, entitled *"Sound Exposures and Hearing Thresholds of Symphony Orchestra Musicians."*

Quoting from their abstract:

"Dosimeters were put on 68 musicians of the Chicago Symphony Orchestra during rehearsals and concerts. The musician's Leq ranged from 75-95 dB(A) with a mean of 85.5 dB(A).

The mean hearing threshold levels (HTLs) for 59 musicians were better than those for an unscreened nonindustrial noise-exposed population. However, 52.5 % of individual musicians showed notched audiograms consistent with noise-induced hearing damage. Violinists and violists showed significantly poorer thresholds at 3-6 kHz in the left ear than in the right ear, consistent with the left ear's greater exposure from their instruments.

After HTLs were corrected for age and sex,, HTLs were found to be significantly better for both ears of musicians playing bass, cello, harp, or piano and for the right ears of violinist and violists than for their left ears or for both ears of other musicians."

The average Leq ranged from a low of 82.4 for bass players to 96.0 dB(A) for horn players.

The 10-page paper is packed with valuable information. If you have an interest in the study of hearing loss by musicians, you should obtain a copy.

The next time I see Mead Killion, he is now a Fellow of the ASA, I would like to ask a few questions about the study. For instance, there are approximately 100 members of the Chicago Symphony. Only 59 participated in the study. Who were the other 61? Were they percussionists, horn players, etc., which we think may suffer more damage from the higher levels they produce, especially during practice which is often more intense exposure than in an orchestra and often longer duration.

The study seemed to bear out what I have observed with the limited audiograms I have conducted on members of Syn-Aud-Con seminars: when I see an exceptional threshold curve, I ask, "Are you a musician?" I observed that musicians usually have better hearing than the average population. I have my doubts about a drummer that works in front of a super-loud monitor, and if he is on drugs while performing, it's all over for his hearing.

The PA-70 Pataxial Loudspeaker

Last week I talked to Tim Trott in Florida who was enthusing about his use of the J.W. Davis PA-70 - a loudspeaker system designed by Dr. Patronis in 1985. (The PA-150 was designed in 1982 and is the inspiration for the many new coaxial loudspeaker systems.)

The coaxial idea is not new, but the use of the microsecond signal delay in the design of the coaxial was new when Dr. Patronis used it. Of course, Dr. Patronis has also worked his magic on the crossover network.

As I thought about Tim's call, I thought what a pity it is that more people don't know about the Pataxial and I called J. W. Davis to see if they had a piece of literature that we could include in our Newsletter mailing. They said they had a Lab Test from Sound & Communications by Farrel Becker that they would like to share

Research on Listening to Sounds Emitted by the Body

John Head attended a class last summer at the farm. He is part of a group involved in special acoustic research. He has written the letter, reproduced here, seeking to find others interested in helping such a project.

Dear Don and Carolyn,

I mentioned at the last seminar I attended that I was very interested in discovering what type of work is being done similar to ours.

We are interested in fully understanding the nature of the voice, the significance of its harmonics, and its indicators of stress. We in this project are using the voice as an indicator of stress and also as a comparison of the "state" of the individual. This will be used by a doctor prior to treatment and also after treatment to show a cause and effect relationship. We feel the voice holds other key information about the "state" of the individual. We are interested in any research or papers that anyone can refer us to for further information on these subjects.

There is another group that is interested in listening to the various sounds emitted from the body. We are new to understanding what is possible so all information and research papers that are on this subject are important to the researchers. We have heard that one can even hear the plaque on the veins with the proper equipment and filters. We want to know more.

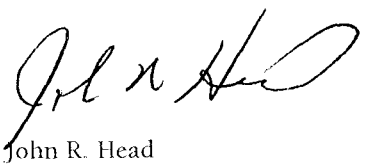
We are interested in a sound system that has computer controlled crossovers. We intend to have a table or chamber where one receives a sound bath. But we are interested in controlling what frequencies are sent to each area of the body.

We as a group feel that the voice and the sounds emitted by the body are some of the key elements to understanding the condition. The transformation of that condition will be a intricate relationship of particular sounds relating specifically to the individuals body and its sounds transmitted into the body in specific ways.

To observe these changes we need a monitoring system that includes the voice, brain wave scans, other physiological conditions and elements we have yet to uncover. We are very interested in hearing your comments, suggestions and criticisms of these theories. Please forward your comments to:

John R. Head
907 Coolidge
Wichita, KS 67203
316-263-9540

I thank you for your assistance in advance and look forward to hearing from everyone.



John R. Head

1992 Concert Sound

Workshop Staff

Workshop Chairman, Will Parry, and Workshop Co-ordinator, David Scheirman, after long hours of planning every detail of the January 15-17 CSR Workshop reported that they had a feeling that this Workshop, their third, would be a *good* workshop and *it was*.

It is truly a remarkable staff. It is our 3rd time to work with the CSR staff and each time we finish the Workshop with the same sense of awe - and, yes, love for these men because of their obvious integrity and love for their work: Will Parry (now with SPL, his own company), Ron Borthwick of Clair Brothers, Albert Leccese of Audio Analysts, M L Procise of Showco, Whelan of Electrotec with superb assistance from David Scheirman.

The Manual

The manual is tangible evidence to everyone attending the Workshop that each member of the staff realized that his part and his contribution to the success of the Workshop was unique and vital. The Manual is a treasure. One person wrote in his Suggestions at the end of the Workshop that the manual was worth the price of the Workshop - well over 200 pages of original material generated just for this Workshop.

Ron Borthwick (top right) and Mick Whelan (bottom right) talking with members of the Workshop during a break

Co-Sponsor - ProSound News

We at Syn-Aud-Con felt that the CSR workshop was "too big" for us to handle by ourselves. We discussed it with Will Parry and he suggested that we invite the Press to participate with one member of the press carrying the major support this year and alternating it in future years. Paul Gallo of ProSound News was an invaluable support for the 1992 Workshop with Mix Magazine and RE/P making major contribution to the promotion of the Workshop. In addition, the press provided a marvelous reception the lst night of the Workshop and they sponsored the breakfasts and dinners. At every break the staff used the opportunity to interact one-on-one with the members of the class.

A Mature Industry

Both Will Parry and ML Procise started their

Syn-Aud Con - Concert Sound Reinforcement Workshop 1992

Employment Requirements and Opportunities

1 - Sound Reinforcement As A Career

A) Love of Music and Technology
- Blend of Art and Science
- Technology and Performers
- The song is the reason, not the sound system

B) Patience
- Have realistic goals and expectations
- Start at the bottom and work your way up
- Shop work
- Initial roadwork - 4th man on crew

C) Perseverance
- Make mistakes but learn the lessons well
- Keep trying to learn
- Watch and listen

D) Willingness to experiment and learn new methods
- Try new techniques and new equipment
- Open mind towards new technology
- Carefully researched opinions

E) Team player
- Work with other sound crew members
- Work with other crews - All work the same Show
- Work with Stagehands
- Responsibility for your part of the job
- The big picture and your place in it
- Priorities and how to set them

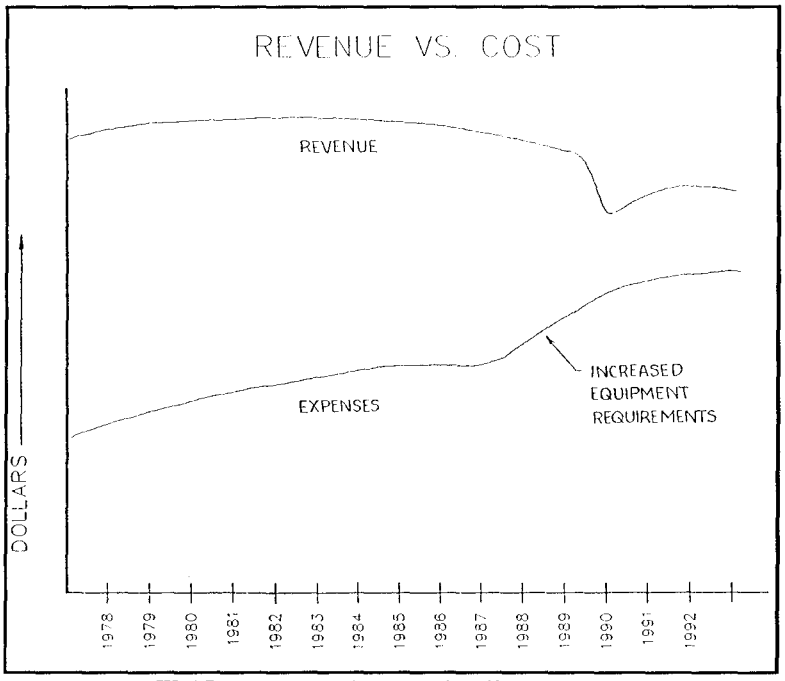
F) Grace under pressure
- Long hours, little sleep
- Trains, Planes, and Automobiles
- Difficult load-ins and Load-outs
- Bad sounding Venue
- Demanding Artist
- Bad Weather
- Questionable power service
- Equipment problems
- The real world

G) Fundamental Skills and knowledge
- Audio Basics - from microphone to loudspeaker, a chain
- Microphones and mic technique
- Wiring and cabling
- Consoles - Block diagram , Signal Flow, and Gain structure
- Signal Processing
  - Effects - DDL and Reverb
  - Dynamics Processing - Limiters and Noise gates
  - Crossovers and Equalisers
- Amplifiers
- Loudspeakers
- Rigging Basics
- A.C. Power and Grounding

H) A Job and a Career as well as a Hobby
- Sense of Humour - Don't take yourself too seriously
- Have fun and enjoy the magic moments
- Good Shows make up for a lot of bad times
- Reputation is only as good as your previous show

Albert Lecesse's eight rules for being successful in your career in the sound reinforcement touring industry

Reinforcement Workshop



Will Parry prepared the graph to illustrate an industry that is being squeezed for profits.

participation in the Workshop with a discussion of the maturity of the industry, the recession and price wars. Both were supported with totally fascinating manual material.

