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Eastern Acoustic Works-EAW



Ken Berger (1) and Kenton Forsythe (R) when they founded EAW in 1977.

Ken and Kenton and some of their staff in 1993 in EAW's expansive production facility.

With this issue of the Newsletter, we are welcoming Eastern Acoustic Works, EAW, as a new Syn-Aud-Con sponsor. EAW President, Ken Berger recently wrote us,

"As I write this, I'm looking at a framed Syn-Aud-Con diploma that hangs on the wall of my office. I keep it to remind myself, as well as my visitors and employees, of the value of education and of your courses."

In 1977, Ken Berger and Kenton Forsythe, who were about to form Eastern Acoustic Works, attended a Syn-Aud-Con seminar in Boston. After the class, Ken Berger asked about Syn-Aud-Con sponsorship. I asked him why, and he said that he wanted to support what Syn-Aud-Con was trying to accomplish. That hasn't changed in 15 years, as Ken's letter shows.

"As one of the leaders in the field of professional loudspeaker technology, EAW has an abiding interest in the education and training of audio professionals. We want to support your educational efforts in this direction in any way we can. Kenton Forsythe and the EAW engineering team have developed many unique approaches and solutions."

Syn-Aud-Con, in return, maintains a very high regard for the engineering talent of Kenton Forsythe and for the manufactured products of EAW.

As you read this, Kenton Forsythe will have participated in the annual Syn-Aud-Con/ProSound News sponsored Live Sound Workshop in sunny Southern California, where he will have shared his insights into the problem of assembling loudspeaker arrays. (We had actually suggested another fine transducer engineer. It was Workshop Chairman, Will Parry, who said, "Why not Kenton Forsythe?" and we said, "Good thinking!")

We hope all you receiving this Newsletter will take a long look at the Syn-Aud-Con sponsors listed on the back cover. Some of them have supported our educational efforts for 20 years - Shure, JBL/UREI, and IRP. We salute all our sponsors. Without them we could not have provided you the caliber of seminars and workshops we have at the low prices we have maintained.



This past year ended with tools available to the sound contractor that were unimaginable back in 1973 when Syn-Aud-Con began.

Much of this innovation and prosperity has been a result of the "Space Race." Dick Heyser's TEF analysis was fallout from his work for NASA. Few research projects have produced as much employment of talent, new knowledge, and useful new industries. Perhaps the most important use of Rocketry (once they are absolutely reliable) will be to use them to send atomic waste to the sun.

All digital, especially in instrumentation, capabilities have deep roots in the monies spent by NASA here on earth.

The space race is a moral equivalent to war but without the bloodshed. Money spent on major technical achievements results in many trained people, new tools, and new perspectives on old ideas. Equal amounts of money spent on social achievements, history tells us, degenerate the race. We may yet witness both effects in this century.

Voltaire, when asked what he'd do if he knew that the end of the world was tomorrow, replied, "I'd go hoe in my garden."

This year at the farm saw the very definition of abundance starting with wild mushrooms in the spring, blackberries all summer, and a garden that burst with produce, and an orchard of apples, pears and peaches. The new ideas, tools and remarkable people attending our classes during 1993 left us with an overwhelming, sense of mental abundance as well.

God willing, and if the creck doesn't rise, 1994 will bring even more prolific good for the Syn-Aud-Con family.



Carlin Sheppard from Modern Sound & Communications in Mobile, AL, came to a farm class in 1992. He stopped by the farm this Fall on his way to Indianapolis. He wanted to show us one of his seven foot custom racks stuffed with Altec 1700 series and destined for a Parisian Department store.

Carlin literally unloaded his van of a ton of boxes to let us see the rack setup. It is a multi-zone system and when Carlin shows up at the site, its a week to a full sound system.

Miracles Do Happen



We went to lunch at Larry's Roadhouse and we had an enjoyable and informative break in our regular schedule.

Carlin is a remarkable young man and we admire his drive and ambition. He suffered a severe, very, very life threatening automobile accident when he was 16 year old and experienced a miraculous recovery. So we dedicate the above illustration from Bob Reim most respectfully to Carlin.



The Wave TM

(Wenger Acoustic Virtual Environment)

This is an interesting development from the minds of well trained Syn-Aud-Con grads, Russ Berger, Neil Muncy and Ron Freiheit. In fact, as I wrote the word "interesting" I decided that it was much too tame a word to describe what they have accomplished.

The WAVE[™] (Wenger Acoustic Virtual Environment) is completely new, a room that can be programmed to simulate the acoustical properties of 16 specific environments (12 pre-set and 4 customer-defined). The WAVE can simulate a practice room, a recital hall, an intimate theater, a recording studio, a cathedral, a premier concert hall, a stadium, etc.

Now, I would think this was all hype if I didn't know the people and the equipment involved: Russ Berger of Russ Berger Design Group in Dallas; Neil Muncy of Neil Muncy Associates in Toronto; Ron Freiheit, project manager at Wenger and Lexicon's LARES (Lexicon Acoustic Reinforcement & Enhancement System).

We heard Neil Muncy's first paper and demonstration given at 1990

AES in Los Angeles. Neil played tapes of his first installation in the Elgin Theater in Toronto. A few months later we heard it demonstrated

at the NSCA by David Greisinger. We were impressed and we wrote in the next issue of the Newsletter:

"LARES ability to allow up to 18dB more gain (not in the direct, but in the reflected sound) makes it a clever use of cross correlation techniques. We heard a remarkable illusion created in a very small hotel room with a sense of ambience and spaciousness that we had previously experienced only in the playback of ITE recordings.

"In talking with Neil Muncy as to his experiences at the Elgin and hearing what we heard at the demo in Cincinnati, we have no hesitation in suggesting that the use of LARES in any of the contemporary multipurpose halls would be beneficial."

That was written in the

Summer 1991 Newsletter and we were disappointed that we hadn't heard much about the use of LARES until Russ called to say that we should get in touch with our grad at Wenger, Ron Freiheit, to learn more about WAVE!

For more information, contact Wenger Corporation, P O Box 448, 555 Park Drive, Owatonna, MN 55060; (800) 733-0393.





Jim Hammond is a fascinating young man. He attended a Syn-Aud-Con class at the farm in 1991. As he was leaving the class, he literally insisted that we be present for a rehearsal the following week in Indianapolis for the upcoming "Praise Gathering", hosted by Bill and Gloria Gaither. He wanted us to observe the equalization process being used by a firm that his company hired to do precision EQ. We didn't want to do it but Jim was insistent, so we did.

It was what we saw that day and a few weeks of thinking about it and talking to Gene Patronis that brought about the development of what we called ACE, Accurately Controlled Equalization, and later Altec gave it the trade name of AcoustaEQ.

When we got to know Jim better we asked him why he was so insistent that we be present for the rehearsal and he just smiled.

I thought of all this when I read a

press release from Altec on Jim Hammond's use of AcoustaEQ. Altec quotes Jim in the press release,

"I started using AcoustaEQ about a year ago, and I've been using it on just about every big concert or seminar I do. When I use AcoustaEQ, I find that I have to do less work on the console to obtain a good sound. Without it, it requires a lot more mental energy to pull the sound I'm looking for out of the system. Before AcoustaEQ, we previously hired a company to come in and do precision EQ for us; so, granted, it's also saved us money."

Jim is leading the way to more efficient adjustment of equalizers and delays in complex systems.

Peter D'Antonio "You Only Go Around Once"

"Sometimes you have to understand that you only go around once."

Peter D'Antonio, PhD, is determined that he is going to live that "one go-around" at the fullest. He leaves a very big footprint where he walks and the audio world is very fortunate to have Peter in our world.



Peter is a senior scientist at the Naval Research Laboratories in Washington, D.C. accomplishing important work. RPG is his hobby that became a business 10 years ago. Now there are over 1,000 installations of RPG diffusors.

The pictures show clearly that Peter's life is not all work. Peter enjoys his family, Elizabeth and baby Michael. (Peter's first wife died tragically over 25 years ago.) Son, Peter, is getting an advanced degree in architecture in Boulder, CO and Jonathan is a freshman in high school.



Note the intense look on Michael's face while he sits on Peter's lap at the computer, his expression, and me looking at a new design program that Peter has developed. This youngster is going to be dynamite when he grows up in this atmosphere. Musically talented, engineering and



scientifically trained, and loving caring parents are seeing to it that there's no human sense in this child that isn't fully programmed for optimum contribution to life and enjoyment of it.

