
# newsletter

SYNERGETIC AUDIO CONCEPTS

P.O. BOX 1134, TUSTIN, CALIFORNIA 92680

VOLUME 4, NUMBER 2
JANUARY, 1977


SYNERGETIC
Working together; co-operating, co-operative

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

## EXCHANGE OF IDEAS

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

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

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## EDITORIAL

Syn-Aud-Con enters its fifth year with the start of 1977. These Newsletters and Tech Topics have played and will continue to play a key role in disseminating the input from 2000 graduates from all over the world.

Early issues of the Newsletters and Tech Topics are now out of print and will not be reprinted in the foreseeable future. Most of the Tech Topics remain available with only those that have been incorporated into the latest printing of *Sound System Engineering* being retired. Because of continuing value of and interest in the early Newsletters, we will include items from early Newsletters in current Newsletters as space permits. Current Syn-Aud-Con Lab Manuals passed out in new classes include all of the current Tech Topics but only the previous 4 issues of the Newsletters.

*Sound System Engineering* is now well into its second printing, having sold out the first printing of 5,000 in a little over 9 months.

The combined output of Tech Topics and Newsletters up to but not including this issue was 400 printed pages. That's a lot of technical material to share. We are endeavoring to put even more content into the available space by generous use of photographic reduction of the typed material. This lets us keep the Newsletters' physical size the same but allows substantially more text per issue.

As Syn-Aud-Con graduates you have access to a unique library in your Textbook and Lab Manual, a library that continues to grow as you do.

Because we try to keep the Tech Topics in print for the Lab Manual while dropping all but the last 4 issues of the Newsletters, we are making generous use of the Tech Topics this issue and in future issues as a way to carry forward to future classes the important material. Thus we have 4 Tech Topics this issue.

## TENTATIVE SYN-AUD-CON SCHEDULE, 1977

| | | | |
|---|---|---|---|
| January 17-19 | Banff, Alberta Canada | June 28-30 | Denver |
| February 1-3 | Anaheim, CA | September 13-15 | Kansas City |
| February 15-17 | San Francisco | September 20-22 | Syracuse |
| March 1-3 | Seattle | September 27-29 | New York |
| May 18-20 | Los Angeles | October 5-7 | Boston |
| June 1-3 | Houston | October 18-20 | Philadelphia |
| June 8-10 | Indianapolis or Columbus | November 2-4 | Washington, D.C. |
| June 15-17 | Chicago | November 15-17 | Nashville |
| June 22-24 | Minneapolis | November 29-Dec. 1 | Orlando |

## SYN-AUD-CON GET-TOGETHER AT AES, 1977

The number of Syn-Aud-Con graduates is too large now to hold our annual "Open House" the first evening of the Spring Audio Engineering Society convention in Los Angeles (this year-May 10-13, 1977). Therefore, we plan to keep a hospitality suite open during the first 2 or 3 days of the Convention to provide a comfortable place to meet other Syn-Aud-Con graduates and friends. More information will be available in the April issue of the Newsletter, but in the meantime, I hope you will make plans to attend the May Audio Engineering Society Convention.

## REVISED SYN-AUD-CON SLIDE RULE SPONSORED BY UREI

Syn-Aud-Con slide rules now have three sponsors. UREI has sponsored the revision of the Syn-Aud-Con Sound System Design Calculator.

Improved $\%AL_{cons}$ scales have been added as well as detailed additions to several of the existing scales to broaden their usage in metric countries. This newer version will be introduced at our February Anaheim class. Graduates may order one by mail for $2.50 if not planning to attend an Update class soon.

Shure Brothers sponsors our reverberation time calculator which remains uniquely exclusive. Price $2.50 to graduates.

Industrial Research Products Inc. will sponsor a new Syn-Aud-Con slide rule that will include time delay calculations, impedance calculations and all minimum loss and impedance correcting pad equations. We hope to have this slide rule in use in our classes by May. It will be mailed to all current subscribers of the Newsletters in the next mailing after the slide rule becomes available.