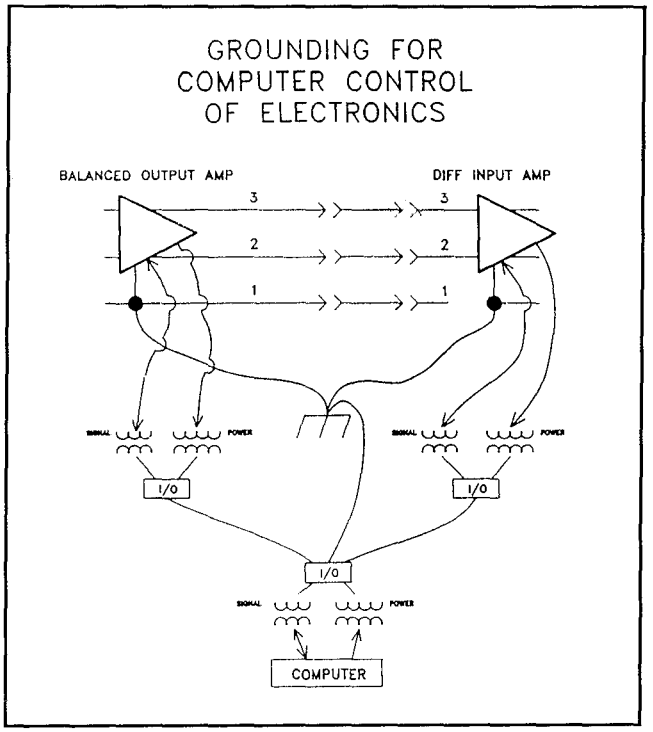
Will asked the members of the Workshop, "How many of you here are under 30? How many of you were in this business before you were 30? How many of you are over 40? You are a microcosm of our industry. The last time I surveyed the age for the top 50 performers able to consistently command the larger budget tours, 47 of the 50 were over 40 years of age. The number of people attending concerts over 40 is significant and growing. We were the revolution in music (and politics). Since our revolution, there has been no new revolution. If you do not think we are in a mature business, look around you. I would venture a guess that 15 to 20 years ago the same core group of people would be here.

"What we need is a new product; a new revolution that will stir things up and generates interest in going out to see the newest artist."

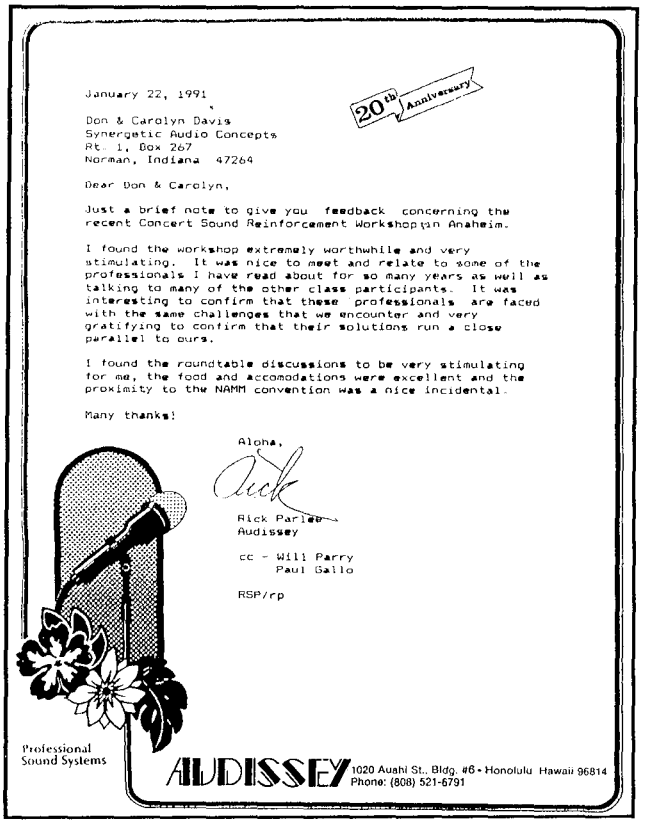
Industry Support

This Workshop would not have been possible without the generous loan of equipment and support and participation from:

Aphex Systems, Crest Audio, Crown International, JBL Professional, Meyer Sound Labs, Midas USA, Motion Laboratories, Shure Bros, Soundcraft USA, T.C. Electronic of Denmark and Yamaha Professional.



One of 50 pages that Ron Borthwick of Clair Brothers generated for the Workshop



January 22, 1991

20th Anniversary

Don & Carolyn Davis
Synergetic Audio Concepts
Rt. 1, Box 267
Norman, Indiana 47264

Dear Don & Carolyn,

Just a brief note to give you feedback concerning the recent Concert Sound Reinforcement Workshop in Anaheim.

I found the workshop extremely worthwhile and very stimulating. It was nice to meet and relate to some of the professionals I have read about for so many years as well as talking to many of the other class participants. It was interesting to confirm that these professionals are faced with the same challenges that we encounter and very gratifying to confirm that their solutions run a close parallel to ours.

I found the roundtable discussions to be very stimulating for me, the food and accomodations were excellent and the proximity to the NAMM convention was a nice incidental.

Many thanks!

Aloha,

Rick Parlee
Audissey

cc - Will Parry
Paul Gallo

RSP/rp

Professional Sound Systems

AUDISSEY 1020 Auahi St., Bldg. #6 • Honolulu Hawaii 96814 Phone: (808) 521-6791

Syn-Aud-Con 1992

Seminar & Workshop Schedule

❖ 3—Day Seminars—$550

Farm—Norman, IN

Sound Engineering Seminars

May 21-23
June 18-20
July 16-18
August 20-22
September 17-19
October 15-7 (Assistant Instructor : Randy Vaughan of Ambassador Enterprises)

An Assistant Instructor will be present at each of the seminars at the farm. Our staff includes:

Farrel Becker, Rick Brehm, Fred Fredericks, Kurt Graffy, Mary Gruszka, Don Heavener, Dr. Patronis, John Prohs, Don Van Oort, and Randy Vaughan.

Microphone Line Tracer

The other day someone called to say that he remembered reading about a microphone line tester in an early Newsletter. Indeed it was early: Vol 2, #2 (Fall 1974). Dave Edwards of Sound & Communications in Jackson MS worked out the line tracer over lunch one day and shared it with us. We think it is still apropos and would like to share it again - 17 years later.

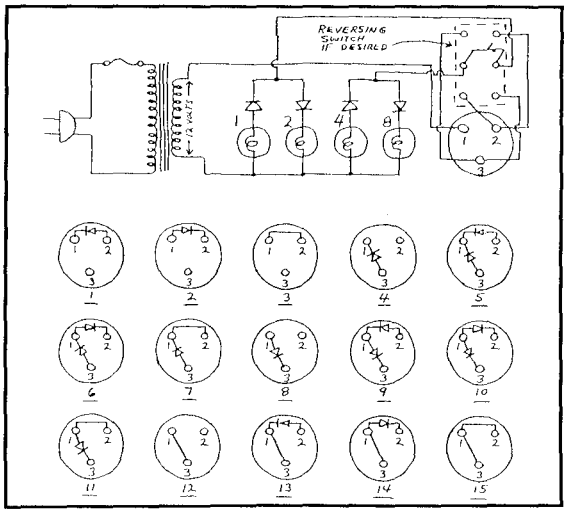
Microphone Line Tracer by Dave Edwards

When a contractor has a number of microphone lines feeding from various positions to a control console point, the lines must be "rung out" before connection to the console or patchbay. This "ringing out" can be accomplished by two men and a VOM in about 1/2 hour, or by one man and a VOM in 4 hours, or by using the device described here, by one man in about *3 minutes*.

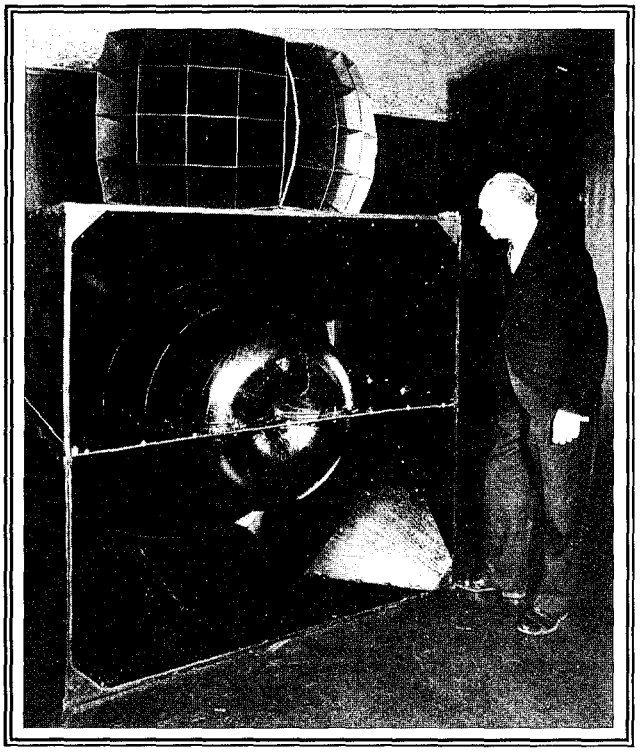
The tester unit is built in a multi-box or other type cabinet, and incorporates a separate pigtail with alligator clips, in case the console end of the mic lines doesn't have connectors.

The remote diode units are built into Switchcraft A3M or equal connectors, and should have the numbers etched on the connector shells. The reversing switch is incorporated in order to find backwards-wired connectors.

To use this device, the diode units are plugged into the microphone receptables, and their positions noted. Then, by using the tester at the console location, all lines can be "rung out" with little effort, in *very little time*. When a line is connected, one or more lamps will light. The sum of the numbers indicates the number of the diode unit at the other end of the line.



Wente & Thuras



Edward C. Wente and A. L. Thuras of Bell Telephone Laboratories circa 1933 have long been names I have revered as founders of the professional standards of our industry. The condenser microphones shown here in Wente's hands, the bass reflex enclosure first developed by Thuras, the compression driver, the multicell horn - the list goes on and on - were first brought to practical usage by these men. They were a team and like so many successful teams, different personalities.

When youngsters encounter their first compression driver, condenser microphones, and engineered enclosures, it's only proper to whisper once again, Wente - Thuras.

Our sincere gratitude to Jim Hunter at Klipsch & Associates for sharing these priceless photographs with us.

Acoustic Energy Definitions

The energy density at a point in a sound field is made up of both kinetic and potential energy, and in a field where standing waves are present, it may be entirely potential at certain points and at others entirely kinetic.