We visited RPG when we were on a trip recently. RPG has a modern new building of 20,000 sq.ft. state-of-theart facility with computerized manufacturing and research capability and a 20-person staff. Key people on that staff are Cythnia Bonavito, Sales, who has been with RPG most of the ten years; Troy Jensen, General Manager, formerly an acoustical consultant/ architect with Peter George in New York; and new with the company, John Groth, Production Manager and Julie Wolf in sales. Paul Kovitz, who you will be hearing more about both at RPG and Techron, works at RPG three days a week on the DISC Project (more on this later).

We have a saying about Owner/ Managers of business: First rate men hire first rate men, second rate men hire third rate men. This staff is 1st rate!

As benefits a really civilized working environment, John had his dog as a working companion, though don't tell Edgurr he is a dog because he really is people.

There's a whole lot going on product-wise. But that is nothing new. Since the beginning of RPG there have been a slew of new products



every year. Peter is now looking at reducing the line as new and better products ideas keep pouring forth.

RPG is working to provide a lowcost line of products including what he calls AcousticTools[™], \$1,000 for an entire room. The AcousticTools for Project Studios contains a new 2-D Primitive root diffusor, a new dedicated B.A.S.S. Trap membrane absorber and an RFZ Abflector.

My favorite new product is the DiffusorbloxTM, a cinder block modular diffusor. It's potential for the sound contractor is enormous. Churches and gymnasiums can be built out of inexpensive DiffusorBlox (mold is delivered to a local block producer; the blocks are made near the job site). There are now four gymnasiums built with the new Diffusorblox. Think what that means if the Diffusorblox becomes universally used. No more acoustic toilets destroying the intelligibility of the program.



The project that is absorbing Peter's time (pun intended) is the DISC Project (Direction Scattering Coefficient). Peter says it may consume the rest of his life.

Auralization won't truly work until one is able to draw a room in a CAD system and then listen to what that sounds like before it is built. It won't work with the acoustic databases we have today. If sound hits the wall at 40 degrees and one is listening at 90 degrees at this time, we can't predict what the person is hearing.

That is the reason for that stack of equipment you see in one picture: five TEF 20's from Techron, five Audio Switchers from Audio Precision, cables from WireWorks, and 37 GLM microphones from Crown. This represents a commitment from these manufacturers to make this project work. They recognize the importance of this project.

Syn-Aud-Con Newsletter



Richard Clark of American Multimedia and a multitude of other endeavors is a man who does not like to compromise.

When he became interested in sound systems for cars, he proceeded in his usual manner to win fifty first place trophies in just two years of competing. He set the record for the most trophy points in a single IASCA season in 1989 as his '86' Cadillac collected a walloping 120 points. When you consider that (a) you only get five points for first place and (b) Clark racked up his tantalizing total in just five months, the competitor's minds boggled.

His Buick Grand National has won \$25,000 prizes for him and since his retirement from active competition, his car has been traveling around the U.S. as well as to England, Germany and Asia. This is not a stoplight boomer. Rich says, "Nobody has ever heard my system unless they're sitting inside the car with the doors closed and the windows up." The system won the prizes for being a spectacular sound stage reproducer.

TEF Measurements Used

Richard used TEF to do his acoustic measurements. He attended our Audio Measurements and Instrumentation Workshop last summer and he took a few minutes to tell the class about his "hobby." He said if the system did not image perfectly, he considered the system a total failure. "If there is not imaging, give'em a zero."

Note the huge waveguide tweeters which are mounted under the dash. The back seat, which looks perfectly normal, is actually RPG diffusors. This is not kluge but an elegant installation. (I'll tell you later a little bit about the talent involved in his hobby.)

To fully appreciate what has been accomplished in this Rolls Royce value Buick get a copy of *Car Audio and Electronics* for August 1992 with its detailed description and superb color photos of this award winning vehicle.

Why Syn-Aud-Con's Interest?

Why Syn-Aud-Con's interest in this car aside from the obvious respect for talent? Rich Clark has purchased In-the-Ear, ITE, microphones and is now applying the same kind of energy and engineering genius to ITE recordings that he has applied to everything he touches. That means magic! I called Rich a week or so after he had received the ITE microphones to see what his response was after listening to the first recordings he had made and he said that he had had his biggest thrill in audio in 20 years. Rich knows how to press my pleasure button.

Rich holds many patents in analog-cassette technology and owns one of the largest cassette duplication plants in the United States. At the end of one of the articles written by Richard Clark about the Buick Grand National, he included a "Richard Clark thanks" (reproduced here to give you a feeling for the talent involved in the project and Rich Clark's obvious dedication to perfection):

Ellen Threatt, mastering engineer Patrick Poovey, student, NC State Drew Johnson, tool-and-die maker Paul Demint, computer programmer Howard Hoyt, analog engineer Andrews Isakson, digital engineer Jeff Dodson, Buick mechanic Ronnie Stallings, chemical engineer Don Richardson, engineer, AT&T and Special thanks to Speaker Works.

I have to make a comment about Don Richardson. In 1988 he attended a Loudspeaker Workshop in Atlanta addressed by Gene Patronis, Don Kcele and Ed Long. I asked Don Richardson why he attended the workshop, and he says, "Just a hobby." It always humbles us to contemplate the talent that sits in each of our seminars and workshops.



Richard Clark displays one of the massive waveguide tweeters mounted under the dash.

John Allen and the Equalization for Motion Picture Theatres John Allen and High Performance Stereo (HPS-4000 Sound Systems) has made quite a name for himself in the area of super fine quality sound for motion picture theatres.

We asked him if he would tell us something about his method of equalization and he wrote the following:

"In equalizing my sound systems, I use pink noise and an Ivie-30 analyzer. In order for the analyzer to show the spectrum we are listening to, the reverberation of the room must be suppressed. This is simply accomplished by placing the microphone in the 'near field.' For this purpose, I define the 'near field' as that area, as I back away from the speaker with pink noise playing, where I do not hear the room. I locate the mike in this area, a point which displays the response I see when I am moving.

"With the analyzer set for 2 dB per LED resolution, I perform the equalization adjustments. After this is done, specifically selected program material is played which allows me to do the final tuning of overall bass and treble as well as the final voicing for natural tone.

"In movie theatres the analyzer shows a HF roll-off. In live theatres set up for music reinforcement, I use no roll-off. This allows the music microphones to be operated flat while speech pickups will need both a bass and treble cut which will, of course, vary with the microphone.

"The point of all this is that ears are the judge, not brainless microphones and analyzers. In order for one to be able to learn such a procedure, one must continuously listen to live unamplified music and try to remember what people really sound like when they speak. This doesn't seem to be the way things work, however."

John is saying the same thing we say about analyzers, as valuable as they are to us, it is the analyzer between the ears that should be the final judgement and the better trained it is, the better the end result will be.



This summer when we were at Purdue University for the Theatrical Sound Design Workshop, Maurie Mogridge, Chief Engineer at WBAA, took

time out of his busy schedule to let me look in on WBAA to once again see the Ralph Townsley design and fabricated custom console that I remembered from my youth in West Lafayette. The metal may have worn thin from the myriad

hands that have operated this console, but it perks on. Thomas Wolfe was correct, "You can't go home again." But seeing this old console came close.

Investments

Investments aren't exactly audio but still we all have to think about how to invest our money - if we have any left after paying the bills.

Investment in the stock market is like buying a computer: when is the perfect time to buy?

Investment Company of America

published a neat chart:

"What would have happened if you had invested \$5,000 a year in the S&P 500 for the past 20 years on the *worst possible day* each year - the day the market peaked...

> 12/91\$464,243. Annual rate of return 13.67%

"What would have happened if you had made the same investments on the best possible day each year - the day the market hit bottom

12/91.....\$593,127 Annual rate of return 15.53%

When I read this chart, I realized that I could be very happy with a 13.67% return and I relaxed and invested when I had the money, forgetting about whether the market was up or down. Obviously we aren't looking at a 30's despression economy during this 20 year period.

"Any Sound Contractor Who is Hanging Anything Over Anyone's Head Without Attending Donovan's Rigging Seminar is Crazy"

David Andrews, Andrews Audio Consultants, NY

David Andrews of Andrews Audio Consultants in New York attended the Rigging Seminar in Secaucus, New Jersey.

Mr. Donovan holds two optional evening sessions, one for people who are especially interested in rigging for permanent installations. It is an informal evening and people are encouraged to share their concerns, questions and solutions. David Andrews was invited to give a talk during the evening.

After the seminar was over, I called David to see what his response was to the value of the seminar. When he told me I asked him if I could quote him. He said, by all means.

"Any sound contractor who is hanging anything over anyone's head who doesn't attend Donovan's Rigging seminar is crazy."