Shure Brothers continues to supply Syn-Aud-Con with their excellent Reactance slide rule.

The combination of these four slide rules gives the Syn-Aud-Con graduate unparalleled computational ability with a minimum expenditure of time and money.

## MIDWEST ACOUSTICS CONFERENCE, 7 MAY 1977

Bob Schulein of Shure Brothers Inc. and President of the upcoming MAC conference sent the following Press Release:

The Executive Committee of the Midwest Acoustics Conference approved the 1977 Program at its June meeting. The Conference will take place on 7 May 1977 from 8:30 to 6:00 p.m. in the Norris Center of Northwestern University.

The subject of this year's Conference is Sound Reinforcement. The Program will emphasize changes in the field during the past few years. For example, the differing requirements of reinforcement of lectures versus reinforcement of rock music will be explained and discussed. Problems of reinforcing dramatic presentations will be contrasted with those of amplifying the sound of a church choir. Of unusual interest will be a discussion of new opportunities opened up by the availability and flexibility of digital time delay methods including the creation of indoor ambience with outdoor sound systems.

-more-

MIDWEST ACOUSTICS CONFERENCE, (continued)

Departing somewhat from its usual format, the Conference will, in addition to individual lectures, feature an audio-visual presentation elucidating the theoretical aspects of sound reinforcement. The audio-visual presentation is being prepared by a special committee of the Conference, drawing upon the resources of leading acoustical consultants.

The component parts of the sound systems - microphones, loudspeakers, and electronics - will then be examined with a special emphasis on the new digital time delay systems.

After presentations on a variety of systems, a discussion of education of engineers and contractors in the design of sound systems will take place. The conference will conclude with a panel discussion.

For information contact: Robert B. Schulein, Shure Brothers, Inc., 222 Hartrey Ave, Evanston, IL 60204. 312-866-2374

## HAPPY ENDING

In a number of classes I have related the story of how a church in the Chicago area was sold a pre-equalized lectern speech reinforcement sound system to replace a very fine permanent system installed in a church that only needed maintenance to restore it to full effectiveness.

From the original consultant, Dave Klepper of KMK Assoc, (Syn-Aud-Con class in New York 1975) comes this happy ending: "The concluding half (of the story) is that the lectern system was not at all satisfactory to the congregation, many of whom remembered the superior performance of my system, before it had been degraded by bad maintenance. So, the situation was resolved when a local sound contractor put the original system that I had designed into first-class operating condition, with three important improvements: (1) addition of a low-frequency loudspeaker to the central cluster to make the system full-range; (2) 1/3-octave-band equalization, replacing the more primitive RC equalization originally employed; and (3) replacement of the tape-loop delay unit (which had been 'repaired' by wiring the input to the output!) by a modern, digital delay unit. I'm very pleased by this conclusion of the story, and I think your graduates should know about it. The original column of multi-cell horns, the original tube-metered tube-type amplifiers, etc. are still in service."

## AN EXCEPTIONALLY USEFUL PAPER ON NOISE MASKING

Reprinted from Volume 2, Number 4

A paper given at the Acoustical Society of America convention by A. T. Edwards and J. Kowalewski, *Open Office Acoustics - An Engineering Approach* contains data that Syn-Aud-Con considers to be of inestimable value to the noise masking system designer. One figure shows the relationship between articulation index and speech intelligibility. Another, the effects of ceiling treatment on privacy, and a most useful one showing the effect of background noise on privacy. Well thought out methods of mounting loudspeakers and modifying their diffusion characteristics are shown in detail.

The paper was given at the April 1975 meeting of the Acoustical Society of America. Write:

A. T. Edwards
Ontario Hydro
800 Kipling Ave
Toronto, Ontario M8Z 5S4

This valuable paper is still available at no charge by writing the authors.

## AUDIO DIRECTORY

An audio professional shouldn't be without SOUND & COMMUNICATION'S BLUE BOOK.

The Directory gives valuable information on most all audio communications' manufacturers (Altec is never listed). Aside from this obvious oversight, it very complete.