The potential energy near a point in a sound field is proportional to the square of the excess pressure.

The kinetic energy in the sound field is proportional to the square of the particle velocity at the point under consideration.

Massa & Olson (1934)

More on Critical Bandwidths

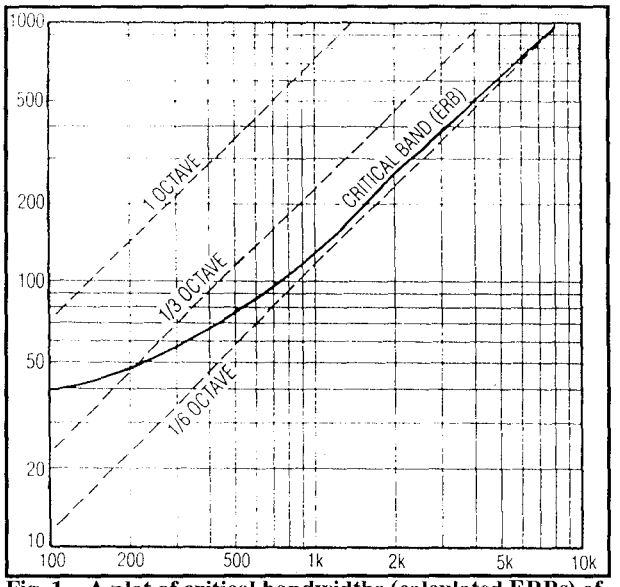


Fig. 1—A plot of critical bandwidths (calculated ERBs) of the human auditory system compared to constant percentage bandwidths of filter sets commonly used in acoustical measurements.

The "Quest", if such a thing exists in audio and acoustics, is to find the measurements that correlate to what the ear/brain system responds to. There are many clues but no positive systematic measurement technique. Those who study the human response of auditory stimuli have found that one of the clues to frequency resolution, so far as amplitude variations are concerned is the *critical bandwidths.*

We are reproducing here three different ways of looking at critical bandwidths. Figure 1 allows you to relate the bandwidths to available constant percentage bandwidth analyzers. Figure 2 shows critical bandwidths plotted vs rectangular bandwidths.

Figure 3 shows two plots attributable to two of the prominent investigators of this subject.

In the measurement of well behaved devices (i.e., no serious narrow band undamped resonances) critical bandwidth measurements should suffice for meaningful amplitude evaluation. What is the meaningful angular equivalent for polar responses? How is distortion heard vs music or speech? What are meaningful "time smear" increments? How many doctoral thesis are available within these simple basic questions?

Critical Band No.	Center Frequency	Classical Bandwidth (Hz)	Classical Bandwidth %	Equivalent Rectangular Band (ERB), Hz
1	50	100	200	33
2	150	100	67	43
3	250	100	40	52
4	350	100	29	62
5	450	110	24	72
6	570	120	21	84
7	700	140	20	97
8	840	150	18	111
9	1000	160	16	130
10	1170	190	16	150
11	1370	210	15	170
12	1600	240	15	200
13	1850	280	15	220
14	2150	320	15	260
15	2500	380	15	300
16	2900	450	16	350
17	3400	550	16	420
18	4000	700	18	500
19	4800	900	19	620
20	5800	1100	19	780
21	7000	1300	19	990
22	8500	1800	21	1300
23	10500	2500	24	1700
24	13500	3500	26	2400

Fig. 2—Critical Bandwidths of the Human Ear

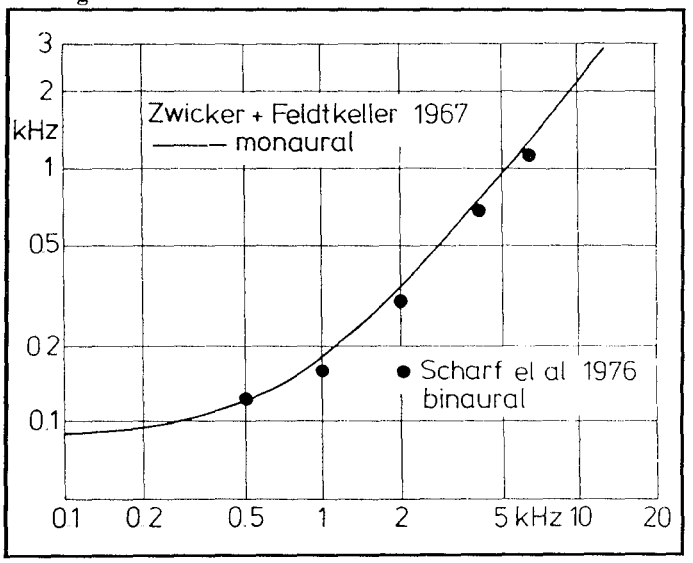


Fig. 3—Critical band center frequency.

The Lord of Uraniborg

There are books, and then there are books. This book took the author, an Indiana University professor, 25 years of remarkably detailed research and was not published prior to his premature death at age 55. The Lord of Uraniborg is a biography of Tycho Brahe who, as all the world should know, accumulated the data that enabled Johannes Kepler to arrive at the Laws of Planetary Motion, which in turn became essential grist for Isaac Newton's mill.. It is a book buyer's dream.

Without Tycho's passion for observational accuracy - unprecedented among astronomers from antiquity to his own day, Kepler, Newton and the quote, "and God said 'Let Newton be' would have been delayed for at least a century.

The author's painstaking construction of 16th century Denmark and Europe down to Basel transports the reader to a place as strange as any "Star Wars" locale.

Tycho wore a silver nose piece (sometimes copper) as a result of his nose being cut off in a duel. He built his island observatory and research center on the Island of Hven, naming it Uraniborg where he ruled as the maverick of his world.

That he was able to transcend his class (top of the heap) and do practical scientific work in the midst of an age that was still 90% based on myth and superstition bespeaks a truly remarkable man.

Victor E Thorens' book is proof of another remarkable man. (Cambridge UP $59.50 ISBN 0-521-35158-8)

The Lord of Acoustaborg Don Davis, That Is

I recently purchased, "The Lord of Uraniborg" by Victor E. Thoren on the life of Tycho Brahe, the Danish astronomer of the Sixteenth century.

As Tycho Brahe was completing his observatory on the Island of Hven, he wrote to a close friend saying,

"I have suitable instruments, partly now ready to be erected, partly under construction, which I believe to be inferior to none, either ancient or modern, in size, craftsmanship, accordance with their purpose, great cost and labor incurred in their construction, and in their extraordinary accuracy. I have planned a building that is to be as well suited as possible for the instruments and for the observation of the stars (substitute acoustic measurements) *in comfort. For this reason, I have withdrawn to this isle* (substitute farm) *in order to devote myself to philosophical and astronomical* (substitute acoustica)*studies without disturbance."*

Five hundred years ago, in order to write such a letter, Tycho Brahe had to be from a noble family background and favored of the King. Today ordinary citizens of a classless, free society can undertake scientific research unfettered by any restraint except the financial one.

So, as Lord of Acoustaborg, I hope to attract to our instruments and projects those who want to know more about what's likely to be ahead because we built our measuring platform on the best of the past, coupled to an insatiable appetite for the future.

A Classless Society

During a recent conversation with Harry Miyahira, President of HME, he told me of the successful efforts of his local church (San Diego area) to bring in Hispanic members. I remarked that my view of the United States of America was that we were a classless, melting pot society and that was why we were and still are a powerful land.

It is unAmerican to place individuals in "classes". We sincerely hope that the politicians mean middle income when they mouth the words "middle class." The words "middle class" implies a low class and a high class. Who are these people supposed to be? Is someone high class because his income is a million dollars a year - even if he made it dealing in drugs?

It is unAmerican to judge another in advance because of race, color, religion, income, martial status, sex, or age. Individuals deserve being judged by what they are and what they do - not what they look like or how much money they make.

Harry said, "Why don't you write that in the Newsletter?"

What Should We Be Measuring?

As human listeners, we can easily tell the difference between speech and music. Our present analyzers cannot. There are speech recognition computer programs capable of learning the unique characteristics of an individual voice. When we listen to sound in a difficult environment and it sounds bad to us - what causes that kind of sound? We can have good intelligibility and poor sound quality or in some cases it sounds good but you can't understand it.

EARLY TEST INSTRUMENTS

In the years right after WW I, there were only two ways to measure audio frequency signals - using voltmeters with a diode in the probe or the voltmeter made by Ballantine Laboratories, Inc. At that time we were measuring in volts and a little later when the initial space efforts called for measurements into the microvolt area (that is: they asked for inventors to work on it) most of us in audio thought they were out of their minds.

While I'm well aware that the majority of audio instrumentation users are still mentally in the "when you have a sine wave level recorder measurement you know what you've got" state of mind, I also know that they have only two choices, namely to be swept aside as old "fuddies" or to get with it and mature in their measurement capabilities. Fear, ignorance, or malicious misbehavior are the motivations behind such non-thinking.

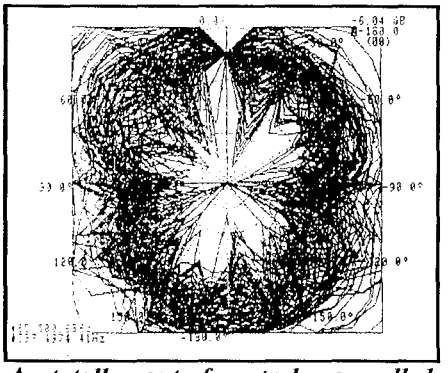
NEW MEASUREMENTS

The past decades most useful measurement in terms of sound systems has been the energy time curve ETC and its use in loudspeaker synchronization work and in speech intelligibility measurements. That's obviously a long way from sine wave level recorder charts both in appearance and in usefulness.

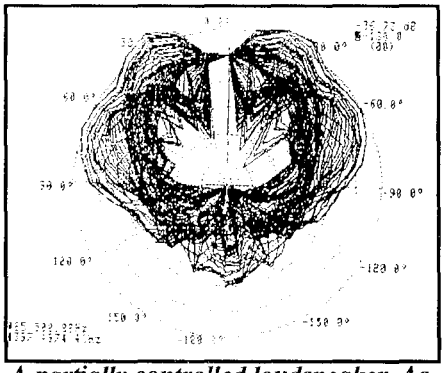
The many who still haven't found out the difference between polarity and phase will be surprised to learn that this decade's measurements will probably increasingly center around acoustic phase measurements of large arrays and that such arrays will, for the first time, begin to sound acceptable to the trained ear. Certainly phase measurements will be key to the accurate reproduction of spatiality in the home which, when it comes to fruition, will make the present flat field stereo sound akin to the early acoustic recordings.