One of the strong motivations behind the Rigging seminars is Syn-Aud-Con. We told Harry Donovan if he would be willing to teach the seminars we would provide the administrative part of the endeavor. It really concerns us that sound contractors are hanging multi-ton arrays over people's heads without training!!

Remember if you modify anything, you are now legally responsible. That is how we came to first work with Harry Donovan. Don was a consultant on a sound system being upgraded. The plan was to use the exisiting 25-year old rigging. That meant that the sound contractor we recommended to install the sound system would now be legally responsible for the safey of the rigging. We could not allow that;

therefore, we asked that Harry Donovan be hired to verify the safety of the rigging. Some 30 horrifying pictures later, \$10,000 was reallocated from the sound system budget to the rigging budget with more to be spent later.



David Andrews (R) with Don (L) and Gene Patronis(C)



Many people live fearful lives worrying about falling asteroids and other less than likely occurrences. It seems that the scientific community has decided to add to the chaos. The real danger is that someone in government will take it seriously and make it a law.

Besides the illustration, the two I enjoyed the most were "*Warning:* This product attracts every other piece of matter in the Universe, including the products of other manufacturers, with a force proportional to the product of the masses and inversely proportional to the square of the distance between them."

"Handle with extreme care: This product contains minute electrically charged particles moving at velocities in excess of five hundred million miles per hour."

These and more appeared in the August 1993 IEEE Spectrum magazine in the "Technically Speaking" column.



Intermodulation Distortion Measurements by Mike Lamm

Editors Note

Anyone who has comments that they would like to make, please correspond with Mike - and send us a copy so that we can share with others.

Mike Lamm, Engineering, Atlas/Soundolier, 1859 Intertech Dr., Fenton, MO 63026. Phone 314-349-3110, Fax 314-349-1251.

Thank you for hosting the Audio Measurements and Instrumentaton Workshop in August. It is always so stimulating to see and hear ideas from various giants in audio.

One of the things that impressed me about the SYSid system is that it can measure intermodulation distortion. The SYSid manual lists three methods for testing IM.

Two things struck me. One, the tones are fixed and are often high in

"I am proud to be a part of this group of professionals"

frequency, e.g., 7kHz or 8kHz. How, I wondered, can we measure the IM distortion of a woofer whose pass band does not extend this high? Conversely, the lower 60 or 250 Hz tone does not seem to be a suitable excitation for a tweeter whose resonant frequency is 1,000 Hz.

Two, I have noticed in measuring harmonic distortion that the distortion level varies radically as the frequency changes. I wondered if this wide variation might also be true of IM distortion.

Therefore, would it be useful to use a pair of tones that are (a) closer together in frequency, (b) not harmonic related, and (c) swept over the bandpass of the device being tested while maintaining the relationship of the two frequencies?

For example, if a woofer was being tested, one might use F1 = 41.2Hz, and F2 = 49 Hz. As F1 passes through 82.4 Hz, F2 would pass through 98 Hz. At F1 - 164.8 Hz, F2 = 196 Hz, etc. In this example I chose tones which are E and G on the musical scale, a minor third, and therefore not closely related as harmonics. Some other interval might be better, but for some reason intuition tells me not to use tones that are even multiples of each other.

When an IM test is performed, the two test tones are just ignored. In a swept IM test, the sweep itself would cover the measurement unless a swept

From Timothy W. Richey of St. Louis:

"Last July I attended a Sound Engineering seminar at the farm. Since then I have chanced to meet many others who have been involved with Syn-Aud-Con in one form or another. I am always impressed with the dedication and intensity these people exhibit for their craft. I am proud to be a part of this group of professionals.

"The experience did not just improve knowledge. More importantly, it increased my desire to know

filter removed the two test tones from the measurement. One possibility would be to use a sweeping filter for each of the two tones. The other is to use a filter wide enough to remove both tones together.

I think it might serve to test any bandwidth transducer equally well and would sweep the entire pass band rather than just one pair of tones. Do you think this approach might have some value?

Spectral Contamination

I have not been able to find anything on spectral contamination testing. I saw a couple of graphs on the screen at the workshop but cannot find anything which defines the test such as number of tones or spacing. If you know where I could get some information on this I would be grateful.

more. It is good to have a resource for this and to know there are others who share my passion for this craft. The sad reality is that there is much about audio I do not know. It helps to have experiences that draw our attention to this very small but hugely important piece of wisdom. I owe thanks to you for providing the experience of Syn-Aud-Con.

"I am still young to the industry. My hope is to find that ultimate challenging position where I will learn and apply audio knowledge creatively. You have helped to set the pace! I'll let you know what comes about."

Clayton Chamberlin Pinnae Response Measurements



Clayton Chamberlin, a member of the audio crew at a very popular Branson show, came to our September class. When we discussed pinnae response measurements with the ITE microphones during class, Clayton said he would like to have a measurement of his pinnae response.

Clayton said he would stay after class for the measurement so Don agreed. I won't go into detail about the cockpit problems, but will say that it ended up that the offhand pictures I took were the only record we had of the measurement.

We have Clayton's permission to print the pictures and we think they are sufficiently interesting to print.



Figure 1a

Figure 1a is what we would call a normal response. All measurements are to 10,000 Hz, measured 45° vertical and

45° horizontal - maximum efficiency of the ear. Clayton has a ruptured eardrum in the right ear (Figure 1b). Note the sharpness of the total response in both 1b and 1c, but most of all note the spike at 4,000 Hz in both ears. (Figure 1b and 1c). Clayton said that he has a sizzle in his ears at high frequencies. We aren't equipped to "read" the measurements but can't help wondering about the spikes.



Figure 1b



Jay Foster—Ancha Electronics, Norcross, GA

A Witness to Chaos

Figure 1c

Jay Foster of Ancha Electronics in Norcross, GA (Atlanta) is an action type guy. After class was over, yours truly was in the throes of trying to make pinnae responses on Clayton Chamberlin, a mixing engineer from Branson, MO. The chaos was in trying to get our older TEF to talk to our Epson printer which it steadfastly refused to do until we gave up. Jay crawled under the equipment table and patiently connected, reconnected and disconnected for as long as his baffled guides asked him. We finally photographed the responses from the large monitor. (We threatened to send the picture to Bob Ancha telling him we thought he should know how Jay relaxed in the class).

Jay attended the September class at the farm and we greatly enjoyed getting to know him.



Pat Brown & John Royer

These two men enlivened the 1993 summer classes at the farm. John Royer flew low level jungle searches for the Marine Corp. in Vietnam. (Maybe this is one of the reasons his response time on our PAC timer is consistently faster than anyone we've checked. Or, is it because his response time is so quick that he flew low level in the Marine Corp.?) John now is in charge of the Indianapolis 500 sound system (one of the world's largest) as well as the State Fairground sound which includes operating the system he designed for the Pepsi Coliseum.

Pat Brown is an experienced sound contractor and is rapidly becoming the in-resident computer Guru at the farm. Pat is a superb craftsman both with the design tools and with installation tools.

The Cup of Good Fellowship

When Duke Mewborn of Baker Audio in Atlanta brought Dr. Patronis and me together, he did one of those special things that God writes down in the "Book of Life" in your favor.

When Verne Seare of Crown brought John Royer and me together, Verne also earned his entrance visa to heaven.

Both Doc and John are so "in tune" with my life that they can think my thoughts for me nine out of ten times.

John Royer pulled in one Thursday morning and I see through the window that he's staggering toward the office door with a large box, so I go to open the door for him.

Says he, "You'll never guess what's in the box."

I'm looking at the large box thinking, "That's too much chocolate."

John says, "I have a friend who owns a pottery plant and he owed me a favor so I asked him to make these." He unpacked a box of Syn-Aud-Con coffee mugs (mine is a tea mug).

John's friend had made enough of them (three more large boxes) that we have enough to give one to everyone who attends a 1994 class at the farm. Ernie and Viv Pence have tried to get us to do something like this for years.

Not only has John provided the perfect momento of 1994 classes, but he designed it far better than we would have and the quality of materials and workmanship are unexcelled by anything we've previously encountered.



John knows that I can't write (I write with pen and paper) without my ever present tea cup at my right hand. I'm the kind of guy who has pet cups. John's design wiped out my pets and instantly took their place on the basis of pure drinkability. Handle the right size and in the right place, rim thickness just right, and the correct capacity combined with the proper material to keep my hot drink hot until I drink all of it.

It's too bad John knows his ancestry. If he'd been an orphan I'd claim him as a long lost brother. (More like a son; Don forgets how old he is. cd).

Oh, Nurse!

Pat Brown's wife, Brenda, is a skilled nurse in Louisville.

Her good nature and pleasant manner leads one to contemplate needing the services of a good nurse. I felt these pictures taken by Carolyn give an indication of the enjoyment of life this young lady expresses. No wonder Pat's always smiling.