# NASHVILLE OPRYLAND TOUR

The Nashville Syn-Aud-Con class held in November 76 had an unexpected treat when Tom Moores of Opryland arranged for the class to have a special tour of the new Opryland OpryHouse. Purcell and Noppe were the acoustical consultants for the building and Allied Sound of Nashville was the installing sound contractor. Hugh Hickerson, head engineer of the OpryHouse was our host.


Tom Moores on the left, chatting with class members, John Malek of Michigan; Susan Sherry of Atlanta; and Rick Devaney of Johnson City, TN

The house curve over a wide seating area was viewed on the real time analyzer to demonstrate their excellent coverage. Acoustic gain was measured as well as $RT_{60}$ using Vic Hall's $RT_{60}$ meter. (Syd Stegall, standing in the middle of the downstairs auditorium, estimated the reverb time as 1.4; Carolyn standing near the stage estimated 1.2 seconds. Precisely on.) Our new HP 97 printing calculator was then used to analyze the sound system design. The internal volume of the room and the boundary surface areas are rough approximations but are believed to be within 10% of the correct values.

As can be seen from the tape, it's a large room but with lots of absorption principally in the seating area where the empty seats approximately match the absorption of a seated listener.

Thanks to a low $RT_{60}$, a very low minimum Q is required. Our assumption of the total array's Q being approximately 2 was borne out by the $D_C$ figure in the space. Note that the array has a $D_1 = D_C = 48'$

In the Opryland Auditorium the following approximate dimensions were obtained:

$D_O$ = 120 ft.

$D_2$ = 120 ft.

$D_1$ = 48 ft.

$D_S$ = 1 foot (for the acoustic gain tests)

If we use:

$$10 \log \left( \frac{Q}{4\pi (D_x)^2} + \frac{4}{S\bar{a}} \right) \text{ to obtain } \Delta D_x s$$

We can then write

$\Delta D_O$ = 41.02 dB
$\Delta D_2$ = 41.02 dB
$\Delta D_1$ = 38.63 dB
$\Delta D_S$ = 7.98 dB

The PAG equation

$\Delta D_1 + \Delta D_O - \Delta D_S - \Delta D_2$ becomes:

38.63 + 41.02 - 41.02 - 7.98 = 30.65 dB

| | | |
|---|---|---|
| V | 1800000.00 | *** |
| S | 90000.00 | *** |
| $\bar{a}$ | 0.000 | *** |
| $RT_{60}$ | 1.50 | *** |
| $\bar{a}$ | 0.653 | *** |
| $S\bar{a}$ | 58800.00 | *** |
| $D_2$ | 120.00 | *** |
| MIN. Q | 0.77 | *** |
| Q AVAIL. | 2.00 | *** |
| % AL cons | 5.70 | *** |
| MAX $RT_{60}$ | 2.42 | *** |
| $D_C$ | 48.35 | *** |
| EAD | 10.00 | *** |
| $D_1$ | 48.00 | *** |
| $D_S$ | 0.00 | *** |
| NOM | 1.00 | *** |
| MAX $D_S$ | 3.74 | *** |
| $SPL_Q$ | 100.00 | *** |
| SENSI | 110.00 | *** |
| EPR | 126.65 | *** |
| WATTS RMS | 2400.00 | *** |
| $SPL_{MAX}$ | 112.78 | *** |
| $D_O$ | 120.60 | *** |
| PAG | 19.22 | *** |

Our acoustic gain measurements of the sound system were made at its normal operating level rather than right at the feedback threshold so 30.65 dB - 6.02 dB = 24.63 dB of expected working acoustic gain. We measured an actual working acoustic gain of 22-24 dB of gain, depending on the location in the auditorium.

That this is logical can be seen by realizing the working acoustical gain should approximate the level change from $D_C$ to EAD + 6 dB FSM.

Thus, $20 \log \left( \frac{D_C}{EAD} \right) + 6$ = 19.64 dB of potential acoustic gain for a $D_S$ = 3.74' and 19.64 dB + $20 \log \left( \frac{3.74}{1} \right)$ = 31.10 dB which agrees substantially with our figure obtained from the more involved equation.