WHY LOUDSPEAKERS SOUND DIFFERENT

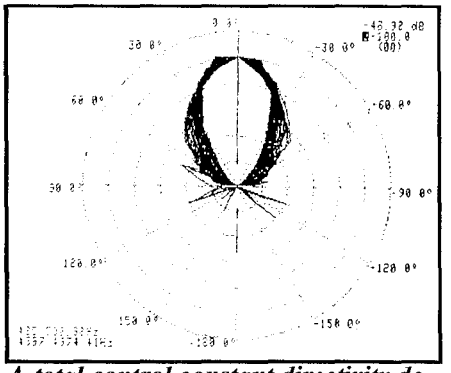
Loudspeakers can have, at a given point of observation, the same "frequency response", the same distortion characteristic, and the same power



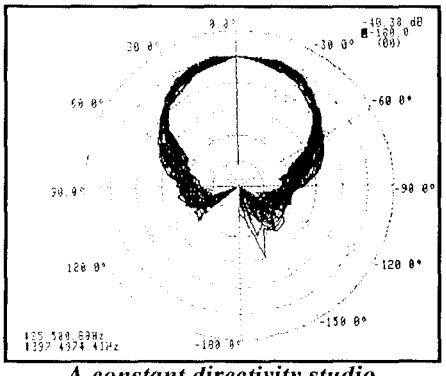
A totally out-of-control so called "omni" loudspeaker. If omni meant a different polar response at every frequency, then it qualifies.



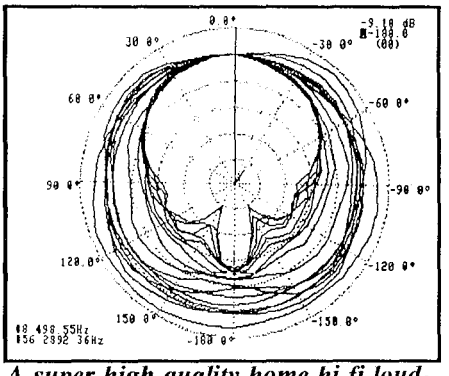
A partially controlled loudspeaker. As the frequency increases its pattern narrows then develops three major lobes.



A total control constant directivity device. This is a case where the name describes the result.



A constant directivity studio type nonitor loudspeaker



A super high quality home hi fi loudspeaker with totally controlled and deliberately manipulated polar response. At the lower frequencies this is a truly omnidirectional loudspeaker.

handling, and yet sound worlds apart when listened to in any normal acoustic environment. Shown here are three loudspeakers that have reasonable "on axis" anechoic responses but sound dramatically different if listened to in a room or if listened to on and off the measurement axis.

CONTROLLED DIRECTIVITY

Controlled directivity, especially in home high fidelity loudspeakers, is almost totally unknown. Even the esoteric units priced into the five figures per pair are wildly out of control in terms of polar responses. One of the best home loudspeaker we have tested is the OHM Walsh 5 which uses directional control in remarkable ways to provide an extremely wide sound stage with spatial integrity. At low frequencies it is truly omnidirectional and at higher frequencies trends smoothly but definitely toward higher aimed directivity. (It should be remarked here that omnidirectionally at low frequencies in a home loudspeaker is desirable but not in a loudspeaker designed for speech in public buildings.)

The range of polar responses we have shown here reveals the fundamental importance of this often neglected parameter. Like all the parameters it must be controlled. Really good loudspeaker design is dependent upon the skillful blending and control of all of them.

1. Synchronized, non-time smeared ETC.
2. Smooth amplitude and phase vs frequency responses.
3. Controlled and appropriate polar control for the intended use.
4. Transient behavior that allow for a smoothly decaying response.
5. Reasonably low distortions of all levels (reasonable being defined as less than 10%)

When all five of these measurements satisfy state of the art criteria it is very unlikely that your ear will have to disagree with your measurements.

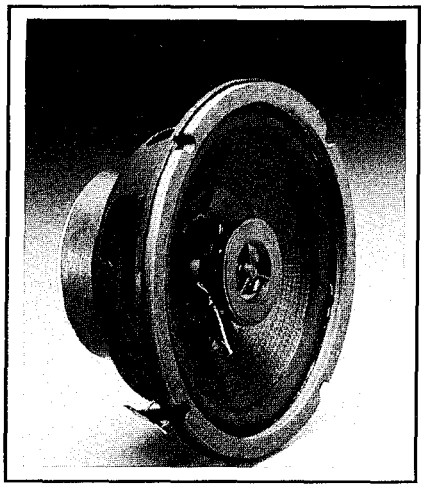
There is a Dearth of Transducer Engineers

Because we are in contact with so much of the talent in the audio industry, we get lots of phone calls from head hunters. The first question we ask is "Who are you and who do you represent?" If they give us that information, we will talk to them. Next, we will NEVER give them the name of anyone who is currently employed unless someone has specifically mentioned to us that they want to change their work.

Not only head hunters call us, but our sponsors and our grads that are working for manufacturers.

One head hunter called back several months after his original call about a transducer engineer for a fine organization to say that no longer would they require the individual to be a transducer engineer but they would accept a physics major whose interest was audio. The individual would receive in-house training and exposure to their design needs.

Mike Lamm, a transducer engineer at Atlas/Soundolier, wrote that they were looking for a transducer engineer and had placed ads in S&VC, S&C and JAES without receiving a single resume. Mike Lamm has a real appreciation of the trend to hire physicists and engineers and give them on-the-job training. Mike started designing transducers at J. W. Davis and he actually trained himself. Mike is responsible for the Strategy series at Atlas/Soundolier—a 6" coaxial that "combines the performance of an 8" loudspeaker with the sound coverage and aesthetics of a smaller unit."



The Illusion of Knowledge

Historian Daniel Boorstin is quoted as saying,

"The great obstacle to progress is not ignorance but the illusion of knowledge."

Interesting TEF Measurements from Farrel Becker

If you think that all measurements should be restricted to universally used techniques and scales, then TEF workers like Farrel Becker will distress you. Here Farrel uses the real potential of the TEF 20 to show what can be done.

From Farrel Becker

Figure 1 shows the spectrum of the A.C. power line from 0 to 1,000 Hz. This measurement was made by setting the TEF to sweep from 0 to 1000 Hz in 30 seconds with Best Resolution on. Note the strong odd harmonics. The even harmonics are also visible. This same measurement can also be made on a TEF 10/12. However the even harmonics will not be visible above the noise. The TEF 20 has a much superior signal-to-noise ratio.

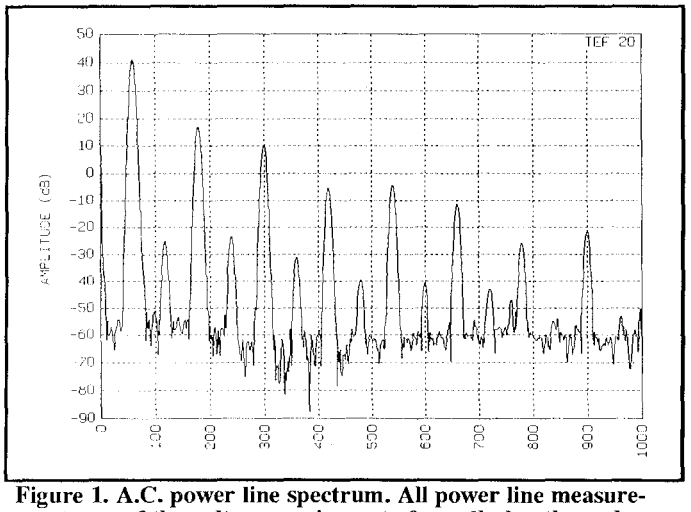


Figure 1. A.C. power line spectrum. All power line measurements are of the voltage coming out of a wall plug through a transformer.

Figure 2 (done on the TEF 10) is an oscilloscope view of the power line waveform. The distortion caused by the harmonics (harmonics caused by the distortion?!) is easily seen.

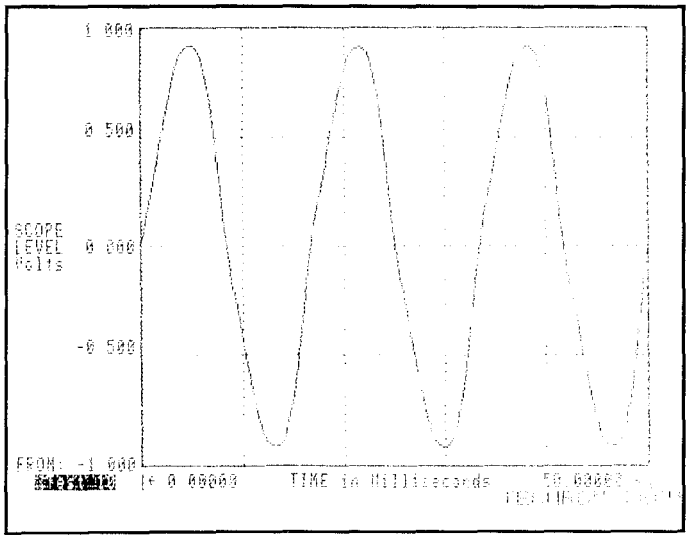


Figure 2. An oscilloscope view of the power line waveform

Ok, the power line does not give us a pure sine wave. At least the voltage is relatively steady. Or is it? The NLA measurement, Figure 3, shows the power line voltage over a period of 1 hour. With a 5.1 second averaging time it varies from about 116 volts up to 118.5 with an average voltage of 117.3 over the entire hour. The instantaneous levels varied from 115 up to 127.6 volts! Of course this was in December! In May the average over a 1 hour period was 124 volts! Oh well.