How Do You Tell a Person's

Occupation:

How do you tell a person's occupation? Ask this question: What is the sum of two plus two and see how it is answered.

We don't know who to credit with these clever answers but we like it and if anyone knows where it originated, we will give proper credit.

JOB

Engineer Scientist Computer Programmer Mathematics Student Accountant Lawyer Banker Senior Partner Trade Union Official Theologian Liberal Theologian Social Worker Politician Civil Servant

ANSWER

About four.
4.0.
4.0000000000000001. I haven't got all the bugs out of this yet.
Can I borrow your calculator?
Five if you are the bank, three if you are the Internal Revenue Service.
What do you want it to be?
Are you lending or borrowing?
I've got people who know about that sort of thing.
Not enough.
It depends on what you mean by "two".
It depends on whether there is such a concept as "two".
How much do you need?
Not as much as when we were in power.
We are setting up a committee to investigate that point so leave it with us a

Ve are setting up a committee to investigate that point, so leave it with us and we will let you know.

Why dBm Ratings?

A recent article stressed the practical current requirements of line drivers. The writer provided calculations of needed current values for his assumed applications using the dB μ (the μ remained unspecified throughout the article but at one point the writer stated +11V peak, +20 dB μ , which implies that μ = 1.10) A further statement was that while the available current vs frequency could vary dramatically, the output voltage *must* remain constant.

What this writer is actually saying is that using the $dB\mu$ or similar voltage specifications, such specifications can be met with dramatically lower power capability than can dBm specifi-cations.

+30 dB μ by his definition would

equal 34.79 volts but any current into any load +30 dBm on the other hand at 8 Ω would be 350 ma, for 150 Ω 81.65 ma, and at 600 Ω 40.82 ma with the corresponding voltages that were required to generate 1.0 watt.

The reason this writer had for writing his article was to defend a line driver that had an output of $+26 \text{ dB}\mu$ but a current output of 16.8 ma.

When you have a dBm rating, you have a power output rating. When you have a dB μ rating, you don't have a power output rating.

Syn-Aud-Con 1994 Seminar & Workshop Schedule

Workshops

Horns II-The Second in a Series of Syn-Aud-Con Workshops

- When: During the week of May 2, 1994
- Where: Nashville, TN we hope

Fee: \$600

Staff: John Murray, Workshop Chairman Jim Carey, Carey Associates Kurt Graffy, Paoletti Associates Dave Gunness, Electro-Voice Mark Ureda, Mark IV Audio

Horns II Workshop will continue to explore constant coverage horn parameters and their effect on multiple-unit arrays. This is not a workshop to learn the basics about horns. The topics covered will be very "cutting-edge" and will push the limits of what we know about these devices. There will, however, be a short review for those who did not attend the first "Horns." Workshop held in November 1992 at the First Baptist Church in Orlando in order to move on to related research topics currently being investigated by the instructors.

The general nature of the Workshop is intended to be interactive with experimental demonstrations being the center of the learning experience. Short lectures of explanation by the instructors will precede each demonstration. An open forum discussion is to follow each demonstration with experience-oriented participation from individual Workshop attendees encouraged.

CHURCH - we hoped that we would have this confirmed by now but we have to be patient. We will send out a brochure on the Workshop to all Newsletter subscribers just as soon as we have everything confirmed. It will be an important and worthwhile workshop. We have talked to Dr. Patronis and he says that if we can hold it in Nashville, he will be there at least for one day.

* 3—Day Seminars—\$550 * Farm—Norman, IN Sound Engineering Seminars May 18-20, 1994 Plan an extra day to attend Indy 500 Time Trials as a guest of John Royer June 23-25, 1994 July 21-23, 1994 August 18-20, 1994 September 15-17, 1994 October 13-15, 1994

2-Day On-the-Road Seminars

Orlando/New York Classes-\$550

It is Syn-Aud-Con's desire to provide 2-day "on-theroad" classes for those unable to attend the more complete 3-day classes in Indiana. Pat Brown and John Royer have been helping us with our farm classes. We want to encourage them to take the show on the road, so we, Don & Carolyn, will travel with John and Pat to Orlando on February 24-25, 1994 and New York (actually Secaucus, NJ) for a class during the week of April 25. (We originally planned the New York class for November, but we just couldn't get it all together in time so we changed it to an open slot in late April.) We want them to gain the experience to offer such classes elsewhere around the country.

Pat Brown is an experienced sound contractor/ consultant with extensive experience helping teach Syn-Aud-Con farm classes. John Royer is a master electrician who runs the sound and broadcasting systems at the Indianapolis Motor Speedway as well as the audio systems at the Indiana State Fairgrounds. John helps teach the Crown IQ classes in Elkhart.

These two men have unique audio backgrounds rich in both theory and practice and a passion for sharing it with you.

For those unable to make the trip to "the farm" for the more detailed treatment of the same subjects, these special classes with Don, Carolyn, Pat and John represent a unique opportunity to participate in a Syn-Aud-Con class.

If Pat and John like the "on the road" classes and the classes like them, there will be 2 or 3 classes a year. We will write more about these classes after the Orlando/New York classes. We, Don and Carolyn, will not be present for future classes but will concentrate our energies on the much loved farm classes.

✤ Schedule of Rigging Seminars, 1994 ◆

Chicago — June 6-8, 1994

Minneapolis (1 day)—July 28, 1994 Specifically for Venue Managers as well as Technical Directors and company administrators

Secaucus, NJ-Nov. 6-8, 1994



Carolyn's great grandmother, Susan, died in 1939 at 96 years of age. She married Oregon Wray, Carolyn's great grandfather, in 1858. In 1883 they moved into a new house we now call the old farm house, where we hold our seminars. The new house replaced an earlier house located near where the old barns now stand. Carolyn's older brothers stayed in her house at night to help take care of the fire and see to her safety (they were in their teens).

During a recent visit to one of Carolyn's older brothers in the DC area, he told us about Grandma Wray telling him how she had stood on the porch of her old house and watched General John Hunt Morgan's raiders (confederates) take their three best horses.

The main part of the raiders had turned east just south of Jackson County at the town of Salem, but scouts and outriders swept through the farm.

General Morgan's raid crossed the Cumberland, near Burkesville, KY, on July 2, 1863. He had 2460 men with him. On the 5th he captured a garrison at Lebanon, KY, then swept north into Indiana, turning east at Salem and on the 13th entered Ohio near Harrison. He marched through the suburbs of Cincinnati on the night of the 13th and on the 18th reached Portland, near Buffington Island, where in a fierce battle he lost 600 men and as many more captured. On the 26th he surrendered to General Shackelford at New Lisbon. He was imprisoned in the penitentiary at Columbus, OH and on the night of November 27th he escaped back to the south.

General Morgan was killed by betrayal on September 4, 1864 in a garden in Greenville, TN.

The reason for his daring raid was to draw the federal troops away from General Bragg's troop movement from Tullahoma to Chattanooga. In that mission his raid was an outstanding success.

I can't look at the front fields anymore without seeing these gray ghosts of the confederacy galloping across them.



Misinstructions From the Misinformed

Don Van Oort of R & D Industries in Milford, IA sent us a set of instructions he found on a church sound system.

The church instructions are sure to keep NOM as high as possible. This ensures that any given microphone will be low in gain. I'll bet the meter doesn't move either - except when it "possibly squeals." PLEASE, if you adjust the microphone settings, the Pulpit, Lectern, and unlabeled mikes should be set slightly <u>LESS</u> than "2". The Altar mike can be slightly higher than "2". If the mikes are set above these levels, we get "feed-back" and possibly squeal. Thank you.

Recent Developments in the Hearing Sciences

Echoes, the newsletter of the Acoustical Society of America, Vol 3, Number 3, Autumn 1993 had a very interesting article written by Brenda L. Lonsbury-Martin. She is, among other things, Director of Research for the University of Miami Ear Institute.

The article is 2-1/2 pages and too lengthy to reproduce here but I would like to quote from the article:

"One significant recent discovery is that noise- or drug-damaged hair cells of birds, and possibly guinea pigs



Owner and author Chris Jordan of Electro Acoustics, Inc.

and even humans, can regenerate. This knowledge has encouraged researchers to learn how to stimulate the regrowth of human inner-ear sensory cells. In the future, it is quite likely that people will retain certain of their abilities to hear by growing new hair cells."

Later in the article,

"One of the most important recent breakthroughs has been the discovery that outer hair cells undergo changes in their shape upon electrical stimulation."