John Prohs, Audio Department, Ambassador College, Pasadena, CA (LA class 1973) has given some very serious thought to our need for a way to measure direct sound.

# A NEW SOUND SYSTEM MEASUREMENT TOOL

## THE "PROZAKALYSER"

### THE PROBLEM

There are a great many problems involved in designing, installing, and measuring sound systems. One neglected area is measuring the actual intelligibility of the sound system at various locations in the seating area. A common technique is to use a conventional sound level meter to determine if the sound coverage is adequate. When using the sound level meter approach, the sound system coverage from seat to seat in a building may be found to be even. Yet during actual use this same sound system may be found to be difficult to understand.

Obviously, system coverage does not tell the whole story.

There is a need for a method of measurement which can determine the intelligibility of the system. Preferably, this determination should be made through measurement techniques when there is no audience present in the building.

### WHAT REALLY NEEDS TO BE MEASURED?

The parameter which really needs to be measured is the ratio of direct-to-reverberant sound. It is believed that a study of the spectrum shape of early reflections might provide useful information as well.

Generally, the time period involved for occurrence of these first few reflections is chosen to be about twenty milliseconds. Twenty milliseconds is chosen because, in most instances, the human hearing system determines the character of the sound from about the first twenty milliseconds of sound energy arriving at the ear. All of the other sound arriving after the early sound (i.e., the twenty-millisecond period) is considered to be reverberant sound. Reverberation may or may not contribute to intelligibility and can have a masking effect, in some cases making the sound coming through the loudspeakers extremely difficult to understand.

In general, the lower the ratio of direct, and possibly early sound to reverberant sound, the more difficult it will be to hear clearly. Assuming the sound system is wired correctly and has good quality components, it is the ratio of direct and early sound to the combination of reverberant sound and noise which determines how well the sound system can be understood. (This measurement is analogous to "signal to noise" in most other electronic system measurements.)

### WHAT IS WRONG WITH THE SOUND LEVEL METER MEASUREMENTS?

The reason a sound level meter cannot indicate if sound coverage is adequate in most buildings is that it cannot separate the direct sound energy from the reverberant sound energy in its measurements. The meter simply picks up the total level in the room and registers it--whether it is an unintelligible din or a very clear signal. In other words, the sound level meter cannot measure intelligibility.

In a reverberant building, it is relatively easy to accomplish even coverage of sound -- as registered on a sound level meter. Simply point the loudspeaker toward the ceiling, and all of the energy bouncing from the ceiling to the various surfaces of the building will have a tendency to average out. The SLM will register close to the same reading anywhere on the main floor. However, in most of the seating areas, the reverberant field will be dominant.

Improperly designed sound systems which fail to cover the audience area with direct sound may indicate that the entire audience area is evenly covered on the basis of total sound. When people fill the seating area, they act as absorbers and absorb some of the reverberant sound which was filling in the areas not covered by direct sound. "Dead" areas may begin to appear; people in these areas will complain that they cannot hear.

### THE SOLUTION

A measurement technique which will determine the direct sound coverage is needed. In fact, if the direct sound could be measured, the direct sound-to-reverberant sound ratio could be calculated. The articulation loss of consonants could also be accurately computed for any condition that could exist in the acoustic environment. The performance of sound systems could then be accurately measured in a meaningful way.

Having a technique which would make it possible to measure direct sound would also allow architects and engineers to specify the articulation loss for consonants and the evenness of direct sound coverage. Also, a method of measuring the coverage could be specified. This would protect the buyer of a sound system from getting a sound system that does not do the job properly.

Presently, many poor sound systems are installed and there is very little recourse for the buyer. Most contractors claim that the coverage specifications have been met if the SLM shows the total coverage is even. Better techniques for measurement need to be specified or many inadequate sound systems will continue to be installed. It is not only the total level of the sound produced but the ratio of direct-to-reverberant sound produced that needs to be measured.