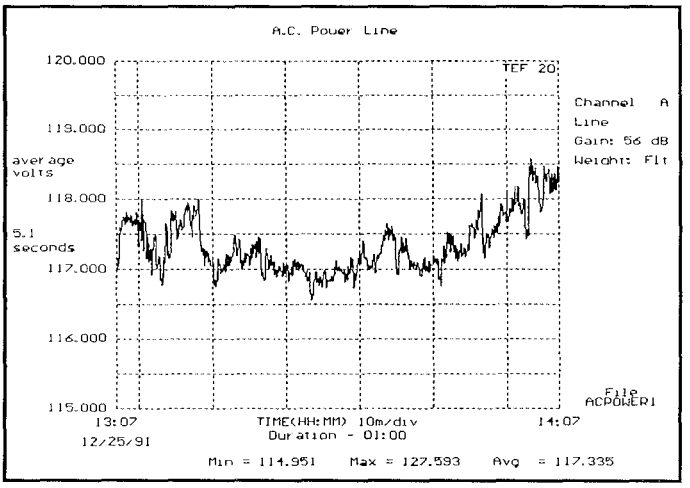


Figure 3. A. C. power line voltage

Also enclosed is another set of printouts that I think is very interesting. For quite some time we have been saying that small rooms do not have a meaningful reverberation time. We have been saying that, while they *do* have a reverberation time, the reverberant field is so far below the ambient noise as to be *inaudible*. We have not been able to measure this reverberation time due to signal-to-noise considerations. The TEF 20 has superb signal-to-noise capabilities and can actually measure the reverberation time in small rooms. (Being able to measure the reverberation time in a small room does not however make it any more meaningful. We still can't hear it!)

Figure 4a is an NLA measurement of the A weighted ambient noise level in my office - 40 dB. The NC measurement (Figure 4b) shows the level in the 2kHz octave band to be about 22 dB. Figure 4c shows the 2kHz ETC taken in my office. Note the time scale is 0 to 250 milliseconds. The direct sound is at 63.6 dB - only 23.6 dB above the A weighted ambient noise. The ETC in Figure 4d is identical to the one on the left except that the output of the TEF was disconnected. It shows the noise floor in the ETC. Overlaying these two ETCs shows that the noise floor in the measurement is at about -10 dB. Remember that the 2kHz ambient noise level was at 22 dB. Using a relatively quick sweep time (5 seconds), the TEF 20 has suppressed this noise by over 30 dB allowing us to see a full 65 - 70 dB of decay! This ETC yields a reverberation time of 0.28 seconds. A very real number, but still of little use.

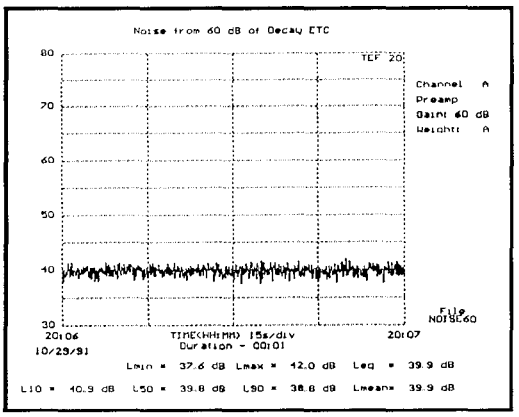


Figure 4a. Ambient noise level

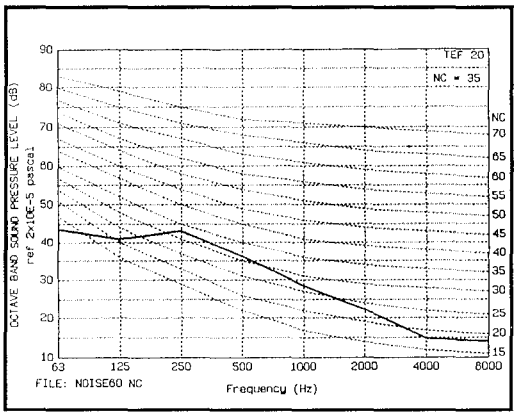


Figure 4b. Ambient nose spectrum

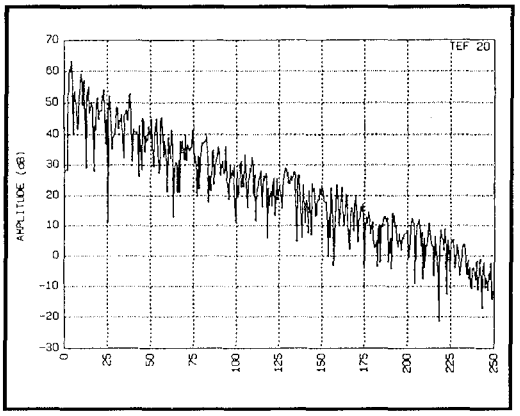


Figure 4c. Small room ETC

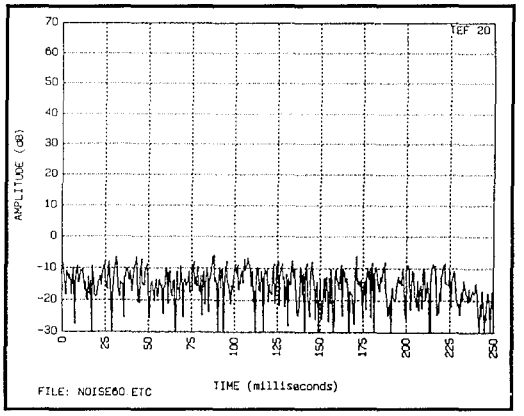


Figure 4d. ETC noise floor

State-of-the-Art Classes

Classes at the farm in Indiana experience the best introduction to the basic fundamentals of audio and acoustics available in our industry. They also are witnesses to a remarkable research facility that this year will feature:

1. Accurately Controlled Equalization, ACE
2. Source Dependent Measurements, SDM. The use of dual channel FFT transfer function measurements using the performer as the test signal
3. Binaural auralization utilizing pinnae response functions to allow the listener to sense the directivity of reflections in as yet unbuilt rooms
4. The latest in narrower band real time analyzers

All of this utilizing the latest PC computer advances such as a "lunch box" 486-33 with 256K caching, 4 mb ram, removable 200 mb hard disc, backlit LCD VGA screen with output for color VGA monitor.

It also incorporates two full-length slots (one for Ariel SYSid), two short board slots (one a TEF HI), both serial and parallel I-Os plus 1.2 mg 5-1/4" and 1.4 mg 3-1/2" floppy disks. The mouse is a 3-button Logitech - all put together for us by Fred Fredericks of San Diego.

Is it important that even newcomers to audio see this level of equipment? We think the answer is an emphatic YES! Why? Because we hear from many of our friends such as Peter Mapp in England that Britons minus Syn-Aud-Con input are wasting their money on vastly inferior systems that cost as much as the best. A Syn-Aud-Con grad fresh from a farm class is far less likely to be the victim of an inferior measurement product - and the audio engineer that fails to compute fails to compete!

To be immodest for a moment, we are always surprised to find ourselves better equipped than the large, lasciviously funded universities, but then our grads have come to expect that.

We Can't Say It Too Often

No electronic equalizer can adjust reflections, echoes, reverberation, ambient noise levels or any other room parameter.

All any electronic equalizer can do is adjust the direct sound level from the loudspeaker. Electronic measurements can be of the electronic system or its components, of the direct sound level, the reflected sound level, the reverberant sound level, the ambient noise level, or some combination of them all.

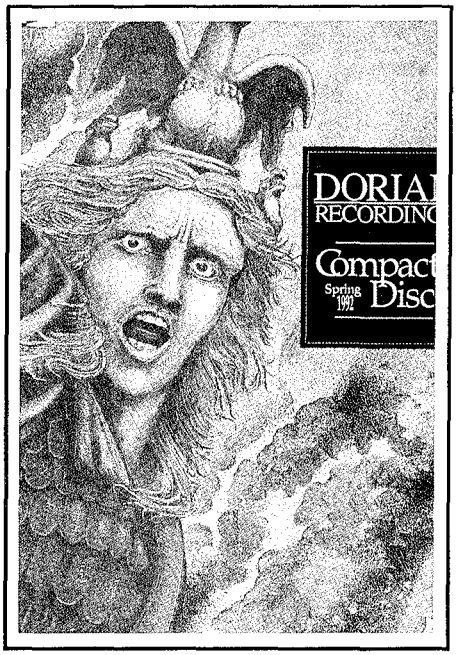
Poncho's Harem

It was late afternoon on a cold day after a 2-day meeting with a fine crew, Don Eger, Ron Bennett, Jim Baumgardner (all of Techron), Sam Berkow, Gene Patronis and Don Davis (Gene and Don missed the pictures). Sam wanted his picture taken with Poncho, the llama, though you notice he never really got very close to Poncho. (Sam has the pictures of Dave Andrews - Beast Meets Beard—on his office wall.) And Don Eger isn't all that eager for Poncho's kiss either. But it is Jim Baumgardner's response to Poncho's nuzzle that sent us into gales of laughter.

Craig Dory & Dorian Recordings

We received a letter from Bob Oliver (reproduced here - he is responsible for the H.E.A.R. data we excerpted in Newsletter Vol 19N2, Pages 24-25.)

Bob's use of the word "hyping" sort of jarred me, and it caused me to reflect on how we got to know the people at Dorian and thought you might be interested in a short story.



We heard a broadcast about 4 years ago on NPR produced by WFMT radio in Chicago of a recording made in Troy Music Hall in Troy, NY - a great hall that we have written about many times in our Newsletters. It intrigued us that someone was making recordings there and we wrote our grad/friend (and chief engineer at WFMT), Gordon Carter, asking if he could send us a copy of the recording - and that is when we discovered Craig Dory.

We called Mr. Dory, told him of our enthusiasm for his recording, discovered he had been 6 years in strategic planning and exploration development at Bell Labs. He left to merge his love of music, acoustics and fiber optics in a recording company in the great Troy Music Hall.

Craig Dory and his associate, Doug Brown, flew out to the farm during the 3-L Workshop: the Loudspeaker, the Listener, and the Listening room, conducted by Peter D'Antonio PhD, Mead Killion PhD, Larry Humes PhD, and assisted by Charles Bilello to see what we were doing.

Later Craig let us to make In-the-Ear recordings (using 3 different people to see what the difference was in what each of us heard in the same seat.) Craig allowed us to see how he miked for his recordings, even allowing us to put our head with ITE microphones in a similar location. (Bob Oliver has reason to compare Dorian Recordings to Bob Fine and the Mercury team.)