And,

"The other fundamental breakthrough in our understanding of hearing has been the observation that healthy ears produce faint sounds as the cochlea performs its normal processing of acoustic stimuli. These ear sounds are known as otoacoustic emissions....The fact that these emissions represent the previously inaccessible internals workings of the ear has led to great advances in our fundamental understanding of the normal ear's performance."

Ms Lonsbury-Martin sums up the article by saying,

"These recent discoveries comprise some of the most significant advances in the hearing sciences: that the sensory hair cells of vertebrates can regenerate; that the micromechanical movements of the outer hair cells appear to form the basis of normal hearing; and that healthy ears emit faint sounds as part of the hearing process, whereas dysfunctional ears do not. These breakthroughs have resulted in some unique insights into innerear function, which currently are coalescing into a new body of knowledge about the nature of our remarkable hearing abilities."

It is a fascinating article about a fascinating subject.

Stating the Obvious

Yes! but it wasn't obvious till Chris shared it.

In an article by Chris Jordan, Electro Acoustics in Fort Worth, he makes the remark:

"Located at the amplifier rack location, I noticed that it was much easier to align the impulse clicks being fed into the system via the walkie-talkie than by the cars of our staff member on the field." Sound & Communications, November 1993.

In the same article, Chris shared another useful idea,

"A way to delay the referee's announcement was devised. When the referee keys the microphone, a McKenzie digital repeater receives the signal, stores it until the microphone is keyed off, and then distributes it to the system.

A separate feed is taken directly from the wireless system to provide the proper lip sync for television broadcasts. Even after using this set up for a while, most people were not aware of its existence but did notice how the referee's calls were loud, clear, and without feedback or recurring echo."

Clever!



Dennis Merkiey, Intersonie

Syn-Aud-Con Newsletter

MAMM Professional Simplicity

Benchmark Media's inexpensive Jr. Audio Director is one of those products that has elegance in the simplicity of its total solution to a given problem.

The ability to change polarity, reverse channels, select channels, and select mono or stereo mode with complete control of gain in any mode in a small box possessing sonic integrity makes this product highly desirable in any serious



home or professional system. This is the kind of engineering we respect.

Benchmark Media Systems, 5925 Court Street Rd., Syracuse, NY 13206-1707 Ph 315-437-6300; Fax 315-437-8119



The Classic Shoebox

The premier concert halls of the world, with the exception of the Concertgebouw in Amsterdam, are shoe box design (i.e., tall, narrow and long). One glance at a true classic, Boston Symphony Hall, reveals there's more to it than just simple geometry. This photograph is courtesy of Benchmark, who has just had the distinction of having WGBH, Boston, install their MDA-102 stereo microphone preamplifier/DA cards, frame, and PS-302 power supplies in the loft of this hall. To quote Jim Donahue, engineer-WGBH, "....in a hall renowned for both its acoustics and its RFI...the results were stunning. We were especially impressed by the clarity of the MDA-102s and their ability to handle the wide dynamic range of a full orchestra with soprano."



Vibratory Motion & Sound 1882

While on a trip east, I came across a small book (132 pages) entitled *Vibratory Motion and Sound* published by Ginn, Heath, and Co. 1882. The author is J.D. Everett, M.A., D.C.L., FRS, FRSE. This book is written at a level on par with Lord Rayleigh's work and some previous owner has written in generous marginal notations.

In the chapter "Energy of Vibrations" he goes immediately into the partitioning of energy between potential and kinetic

$$\int_{0}^{a} \mu x dx = \frac{1}{2} Ma^{2}$$

Using the notation of the integral calculus, denoting the amplitude by 'a' and any smaller displacement by 'x' the force in the position 'x' is μx . The work done in moving over the element dx is $\mu x dx$, and the whole work is as indicated in the formula above.

The author then proceeds with a visual proof using triangles. The rear of the book has unusual "fold outs" depicting various waveforms.

To reiterate once again, "The ancients are still stealing our inventions."



17

The decibel de

The decibel is written small 'd' for deci (one tenth) and large 'B' for Bell (Alexander Graham Bell). The Bell is defined as:

$$\log_{10} \frac{p_1}{P_2}$$

In English this is the logarithm to the base ten of a power ratio. Defined mathematically, one Bell is equal to a power ratio of

10(1.0)

One tenth of the logarithm would mathematically become the tenth root of TEN

10^(0.1)

or a power ratio of 1.258925412...

Two amounts of power are said to differ by 1.0dB when their ratio is

10^(0.1)

and any two amounts of power differ by NdB when they are in the ratio of

$$10^{n(01)}$$

$$\frac{P_1}{P_2} = 10^{N(0.1)}$$

$$Log_{10}\frac{P_1}{P_2} = Log_{10}10 [N(0.1)]$$

Since the

 $Log_{10}10 = 1.0$

we can write:

$$\log_{10} \frac{P_1}{P_2} = N(0.1)$$

and

$$\frac{\mathrm{Log}_{10}\frac{\mathrm{P}_1}{\mathrm{P}_2}}{0.1} = \mathrm{N}$$

finally

 $10 \text{ Log}_{10} \frac{P_1}{P_2} = \text{NdB}$

The above is the logarithm notation while below is the exponential for this relationship

$$\frac{P_1}{P_2} = 10^{\left(\frac{NdB}{10}\right)}$$

Once you have mastered these two forms, any problem involving decibels resolves into simple algebra.

Remember that the decibel is only an exponential representing a *power* ratio. It is not a given power. A change from one watt to two watts causes a 3.01 dB increase, so does 1,000 watts being increased to 2,000 watts. The *difference in level* produced by either change is barely audible.

The Effect of Voltage on Power

For a given resistance the power varies as the square of the voltage

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

This means that a two to one change in power would be a four to one change in voltage.

$$10 \log_{10} \left(\frac{2v}{1v}\right)^2 = 6.02 \text{ dB}$$

Since multiplication is easier than exponentiation we could write:

$$20 \text{ Log}_{10}^{2/1} = 6.02 \text{ dB}$$

because multiplying logarithms is the same as raising to an exponent in arithmetic.

Voltage *ratios* for given dB changes can be found so long as both voltages are across the identical resistance. The mark of a rank amatuer is the misuse of voltage ratios across differing resistances.

Some West Coast wags use milliBells mB for awhile which, for a power ratio of two to one, resulted in:

$$1000 \text{ Log } \frac{2}{1} = 301.03 \text{ mB}$$

You should now know how to find centi, micro, nano, pico, femto, and atto Bells. Have fun!

18

Dr. Harvey Fletcher and the Acoustical Society of America

Dr. Harvey Fletcher (1884-1981) directed acoustical, and later, physical research at Bell Telephone Laboratories from 1925 to 1952. In his youth Dr. Fletcher was robbed of the Nobel prize by his PhD advisor, Professor Millikan, at the University of Chicago. This only came to light after Dr. Fletcher's death from the biographical materials he left behind.

Dr. Fletcher was the key founding member of the Acoustical Society of America (key because he alone of the four founding fathers had the prestige and access for reaching potential members). The other three were, Wallace Waterfall, Floyd R. Watson and Vern O. Knudsen. Floyd R. Watson was the acoustical consultant for the Purdue Music Hall (now called the Elliot Hall of Music.)

The ASA was founded in 1928 (the year of my birth). By May 1929 they had 500 charter and regular members and one of those members is still active in the society today, namely, Robert W. Young.

Remembering that 1928 was an important year in making the motion pictures talk, the men that I was privi-



Dr. Harvey Fletcher, one of the founders of the Acoustical Society of America, with a stereophonic demonstration loudspeaker.

leged to work with at the old Altec were all associates of these giants. I've read so much of their work and handled so many of the artifacts they generated that I sometimes feel as if I was of their generation.

Hearing Aid Brain ReWiring Accommodation Time

We are very fortunate to be on the mailing list for the Etymotic Research Newsletters, mostly written by the erudite Mead Killion.

Recently we received an article written by Stuart Gatehouse, PhD and Mead Killion, PhD on the subject of how long does it take to get used to a hearing aid. The answer - "The brain's habit of rewiring itself takes time, an important concern in good fittings."

Those of us engaged in physical activities requiring precision repeat-

ability of motion learn that it takes anywhere from 2500 to 3500 repetitions before you acquire the "muscle memory" that makes the action automatic upon being called for.

Prof. Gatehouse in Scotland has been studying how long it takes for the brain to make use of new information from a hearing aid. It looks as though the brain makes little use of the new information for five to six weeks, then gradually starts to use it.

Drs. Gatehouse and Killion con-

clude the fascinating three-page article:

"Our thesis is that the brain is not only an incredibly powerful processor, but that this processor reprograms itself over time to optimize the use of the information that is available to it. The practice of fitting hearing aids (both in selecting adjustments and rehabilitation support) should take this into account. Identifying the factors which govern the degree and speed of accommodation to hearing aids will remain prime areas for research."