It was the desire of this writer to develop such a measurement system. There are systems that can measure direct sound but most of them are bulky, expensive or very difficult to work with. It was my goal to produce a piece of test equipment which would give the necessary data in a manner which could be easily used by the sound contractor. I found need for such a device in order to do an effective job of installing and maintaining convention sound systems.

### DEVELOPING THE TEST INSTRUMENT

I took the following approach:

1. Outline exactly what the instrument needed to accomplish.
2. Brainstorm for various design ideas and approaches. (Outside opinions of recognized authorities in the audio field were obtained.)

A NEW SOUND SYSTEM MEASUREMENT TOOL (continued)

3. Acquisition of parts to do the job. (Most of the parts were acquired from surplus material and existing stock.)
4. Breadboard and test circuits.
5. Draw diagrams of the completed circuits.
6. Test final circuit for operation.
7. Package unit.

The entire project flow was very smooth. The only complications were caused by parts acquisition. Delivery time on some of the integrated circuits was excessive. Most of the unit was constructed of common, easy-to-obtain parts. (Some of the design may yet be simplified, to use fewer and more readily available parts.)

HOW IT WORKS

The technique used to separate the direct sound from the reverberant sound is one of time delay measurements. The measurement relies on the fact that it takes time for sound to travel from one point to another and that the shortest distance between two points is a straight line. (This relationship is also used by Richard Heyser in his measurement techniques utilizing a spectrum analyzer.)

The instrument which has been constructed has four main sections: an automatic send section, a timing section, an automatic-receive section, and a memory section.

The send-section is adjustable to send 24 different pulses into a room through the sound system which is being tested. The pulses can be sine wave pulses, one-third octave bands of pink noise, or any 24 external sources. The unit processes all sources so that there is zero cross switching.

The length of time of the pulse is adjustable and the time between the pulses is adjustable. (The unit will not allow any pulse length less than one full cycle to be emitted.) In other words, the analyzer can put out a pulse of 100 hertz, wait for the programmed length of time; and then put out a pulse of 125 hertz, and wait for the programmed length of time; and then put out the next pulse in the sequence. The sequence is continued until 24 *different* pulses are automatically sent through the sound system. The time adjustment between the pulses is adjusted to allow the first pulse to decay far enough to avoid interfering with the reading when the second pulse is received. If the room is quite reverberant, the time between pulses will need to be longer than if the room has a short reverberation time.

After the first pulse is sent, an adjustable time delay turns on the receive section. Normally, this time delay would be adjusted to equal the time required for the sound to travel from the loudspeaker system to the measurement microphone location. (The measurement microphone is connected to the receiver section.)

This time delay can be calculated--the speed of sound at 72.5'F is 1130 ft/sec.; if the receiving microphone is 113 feet away from the loudspeaker system, the time delay would be 113 feet divided by 1130 ft/sec., which equals one-tenth of a second. Therefore, in this case, the receive micrphone circuit would be turned on one-tenth of a second after the first pulse begins. The time the receive circuit remains on is adjustable (1.25 ms to 40 ms); but if direct sound is being measured, the receive section would be turned on for 20 milliseconds or less. The receive section remains turned off until one-tenth second after the beginning of the second pulse. Therefore, only the direct sound is admitted; all other sounds occurring during the time period the receive section is turned off are not allowed to enter into the measurements (i.e., the reverberant sound field will not be measured.)

The receive section then determines the r.m.s. value of the signal and this value is stored in the memory. This process is repeated for the following 23 pulses. After all 24 pulses are received, the test instrument is switched to "read," and the acquired data is displayed on any standard oscilloscope. This data is displayed as a frequency response graph in decibels.

The unit contains two separate memories so that two graphs are displayed. One trace may be retained in memory so that subsequent tests may be compared to it if desired. A Polaroid camera can be used to take a picture of this graph if a permanent record is desired.

The receive microphone can be moved to another location, the new time delay time can be adjusted, and with the flip of a switch, the frequency response at the new location will be automatically graphed.