After the recording session, we listened to the ITE recordings and the Dorian recordings and we learned an interesting fact: Our ITE recordings made in the relative position to the Dorian microphones were an accurate recording of what our heads heard there, but were not as pleasant to listen to as Craig's recordings. Accuracy and musicality are perhaps in conflict.

We have learned over the years that the surgical accuracy desired in a monitor may not be what will generate a musical experience in your home, though the two are closely related.

We felt that we could move about Troy Music Hall with our ITE microphones and achieve the warmth and balance (musicality) that Craig Dory achieved with his mikes and location, but it isn't likely that ITE microphones will be used for a recording until they can be made even quieter, and a failsafe method of securing the probe in the ear is found - and that may be possible now. A patent has been issued to Nicolet Instruments in Wisconsin for just such a headband.

Anyway, that is just a little history of our association with Dorian Recordings - nothing about the tremendous enjoyment we receive from the recordings. One reviewer put Dorian's recording of Mussorgsky's Pictures at an Exhibition on his list of "Records I Would Kill For" - the same record that Don Keele often uses as a reference disk when he is doing his highly respected "Tested in the Home" reviews for Audio Magazine. cd

January 23, 1992

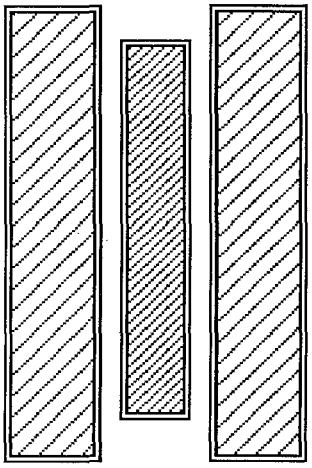
Dear Carolyn & don,

Happy New Year! Hope this note finds you all well. Thanks for your letter of 11/26/91. Yes, I did receive both the Klark Teknik manual and Optimizing Home Listening Rooms. Hope the HEAR stuff will be useful. It's coming from a different direction, one that is perhaps more readily identified with if you're a musician, soundman or roadie.

Thanks for hyping Dorian Records. Edie bought me several Dorian CD's for Christmas. Their story reminds me of the loving care Bob Fine and the Mercury team used to take back in the '50's. It's always nice to see good things happen to those who bring to their work special love and joy.

Keep us in mind. Peace in the coming year.

Bob



A Commentary on Our Times

As I grow older, the wisdom of my forebearers becomes more and more apparent. The United States was a Republic--not a democracy, the Bill of Rights was sacred, the purpose of man's living was not trivial. They did not live in a perfect world, but they worked toward it. They demanded that the succeeding generations situation would be an improved one. God, Country, family were paramount.

Republics engender strong self reliant men and women. In ancient Rome, while still a republic, we can read about Horatius Cocles 508BC whose feat was preserved by the Historian LIVY who adopted the account left by Varro a contemporary of Cicero.

"The Etruscans, led by Lars Porsena, were attacking Rome itself and the situation was desperate. They had swept to the very banks of the Tiber River."

In the immortal ballad penned by Macaulay in *"The Lay of Ancient Rome."*

"Then out spoke brave Horatius, The Captain of the Gate, 'To every man upon this earth death cometh soon or late and how can man die better than facing fearful odds for the ashes of his fathers, and the temples of his Gods'."

Horatius and two stalwart Roman friends Herminius and Lartius then faced alone the fury of the Tuscan spear men and held the wooden bridge into Rome until those behind them destroyed it. The lone survivor, Horatius, then plunged in full armor, into the Tiber and swam it. A grateful country gave him all the ground he could plough around in one day and erected his statue in the temple of Vulcan.

Horatius' defense of the Sublician bridge until it could be denied the Etruscans has had its counterpart in the Marines at Belleau Wood where they went in 9444 men strong against a German division. When only 3000 were left, they attacked with the immortal exhortation of a Master Gunnery Sergeant, two time Congressional Medal of Honor winner, Dan Daly, who standing on the bullet ripped sand bags yelled, "Come on you son's of bitches! Do you want to live forever?" and they took the woods.

Now I've heard all the academic horror of such men and I've witnessed the drug burdened results. We now have twice put men into war's we did not intend to win. A large part of our population is in fear on their own streets. Our young are endangered by a disease whose origin is unspeakable. Our schools no longer teach why the Bill of Rights was produced and mention of God is verboten in a school.

What's still good is that man's tendency is, in spite of the downward pull of the public institutions, upward because many parents recognize the need to oppose the public education system and provide their children with both moral and ethical standards that have nothing whatsoever to do with "What everyone else is doing."

The political system and the greed of the belligerent ignorant may swamp the United States one day but there are signs that the maligned "silent majority" still resists the media version of America. Thank God!

The current events in the Soviet Union show that men and women everywhere have the desire to be free of oppressive government. Yeltson's speech from the top of a tank has been quoted as "He stepped up on a Soviet tank to deliver his impassioned speech, but when he finished he stepped down form a Russian tank onto Russian soil."

Let's hope they find their way closer to a republic than a democracy.

We Agree!

Dan Sweeney has written two articles for Sound & Communications, "The Low Q Alternative, Part 2" (October 1991) to satisfy advertisers.

He states:

"Bose engineers accept traditional wisdom regarding degraded speech intelligibility in the presence of extended reverberation times, and do not advocate the use of low or medium Q speakers where an adequate ratio of direct to reflected sound cannot be maintained.

"According to Bose's Ken Jacob, low directivity speakers do tend to produce more late arriving energy than high directivity speakers, and so high Q horns do offer slightly better intelligibility. But that's a function of distance. By placing the low Q speaker closer to the listener, you can equal the intelligibility of the high Q speaker.....We can get the same results with distributed systems that are cost competitive and much less obtrusive. We don't try to compete with high Q horns in huge outdoor stadiums though."

We are in total agreement!

A Correction for SOUND SYSTEM ENGINEERING Gain Equation

In Sound System Engineering, second edition, page 101 there is an equation for making a quick check of the gain of an entire system.

$$G = 20\,\text{Log}\left(\frac{E_{OUT}}{E_{IN}}\right) + 20\,\text{LOG}\left(\frac{R_{IN}}{R_S + R_{IN}}\right) + 10\,\text{LOG}\left(\frac{R_S}{R_L}\right) + 6.02\,\text{dB}$$

Note the correction. The incorrect coupling factor read:

$$20\,\text{LOG}\left(\frac{R_S}{R_S + R_{IN}}\right)$$

The correction is $20\,\text{LOG}\left(\frac{R_{IN}}{R_S + R_{IN}}\right)$

The second factor we have encountered is knowing what each label represents:

For example: If R_S = 150Ω, R_{IN} = 3000Ω, R_L = 8Ω, E_{IN} = 0.0015V, and E_L = 10V then:

$$G = 20\,\text{Log}\left(\frac{10}{0.0015}\right) + 20\text{LOG}\left|\frac{3000}{(150) + (3000)}\right| + 10\,\text{LOG}\left|\frac{150}{8}\right| + 6.02\,\text{dB}$$

$$= 94.8\,\text{dB}$$

The coupling factor is employed at the input circuitry. What it is actually doing is adjusting E_{IN} to E_S.

A good exercise that will further familarize you with these concepts is to work out the same problem by the equations shown in Fig. 5-6 on page 93.

Tinnitus

Hearing loss and hearing protection has become a very "in" subject and there is usually an article in at least one of the audio publications each month.

In January, EQ magazine carried an article by Martin Polon, "Hearing is Believing" discussing tinnitus:

"The medical consequences of hearing damage can include the onset of a condition called tinnitus. This disorder takes various forms but has been characterized by many permanent sufferers as 'having a jet engine in each ear revving up for takeoff - twenty-four hours a day seven days a week -- fifty-two weeks a year. Permanent tinnitus, caused by cumulative and consecutive hearing damage, is almost never reversible and can cost those afflicted their sleep, their ability to concentrate and often their further contact with audio."

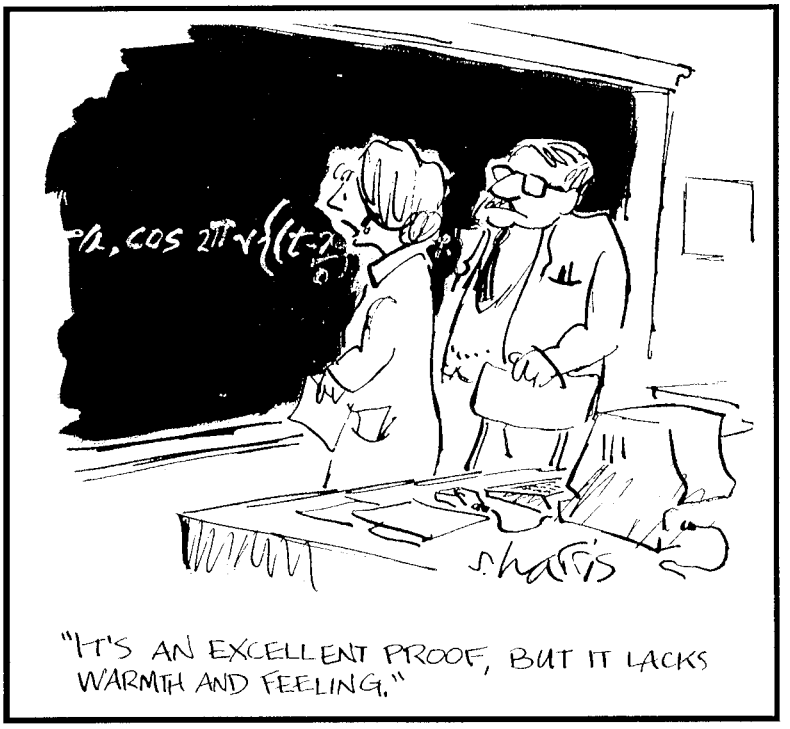
Martin Polon continued,

"One not-so-famous but steadily employed studio and back-up musician described his current life as a less than desirable state of affairs: 'After fifteen years of cranking it up, I seem to have blown my ears away. I cannot hear normal conversations more than a few inches away from my head due to the damage. The tinnitus means I cannot ever be in a completely quiet place or the roar will drive me completely over the edge. I sleep with a rainfall machine in my bedroom and I keep a TV on all day in the office. I can't handle music any more. I have to keep 'masking noises' available or I start to come apart. Some gig, huh?'"