If you have a special interest in this subject, contact Etymotic Research, 61 Martin Lane, Elk Grove Village, IL 60007, Phone 708-228-0006 or 708-228-6836



Pressure is in force per unit of area. Force in base units is $KG \cdot M$

<u>s</u>²

and in S.I. is called NEWTON Pressure in S.I. is

 $\overline{M^2}$

Can We Determine the Whole Temporal Structure of the Universe . . .?

Magnificent Music



Carolyn and I rarely listen to recordings technically. We listen to music. If the recording technology intrudes we may admire the technical achievement or abhor the lack of it but such recordings rarely are heard twice.

Dorian Recordings have issued two new recordings that merit inclu-

Combined this becomes $\frac{KG}{SM}$

The kilogram is a unit of mass independent of the force of gravity. Force varies with gravity, a given mass being capable of exerting a greater force in a more powerful gravitational field. When the force is not the result of gravity and a mass, it should be labeled Newton (N).

A reference source provides the following:

1 lb per sq ft = 127.6 dB 1 lb per sq in = 170.8 dB 1 atmosphere = 194.1 dB

To quickly calculate how many lbs per sq ft are in one atmosphere we could

$$10\left(\frac{127.6}{20}\right)10\left(\frac{194.1}{20}\right) = 2113.49$$
 lbs/sq/ft

and

$$\frac{2113.49}{144}$$
 = 14.7 lbs/sq/in

John Bahcall, Astrophysicist at the Institute for Advanced Study, Princeton, says, "I personally feel it is presumptuous to believe that man can determine the whole temporal structure of the universe, its evolution, development and ultimate fate from the first nanosecond of creation to the last 10¹⁰ years on the basis of three or four facts which are not very accurately known and are disputed among the experts. That I find, I would say, almost immodest."

From "Who Got Einstein's Office" by Ed Regis.

sion in the 100 records I'd take to a desert island with me if restricted to that number for the rest of my life.

The first is "Russian Romantics for Cello and Piano." DOR-90188 is a 20 bit DDD fiber optic transmission CD that simply disappears while you listen to the performances by Andres Diaz, Cello and Samuel Sanders, Piano.

Carolyn and I don't claim to be music critics nor experts in recording, but after forty-plus years of attending live concerts all over the world and having in that time personally heard many of the world's greatest artists perform in what critics, after the event, judged memorable performances, we do know what we like. All we can say about this disc is that if you don't forget everything but the music, then either your system or your hearing is below par.

The second piece of music is "Mahler's 5th" DOR-90193 by the Dallas symphony conducted by Andrew Litton. This recording is made in the presence of a live audience and consequently you hear the Eugene McDermott Hall at the Morton H. Meyerson Symphony center in Dallas as it should be heard. Mahler's 5th is like a walk through a dark primeval forest that leads to a mountain path that takes you up into a world of light and distance.

If you love classical music, you'll love these two recordings.

Syn-Aud-Con Newsletter

The Ancients are Stealing our Inventions



Figure 1

Have you ever tried to place yourself back into the mental state of another time and place. Most of us, when thinking about the past, view it from our 20th century perspective. To go back in years and try to think out something from their perspective is more difficult and vastly more interesting.

For example, 3,000 years ago cats were worshipped and highly prized in Egypt because they saved the stored food supply from the omnipresent rodents. Four hundred years ago, due to religious beliefs, cats were often persecuted. A "scientist" of that day (our 1657 book on sound) thought nothing of using cats with differing pitch yowls in an instrument that, when the key was pressed, resulted in differing combinations of cat yowls by pressing on their tails. (See Figure 1)

During that same period dancing was prohibited in parts of Italy and the music we call the Tarantala was originally

used as an antidote for the bite of the Tarantulas (at least that was the best excuse to give if caught dancing). (See Figure 2)

We thought we'd share some of the illustrations from our 1657 volume **Magiae Universalis** (See Preface in *Sound System Engineering* for more on this book.)

Kasper Schott, a contemporary of the better known Athanasius Kircher is the author. Frederick Vinton Hunt



Figure 2

wrote in his **Origins in Acoustics**, "When Schott's description of Guerickes pump reached England in 1654, it came to the attention of Robert Boyle and he set about at once, with the help of his assistant, Robert Hooke, to modify and improve it." This led to his famous experiment of the watch in a vacuum.

I've included two more illustrations to indicate the degree of mechanical ingenuity going on in that century.



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It's a cold November evening at the farm. We've recently returned from a trip to Gettysburg, Washington D.C. and Williamsburg. I've walked the dogs—they're kept confined because its deer hunting season—let in the cats, split enough wood to insure the weekend and am now by the wood stove end of the dining room table.

Being older is "another country," as Jeff Cooper has so aptly put it, and my thoughts are generations away from the events of the day. Just as each individual is responsible for his or her own salvation so too they live in a manner that is the summation of ten million individual choices each and every day that finally vector into what has been named "character."

Bill Hybels of WillowCreek Church in the Chicago area has stated that, "Where your mind turns to when it's free to turn where it wishes—that is your God." I guess I'm an ancestor worshiper because when free to do so, I mentally walk with the movers and shakers of this earth especially those unafraid of mortality and the shackles of fearful mere existence. To me, physics is the ruler of the material world but life is not beholden to it. The only true miracles in my life have had to do with cataclismic changes in thought that occurred in the searing light of a radically changed viewpoint. One of the results, at least in my case, has been an instant violent detection and dislike of distorters of the few and precious truths I have made my own. This distaste manifests itself in a desire to live away from such people and I've been fortunate to be able to do so.

One of the joys of being more experienced is the understanding of

how many truly marvelous human beings there are on this planet. I've always been deeply touched by heroic poetry but only on the rarest of occasions heard it recited aloud. Recently I was with a group that included father, mother, and son capable of reciting and acting out their recitations as

part of a group commemorating Theodore Roosevelt's birthday.

Each time we venture from the farm we are always delighted to see that the brief glimpses of television we see at home have nothing to do with what's going on where we go. I intensely dislike large cities, but when I visit one I find the vast majority of people decent, friendly, and about their business. Listening to a half hour of TV news leaves you feeling you should sandbag your home. I can honestly say that I have a deep interest in history and from that interest perceive that the opportunity to become a thinking person is far greater today than at any previous time.

Audio and acoustics are a pair of happy disciplines that encourage and hone "cause and effect" thinking.

Electrons, not being able to be seen, touched, smelled, tasted or heard yet being able to be manipulated by



the engineer, personifies the power of a trained human mind.

To be inspired means "to be touched by the hand of God." It has been said that if all trace of our civilization were to be destroyed humans would eventually re-find $E=Mc^2$, but it can't be insured that the works of Shakespeare would reappear.

Sobering thought, that!

The Community Family

We recently saw a "family" photograph of the Community team published in *Pro Sound News*. It was in celebration of 25 years in the audio industry. It gives us a genuine thrill to see people, who have worked as hard as these people have, rightfully savoring the success their unique talents so deserve. These four—Bruce Howze, Christine Howze, John Wiggins, and Charlie Moore—would be absolutely fascinating people, deserving of our interest, if they had never produced a product. That they have produced exceptional products is the manifestation of their ability to work as a true team (something entreprencurs often find difficult to accomplish).

So, when we look at this "family" photo, it's with deep appreciation for their accomplishments as both friends, innovators and as business people. Our congratulations to them on their 25th.





Positive numbers have a sign (+) which indicates a direction on the Argand chart.



The same symbol (+) can also be used as an operator (i.e., telling you what operation to perform).

This means that in arithmetic we need to account for the magnitude (number) the sign and the operator. For example:



The negative sign (-) indicates a *rotation* of 180° (i.e., move a different direction away from the origin than does positive numbers). Examples:

$$(-2) + (-2) = -4$$

 $(-2) - (-2) = 0$

In this last case the (-) operator caused another 180° rotation. The symbols (x) and (\neq) are used exclusively as operators.

$$+2 x +2 = +4$$

(-2) x (-2) = +4

Here the first minus two rotated 180° and *multiplying* by a second minus two resulted in another 180° rotation thus ending up on the positive scale.