This test instrument can also be used to determine the polar response of loudspeakers and the frequency response of loudspeakers without the use of an anechoic chamber. Very few sound contractors have access to anechoic facilities, and the anechoic chambers are usually only large enough for high frequency testing. By using the new test instrument, it is possible to make accurate low-frequency tests as well as tests farther from the source of sound than can be made in an anechoic chamber.

When using the test instrument for anechoic measurement, care must be taken to make sure no reflections are included in the measurements. The length of time the receive section is turned on must be short enough to prevent this. As an example, if the time the receive section is turned on is 40 milliseconds, the distance sound can travel in 40 milliseconds is 72.5F is 0.04 ms. times 1130 ft/sec.--or 45.2 ft.

To prevent reflections from interfering in this case, the path between the loudspeaker and the receiving microphone must have no object which would cause sound to be reflected with a path distance of 45.2 feet or less. (The boundaries are an ellipse with the foci located at the microphone location and the loudspeaker location. The boundary of the ellipse is the locus of points, the sum of whose distance from two fixed points--the microphone location and the loudspeaker location--is constant. This constant is the distance sound can travel during the time the receive gate is turned on.)

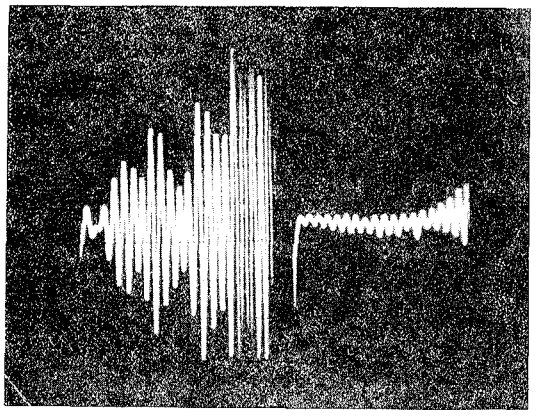
This test instrument should prove extremely useful in the field of sound reinforcement. It is hoped that similar instruments will be used by most sound contractors and that as a result, sound system quality will be improved.

## "RINGING" OUT A STAGE MONITOR

Graduates of the Columbus, Ohio class, 1976. had a very interesting demonstration of how to "wring" or "ring" out a stage monitor by Fred Schultz of Concert Audio in Nashville, Tenn. and Link Summers of Audio Analysts. Fred adjusted a filter set by ear while Link generated an impulse sound by using the resonant cavity in his mouth.

Fred Schultz again demonstrated this unique technique to our Nashville 1976 class at our request and we were able to photograph the impulse he creates on the oscilloscope. The total impulse is around 50 msec.

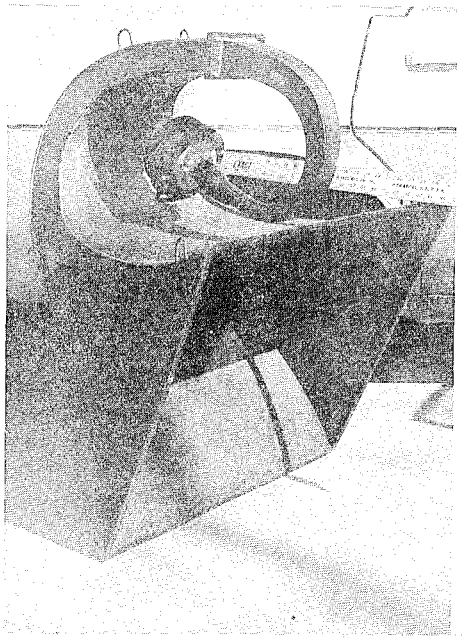
We need this duplicated acoustically from a loudspeaker of 2" or less.