Professional Services

Acoustical Consultants may list their cards on this page. There is no charge. The only requirements are that you are a full-time consultant, that you have attended a Syn-Aud-Con seminar, and have an active subscription to the Syn-Aud-Con Newsletter. If you would like to be on our Consultants page, send in four (4) business cards for our file.

"It's an Excellent Proof, But it Lacks Warmth and Feeling"



This cartoon appeared in "Physics Today". It received a bit of criticism. There were people who thought it smacked of male chauvinism. When I saw it I recalled a letter that I had written Joel Lewitz expressing my appreciation to him for having attended the Women in Audio program at the Fall 1990 AES. It was very successful, due to the magnificent work of Shelly Harrison, Cari Casteel-Stone, and Erika Lopez.

I will reproduce the letter here because it expresses my thoughts about Women in Audio. Be sure that I am not talking about other engineering disciplines. It may very well be that audio is a very special case in that it is a perfect blend of art and science - which makes the work so satisfying.

Letter to Joel Lewitz

"I appreciated seeing you at the Women in Audio session. I saw a file the other day for the first one held 10 years ago when I was Convention Chairman of the AES. I suspect another ten years will go by without much progress. I don't really think we have 'male chauvinist pigs' to blame. I think Women in Audio are mostly interested in the 'art' of engineering. How many of the women attending that session did you see in the acoustics and electro-acoustics technical sessions? I can count them on one hand. I suspect that if they attended any sessions it was the recording workshops, not recording technical sessions. Most of the women are like me: they will learn what they can learn by osmosis and on-the-job-experience. Of course, Mary Gruszka is the exception. Many of the Women in Audio were working in the exhibit booths rather than attending technical sessions. Women make good business people. They like listening and interacting with people." cd

FOR SALE: TEF 20HI. Just a few hours of use. $4900 new. Asking $4,000. Six months left on the warranty. **CONTACT:** Larry Shank, 219-287-3636

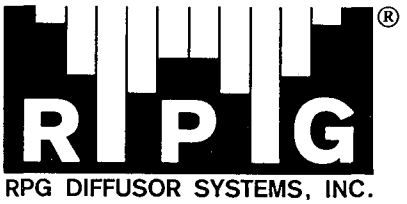
Compound Engineers

"They can take one problem and make ten out of it."
John Royer

Radio Astronomy

1 jansky = 10^{-26} w/m^2/Hz

An omnidirectional source on the moon radiating 0.1 watt would produce a power density at the earth of 1 jansky. By contrast a weak but readily observable signal would be 10^{-4} jansky.



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

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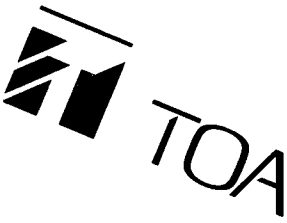

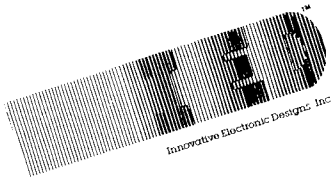

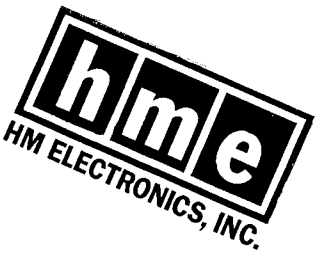

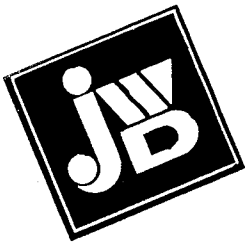

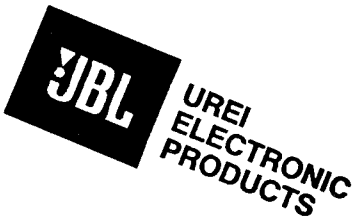

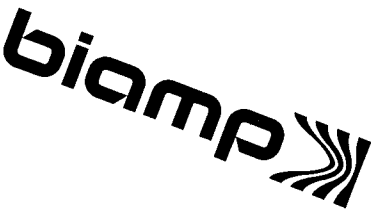

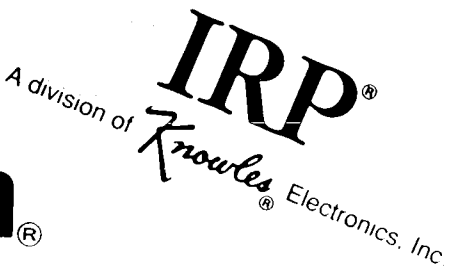

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**Special Supplement
No. 1 to Syn-Aud-Con
Newsletter Vol. 19 No. 3**

Linear System Transfer Function or What are Poles and Zeroes?

by

Eugene Patronis PhD

In the most general and useful sense the transfer function of a linear system is the Laplace Transform of the system's response to an impulsive excitation. The impulse response itself is a time description of the behavior of the system and is not the system's transfer function. The process of taking the Laplace transform of the impulse response describes the system's behavior not in the time domain but rather in the complex frequency domain. The utility of this description is that it allows one to predict what the behavior of the system will be as allowed by the laws of physics for any type of excitation. In other words, the transfer function is a universal description of the physically allowed system behavior. The Laplace transform variable is the complex frequency denoted by S. S is complex meaning that it has both real and imaginary parts.

$$S = \sigma + j\omega$$

Where $j = \sqrt{-1}$, σ is a positive or negative real number and ω is $2\pi f$ with f being the ordinary frequency except that it can be both positive and negative.

The transfer function itself is denoted by H(S) meaning that H is a function of the variable S. H describes a two dimensional surface when plotted versus S. The elevation of this surface at any point in the S plane is the magnitude or size of H for the corresponding value of S.

The transfer functions describing physically realizable systems in electronics, acoustics, and electroacoustics are found to be expressible as quotient of polynomial expressions involving S. For example, the transfer function for a common bandpass filter is given by

$$H = \frac{\frac{\omega_0 S}{Q}}{S^2 + \frac{\omega_0 S}{Q} + \omega_0^2}$$

In this expression, Q is the quality factor of the filter, ω_0 is $2\pi f_0$ and f_0 is the center frequency of the filter.

The poles of the transfer function are values of S which when substituted in the denominator will make H become infinitely large. The zeroes of the transfer function are values of S which when substituted in the numerator will make H become zero. The example transfer function has a single zero at S = 0 and two poles located at

$$\frac{\omega_0}{2Q}\left(-1 \pm j\sqrt{4Q^2 - 1}\right)$$

The locations in the S plane of the poles and zeroes of the transfer function uniquely describe the behavior of the system for any type of excitation.

For example, the steady state behavior of the system for sinusoidal excitation wherein S is restricted to being simply $j\omega$ is obtained by substituting $S = j\omega$ into the expression for H. What results is both the amplitude and phase response of the system

expressed as a function of frequency.

Additionally, the system's transient response in the time domain is given by the inverse Laplace transform of the transfer function. A major consequence of this is that in order for a system to be physically realizable as a stable system, its transient behavior must decay with time. This requires that all poles of the system transfer function have negative real parts, i.e., there can be no poles located in the right half of the complex plane although the zeroes may be located anywhere. Physically realizable stable systems of the minimum phase variety are additionally characterized by having their zeroes also restricted to the left half plane, or at worst, restricted to the frequency axis.

Equalization amounts to cancelling an undesired pole by a superimposed zero and then substituting another pole at a more desired location, or cancelling a zero by a superimposed pole and then replacing the zero by one located at a more desired location. This technique can not be employed in a non-minimum phase system, however, because in such systems the zeroes fall in the right half plane where poles are not allowed for stable systems.

Some of these properties are illustrated in the figures. Figure 1 is for a low frequency loudspeaker. Figure 1a depicts an isometric view of the second quadrant of the S plane surface. Figure 1b shows the intersection of the surface with a plane through the frequency axis. This intersection is the conventional amplitude response versus frequency curve. Figure 1c is a contour plot of the surface looking down on the S plane. Figure 2 is the same as Figure 1 except that now the subject is a simple band pass filter. Figure 3a is an isometric view of the surface for a simple all pass filter and Figure 3b is

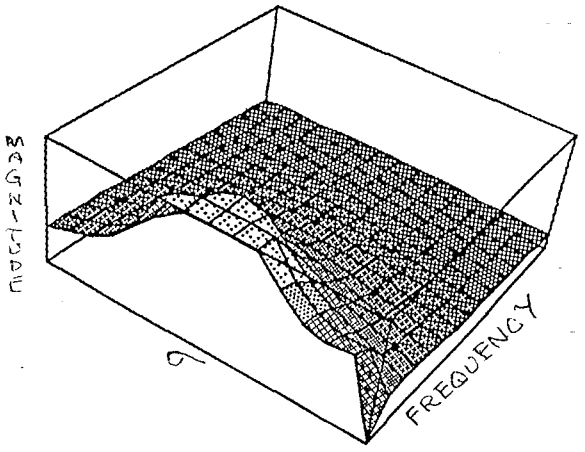

Figure 1a.

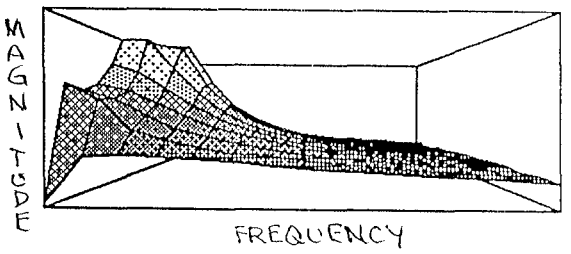

Figure 1b.

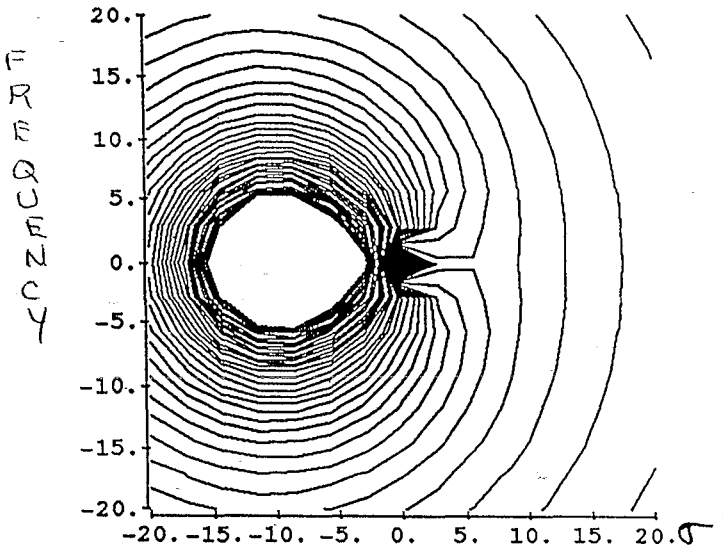

Figure 1c.