 $(-2) \div (-2) = +1$ allows the reverse rotation to occur. The symbol (i,) (j) and $\sqrt{-1}$ indicate a 90° rotation on this chart. The impedance term

Ze^{iθ}

indicates that Z is the magnitude of the impedance and $e^{i\theta}$ is the angle between the positive axis and the impedance vector. $e^{i\theta}$ says perform the following operation.

$$\cos \theta + i \sin \theta$$

Example:

 $\theta = 20^{\circ} \quad Z = 8 \ \Omega$ $Z \cos \theta = 7.5 \ \Omega \ ACR$ $Z \sin \theta = 2.74 \ \Omega \ x$

and you now have:



Rancho Carrillo & California Fires

A lot of Syn-Aud-Con grads have been Newsletter subscribers since taking their first Syn-Aud-Con class, and many of those attended seminars at our Seminar Center at Rancho Carrillo, CA (an inholding in the Cleveland National Forest 13 miles from San Juan Capistrano).

It is gone now, all the structures we called the Main

Ranch which included the Seminar Center, and the house, office and barn we owned when we lived there is gone, along with 12 of our neighbor's homes and many outside structures because every effort was made to save the houses.

A fire was deliberately set that came eight miles across canyons to the only houses between where the fire was set and the ocean ten miles on the other side of Rancho Carrillo. The fire completely circled the community (250 acres with 60 some homes) taking the houses that were next to the National Forest. There were no fire trucks, no fire fighters, no helicopters or bombers. They were all in Laguna Beach. The neighbors helped each other, as they have always done at Rancho Carrillo which maintains their own eight miles of private road, the fire department, water company, and without the power company (electricity generated by generators, windmills and solar).

Every year since selling at Rancho Carrillo in 1987 we have gone back to visit friends and to stand on our hill and look out to the ocean, the LA basin and the mountains in back of LA and to hike through the woods. Not this year. It would be too painful to see the tragedy.



Syn-Aud-Con Seminar Center 1980-1983

Defining Electrical Gain

The gain or loss of a device under test (D.U.T.) is defined by the power increase (gain) or power decrease (loss) that occurs to a specified power level from a preceding device as measured at the output of the D.U.T. Note carefully that what occurs at the input of the D.U.T. is not of concern but rather what happens at the output of the preceding device. What we are measuring is the power level available to the D.U.T. subtracted from the power level output of the D.U.T.

The preceding device is normally identified as "the source." The maximum available power from a source is found by:

$$W_{s} = \frac{\left(E_{s}\right)^{2}}{4R_{s}}$$

where: Es is the maximum source voltage (i.e., open circuit voltage)

R_S is the internal source resistance.

The constant 4 results from E_S being an open circuit and $R_S = R_L$ for maximum power output (i.e. E_S sees a voltage divider consisting of the internal R_S and the external $R_L = R_S$)

The output power of the D.U.T. is found by:

$$W_{OUT} = \frac{\left(E_L\right)^2}{R_L}$$

where:

 E_L is the voltage across R_L R_L is the final load resistance

Note here that where the output of the D.U.T. is the preceding device for another D.U.T. (i.e., a source) then its output level becomes an available power level 4 when that contingency arises.

$$W_{OUT} = \frac{\left(E_L\right)^2}{4R_L}$$

Gain or loss calculations are allowed from voltages *when and only when* both voltages are measured across identical resistances.

Fig. 1 a&b illustrates how to calculate gain or loss from voltages.

Fig. 1a shows a source with its E_S and R_S values given. If we attach this source to an $R_L = R_S$ by means

$$\frac{1.015v}{2} \left(\sqrt{\frac{8}{150}} \right) = 0.12v$$

of a 'lossless' transformer of an appropriate impedance ratios (i.e., 150/8), we can then calculate

and from Fig. 1b we can read the output voltage across an

$$20 \log \frac{0.5}{0.12} = 12.6 \, \mathrm{dB}$$

identical R_L for a D.U.T. connected to this same source of 0.5 volt

$$\left(E_{IN} = E_{S} \left(\frac{R_{IN}}{R_{S} + R_{IN}}\right)\right)$$

of gain (because its a positive value). Again note that the input voltage of the D.U.T. is 1.0 volt and even though the output voltage is one-half the input voltage, the gain is actually 12.6 dB.

The text book way to find gain or loss of the D.U.T. is: Transducer Gain or Loss =

$$10 \operatorname{Log}\left(\frac{\left(\operatorname{E}_{L}\right)^{2}}{0.001\left(\operatorname{R}_{L}\right)}\right) - \left[10 \operatorname{Log}\left(\frac{\left(\operatorname{E}_{S}\right)^{2}}{0.001\left(\operatorname{R}_{S}\right)}\right) - 6.02 \text{ dB} \right]$$

output level
in dBm available power
in dBm

Again note that the available input and output powers are in dBm (actual power levels) and their resultant is in dB (a power ratio).

Therefore, gain or loss in dB is a power ratio that can be applied to what's available (whatever the starting value) to obtain what will happen at the output of the system upon substitution of the D.U.T. in place of an ideal lossless transformer.



Figure 1 a & 1b

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Sound Velocity

A very basic difference between audio signals (i.e., electronically propagated) and acoustic signals (i.e., propagated via air, water, etc.) is the propagation velocity. Sound in air at normal temperature (72°F) is 1130 feet per sec. (344.42 M/sec). One result of this is that acoustic wavelengths, for a given frequency, are much larger than those for electronic systems.

Units in the U.S. System make dimensions approximately 1 msec/foot.

Inverse Square Law

Acoustic waves spreading spherically cover a four times greater area for each doubling of the radius from the sound source. This means that for a given radiated power W at some reference distance the power will be W/4 at twice the reference distance (one quarter the power per unit of area).

The decibel

Probably worth memorizing is the following decibel values relative to acoustic signals.

 $+3 \, dB = twice the power$

- -3 dB =one-half the power
- $+6 \, dB =$ four times the power
- $-6 \, dB =$ one quarter the power
- +10 dB = twice as loud
- -10 dB = one-half as loud

Spacing of 1/3-octave filter centers are in power ratios that are one decibel apart.

Center frequency Decibel

1.25	1 dB
1.60	2 dB
2.00	3 dB
2.50	4 dB
3.15	5 dB
4.00	6 dB
5.00	7 dB
6.30	8 dB
8.00	9 dB
10.0	10 dB

Doubling the distance from a sound source results in a change in level of -6 dB and halving the distance to a sound source results in +6 dB so long as you are within critical distance.

<u>September Farm Seminar—1993</u>



Some

Handy

Intelligibility

Relationships

When it has been determined that it's not ambient noise level or room geometry that is causing reduced intelligibility then the following relationship can be brought to bear.

If the N factor is too large, consider making D_2 no longer than:

$$D_{2(ss)}\left(\sqrt{\frac{1}{N}}\right) = D_2$$

If D_2 needs to be made longer and devices can be changed examine lengthening D_2 by:

$$D_{2(ss)}\left(\sqrt{\frac{Q_{new}}{Q_{orig}}}\right) = D_2$$

If at the drawing board stage you may want to suggest that a more reasonable D_2 could be obtained by:

$$D_{2(ss)}\left(\sqrt{\frac{Sa_{new}}{Sa_{orig}}}\right) = D_{2}$$

Experimental Insight into the 'N' Factor

The 'N' factor is defined as: "N is the total acoustic power radiated by a system divided by the acoustic power radiated by a device or devices producing a direct sound level L_D at some distance D_x ."

The "system" can be a sound system or an HVAC system or any other set of acoustic sources. The devices can be single loudspeaker, multiple loudspeakers, air outlets, or any other acoustic source providing direct sound level to a given listener's position.

The general case formula for 'N' is:

$$\mathbf{N} = \frac{\left[\left(10^{\left(\frac{\mathbf{L}_{\mathbf{w}}}{10}\right)} \right)_{+} \left(10^{\left(\frac{\mathbf{L}_{\mathbf{w}}}{10}\right)} \right)_{2} + \dots + \left(10^{\left(\frac{\mathbf{L}_{\mathbf{w}}}{10}\right)} \right)_{N} \right]}{\left(10^{\left(\frac{\mathbf{L}_{\mathbf{w}}}{10}\right)} \right)_{D}}$$

Sources

In many systems, unexpected virtual sources appear by virtue of full frequency range reflective surfaces. We ran speech intelligibility tests in a room 60 ft. long, 40 ft wide, and 10 ft. high (i.e., 18m x 12m x 3m) with 63 loudspeakers installed in the ceiling.

The measurements were taken first with four loudspeakers on (labeled 1-4), then eighteen loudspeakers (labeled 1-18), and finally all sixty-three loudspeakers turned on. See Figure 1.



Figure 1—Four speakers labeled 1-4 Sixteen speakers labeled 1-16

Two parameters require individual judgement on the part of the measuring engineer. One is how many loud-speakers are contributing to L_D at a listener. Second, which loudspeakers have virtual sources associated with them. The microphone's position is shown in each illustration.