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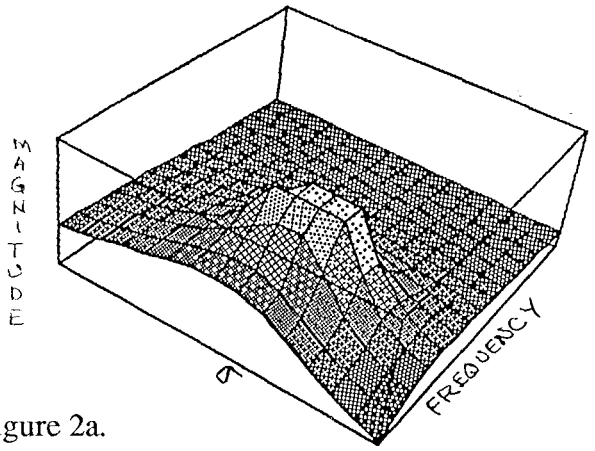


Figure 2a.

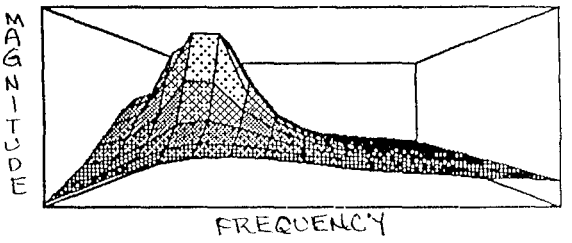


Figure 2b.

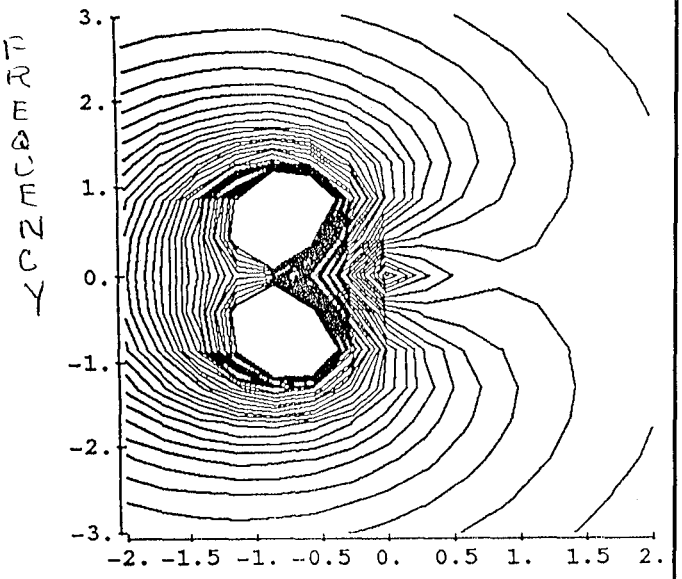


Figure 2c.

Figure 2 is the same as Figure 1 except that now the subject is a simple band pass filter. Figure 2a depicts an isometric view of the second quadrant of the S plane surface. Figure 2b shows the intersection of the surface with a plane through the frequency axis. This intersection is the conventional amplitude response versus frequency curve. Figure 2c is a contour plot of the surface looking down on the S plane.

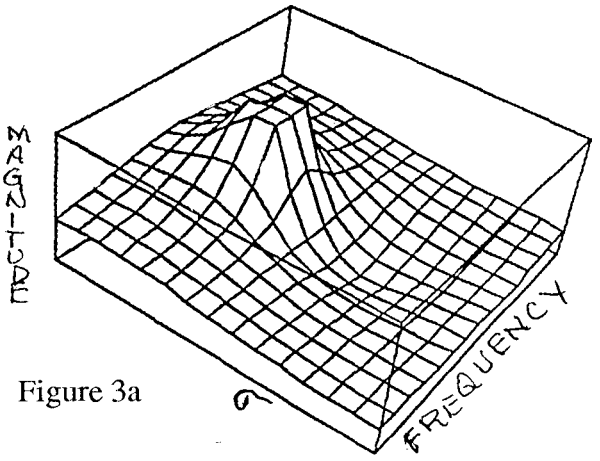


Figure 3a

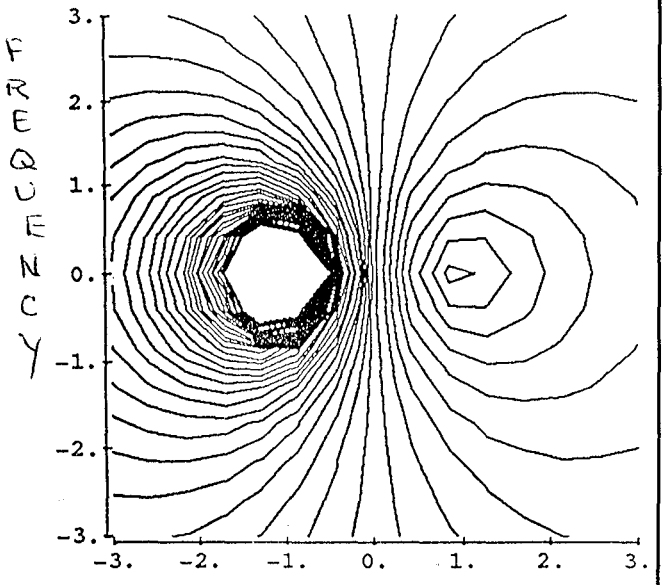
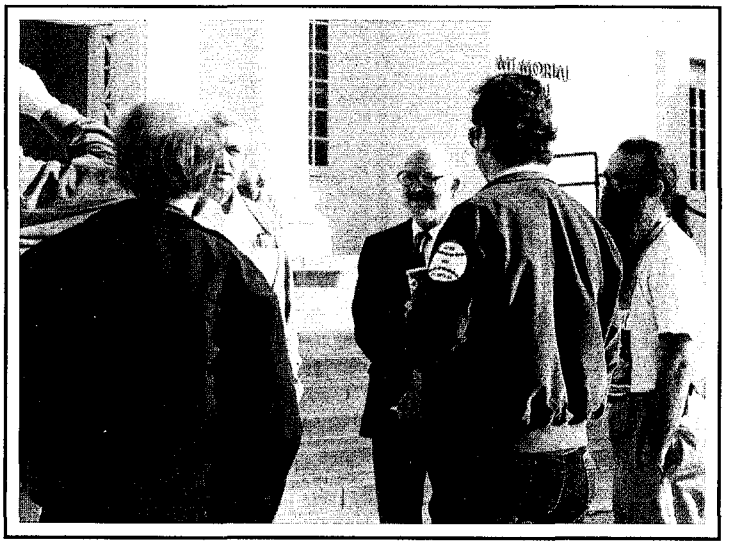


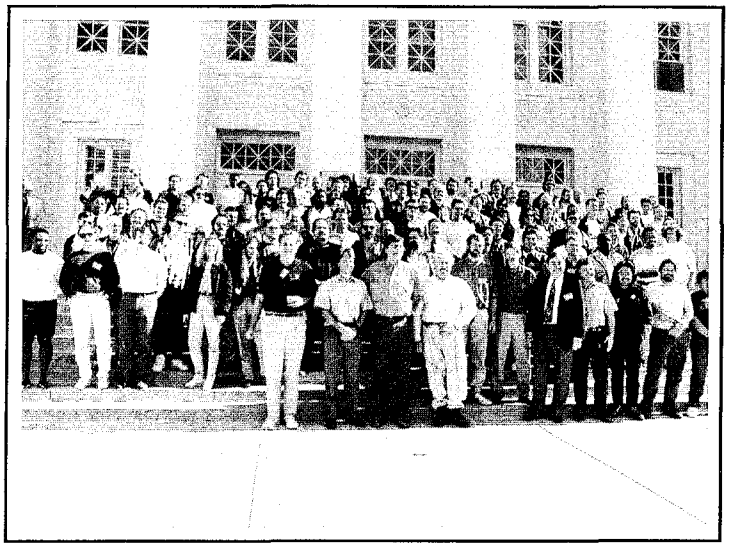
Figure 3b

Figure 3a is an isometric view of the surface for a simple all pass filter and Figure 3b is the associated contour plot.

Our 3rd Concert Sound Reinforcement Workshop was held this January at Chapman University Auditorium in Orange, CA. It is an ideal "real life" environment for the kind of sonic magic "the big five" can generate: Ron Borthwitk of Clair Brothers, Albert Leccese of Audio Analysts, Will Parry of Maryland Sound (now with his own company, SPL), M L Procise of Showco and Mick Whelan of Electrotec. This Tech Topic is a brief review of the invited paper that Dr. Patronis shared with members of the Workshop. Dr. Patronis, Don Davis, and Paul Gallo (editor of ProSound News - cosponsor of the Workshop) are shown here at the entrance to the auditoirum at Chapman University.



Left to right, Bob McCarthy of Meyer Sound (with his back towards camera), Don Davis, Gene Patronis, David Andrews and Brian Oppegaard of QSC (back to camera). The Meyer SIM equalization system was shown at the Concert Sound Reinforcement Workshop as an exhibit (it was not used on the house system) and the pros and cons were discussed. Gene Patronis delineated the physics that disallows equalizing echoes, reflections, reverberation and other room domain effects. If one accepts these facts, the Meyer system can then be recognized as another viable equalization system for direct sound level.



The glamour of working with the "big five" in a real life environment does draw a good crowd. They were well and truly rewarded for their time and effort..

Rick Parlee of Audissey in Hawaii wrote,

"I found the workshop extremely worthwhile and very stimulating. It was nice to meet and relate to some of the professionals I have read about for so many years as well as talking to many of the other class participants. It was interesting to confirm that these professionals are faced with the same challenges that we encounter and very gratifying to confirm that their solutions run a close parallel to ours."