Case One

If we assume that only 2 of the 4 loudspeakers provide L_D to the microphone in the four speaker case and that 12 out of 18 do so in the 18 speaker case, the N factor stays roughly the same (2 to 1.5) while the direct sound level goes up by:

$$\frac{12}{2} = 6$$
 10 Log 6 = 7.8 dB

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We measured 7.9 dB. If we then look at all 63 loudspeakers turned on and our 'N' becomes

$$N = \frac{63}{12} = 5.25 \qquad 10 \text{ Log } 5.25 = 7.2 \text{ dB}$$

If we assume all the loudspeakers adjacent to the walls have virtual image counterparts then N would be:

$$N = \frac{63 + 21}{12} = 7 \qquad 10 \text{ Log } 7 = 8.5 \text{ dB}$$

We measured 8.4 dB (i.e., the N factor changed the L_D - L_R by 7.9 dB to -6.83 dB from +1.11 dB). See figure 2a and 2b. This suggests that the virtual sources did play a part in the actual N factor.

Coverage Vs Intelligibilty

When, in order to insure audience coverage, the number of loudspeakers is increased thus increasing the N factor, three main remedies are available. The first is to increase the directivity factor Q of all the loudspeakers by the same ratio as N increased. This insures that the L_D-L_R stays the same. The second avenue is to shorten the distance from the source to the listener by the square root of 1/N. There is a third alternative and this is to increase the absorption Sa in the space by the same ratio as N.

Increasing Q raises L_D without affecting L_R . Shortening D_x raises L_D without affecting L_R . Increasing Sa lowers L_R without affecting L_D .



Carolyn's Helper

Tilly (his full name is Tillard, a name given to him by the cat orphanage where we got him) is our senior citizen cat. We don't know his age as he was an adult cat when we took him in, but we've had him for fourteen years so he's a minimum of two years older than that.

Because of his seniority and also because of his extreme gentleness he's Carolyn's most looked after pet. Having to live with two really aggressive males, Pete and Rascal, Tilly has to spend the greater part of every day avoiding being mugged, and where better than on top of a warm computer.

This time of year is Tilly's favorite as he uses inverse square law between himself and the woodstove to achieve a really warm fur. In fact, I don't need to look at the fire to know what temperature it is, I only need to observe Tilly's distance from it.

In the mornings when Carolyn and I read our devotionals, Tilly prefers my lap as a haven from Rascal's attacks. Rascal, much like Custer, believes that a charge at the first sight of an opponent is the preferred modus operandi and Pete, in spite of daily experiences, usually strolls into range totally in condition "white." Pete is the larger and more powerful of the two, and when pressed, wallops the hell out of Rascal. Rascal merely regroups and charges hell bent for leather back into the fray until Pete gets disgusted and runs off and hides. The only worry we have about Rascal is his finding a "Sitting Bull" in the form of a coyote as he also employs the same tactics with our dogs. The dogs are suitably programmed but coyotes may not be.



There's something sobering about reading in the Bible while watching natural predators operate, but then what we're doing is seeking our Father's lap.



A very first consideration when switching gears from electronic thinking to acoustic thinking is the velocity of sound which is but a tiny fraction of the electromagnetic propagation rate. The velocity of sound at ordinary room temperature 72°F is stated to be 1130 ft/sec. This parameter determines the primitive period for a given rate of phase change and the wavelength for each primitive period.

The term "frequency" with the label "Hz" (Hertz) is the description of the rate of phase change. For example, 1000 Hz simply means that the signal has gone through 1000 complete 360° or 2π radian of phase during a period of one second.

Because the sound is traveling 1130 ft. per second one full wavelength (i.e., one full 360° or 2π radian) phase change occurred every:

$$\lambda = \frac{c}{f} = \frac{1130}{1000} = 1.13 \text{ ft.}$$

where: λ is wavelength c is velocity f is frequency

The primitive period for this same signal (i.e., 1000 Hz) is then

$$P = \frac{1}{1000} = 0.001 \text{ sec.}$$

This means that if you were examining such a signal and wanted to know its frequency you would need to observe it for a minimum of 1.0 millisecond.

Frequency and Time Resolution

Frequency times the primitive period equals unity. This means that:

$$f x P = 1.0$$

 $1/f = P$
 $1/p = f$

For a frequency resolution of 100 Hz you need a time window of

$$\frac{1}{100} = 0.01$$
 sec.

and because sound is traveling 1.13 ft per millisecond, you would then need a space window of $10 \times 1.13 = 11.3$ feet.

These differing viewpoints of the identical acoustic event set the physical constraints on our observation of them. This is true for FFTs, RTAs and TEFs.

Energy

When we add the amplitude of the signal (in pascals), we obtain an approximation of the energy being produced by squaring the variation from ambient atmospheric pressure, taking its mean value, and finally obtaining the square root resulting in a RMS value that can be interpreted as that much pressure above ambient pressure.

The sine wave test signal persists as the stimulus of choice thanks to its mathematical clarity and robustness. Its RMS value is clearly defined relative to its peak value (0.707 of peak) its crest factor is small 3.01 dB (i.e., the ratio of peak to RMS) and Fourier analysis of complex waveforms results in multiple sinc waves of different frequencies. Chirp test signals (swept sine waves) are the stimulus of choice for TEF and Ariel SYSid systems.

When we do an acoustic spectrum measurement, we are observing the magnitude. The display is:

Magnitude =
20 log
$$\left(\frac{\text{amplitude in pascals}}{0.00002 \text{ pascals}}\right)$$

for each frequency excited by our test signal constrained only by our chosen "time window" in terms of frequency resolution.

The Heyser Spiral

The amplitude of a complex waveform is the result of two factors called the real part and the imaginary part. In a plane progressive wave in the free field (i.e., before reflections occur) the real part is proportional to potential energy and the imaginary part is proportional to kinetic energy. The amplitude is equal to:

Amplitude =

 $\sqrt{(\text{real part})^2 + (\text{imag. part})^2}$ and the magnitude is Magnitude =

10 log $\sqrt{(\text{real part})^2 + (\text{imag. part})^2}$

The phase response can be found by

phase = arc tan $\left(\frac{\text{imag. part}}{\text{real part}}\right)$

The Heyser spiral reveals that amplitude and phase are simply two different viewpoints of the same event.

If this is so, why bother to measure phase.

- 1. It's a more sensitive parameter to find the f_c of filters.
- 2. It reveals driver displacement, something amplitude can only do very coarsely. (i.e., inverse square law) whereas phase can show minute fractions of an inch.
- 3. It is a clear detector of polarity.
- 4. It reveals non minimum phase behavior.

These basic terms used in acoustic measurements should be part of your "read only memory" as you look at the displays on the various measurement tools from an oscilloscope to a TEF.



Hearing

Protectors That

Let You Hear the

Room Decay

Stereophonically

We wrote about a superb hearing protector for shooting in our new Farm, Firearms, Facts and Fancies, then I realized that we really should write about it in our Newsletter.

The Peltor 7-S Stereo Hearing Protector provides adequate sound reduction while allowing one to clearly hear all range commands and normal conversation. One does not hear the explosive wavefront.

I was wearing the protectors one afternoon at our shooting range which has woods on two sides and the shooting echoes back from the woods. I was not hearing the initial explosion but hearing a beautiful decay from the woods. Wow, what beautiful protection in a space being measured and what a way to hear the decay only.

Highly recommended for a serious acoustician.



Cost \$165.95 — Dillon Precision Products, Inc., 7442 E. Butherus Dr., Scottsdale, AZ 85260-2415. PH: 800-223-4570 or 602-948-8009.

October Farm Seminar-1993



A Syn-Aud-Con First

While "the ancients are stealing our inventions," I am rapidly approaching parity with them as evidenced by our having the first GRANDCHILD of a grad attend class at the farm. (His grandfather, John Leadbetter, attended the Orlando class in 1978.) Craig Leadbetter of Leadbetter Electric in Marquette, MI is already a big man in audio (see picture). We predict he'll become a great one as well. If a great grandchild shows up, I'm retiring.





Marriage

Marriage is once again being spoken of by the anchorless as something worthwhile. Here's a couple celebrating their 25th wedding anniversary at their church with their family and friends. The Don Eger's don't have to engage in the dialogue—they have lived it and personify its rewards.

The Eger children (actually two marvelous young adults, Tim and Heather) arranged the party, and Carolyn and I drove up from the farm in October to Elkhart to share in this event.



Proof of the Power of Love



This couple has been in love for over 44 years without any attenuation and considerable amplification. Yes! Our outsides are a little older, but the interiors are still children.



Courtesy of Chris Dietze

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.



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