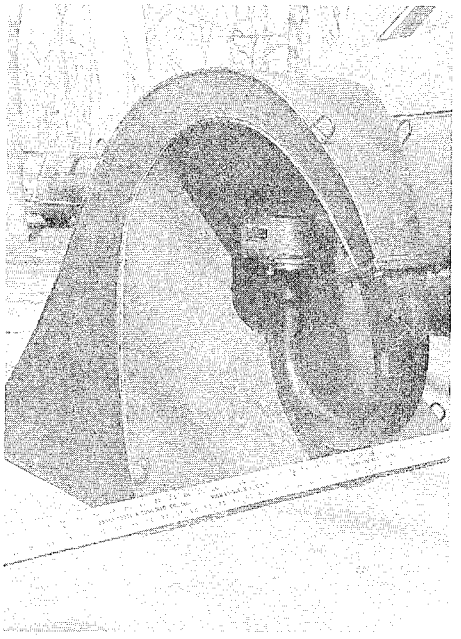


As Link Summers worked his way carefully around the windscreen of the microphone with his lips against it, remarkably narrow areas of instability in the polar response appeared.

## W.E. THEATRE HORN & DRIVER

In the last Newsletter, Volume 4, no. 1, Page 3, we showed an early W.E. horn and driver for use as a monitor, courtesy of Ted Uzzle of Cinephone in Cambridge. We mentioned that there was a larger horn for use in the theater itself. Here is an example of the larger unit that was removed from a New Jersey theater by Bernard (Bob) Martin of Central Jersey Sound (New York class 1976)





## THE FAILS MANAGEMENT INSTITUTE

The Fails Management Institute conducts seminars for people in the contracting business. We have not attended one, but have subscribed to some of their publications, and we have heard from people who have attended their seminars that their "Pricing and Bidding Strategy" Seminar is especially useful. It is a two-day held in different locations around the country. If you are interested you can write: The Fails Management Institute, 625 Oberlin Rd., P O Box 10956, Raleigh, North Carolina 27605.

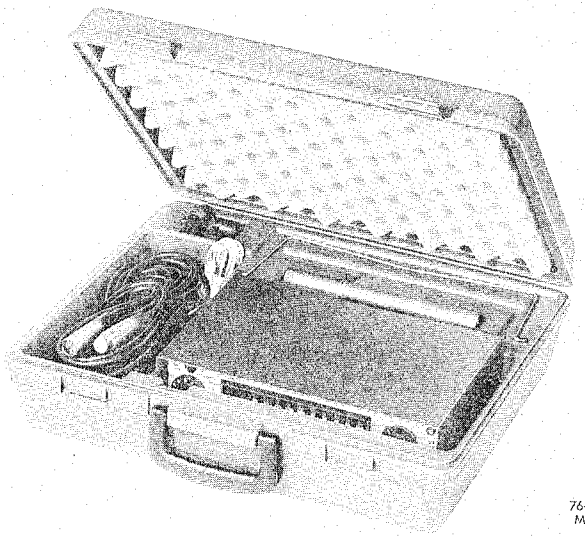
In one of their recent publications they listed the 9 reasons why small businesses fail: (1) Slipshod accounting, (2) Failure to diversify, (3) Investing too much in fixed assets, (4) Too many relatives on the payroll, (5) False confidence, leading to expansion without regard to market limitations, (6) Extending credit without sufficient checking, (7) Failure to detect and shift with changes in the marketplace, (8) Neglecting tax considerations, (9) Lack of an organized marketing plan.

# SPONSOR TOUR

We took the opportunity during our Fall Tour of classes to visit our Sponsors in the Middle West and East.

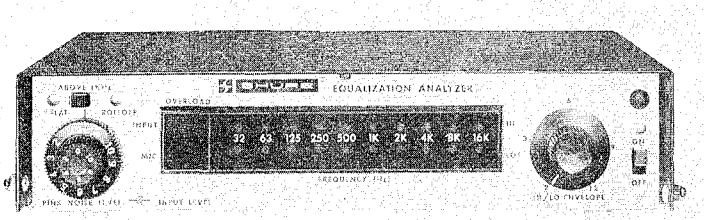
## SHURE BROTHERS INC.

When we stopped in Chicago area to visit with Shure Brothers Inc in September we were presented with their new octave equalizers and their remarkable new analyzer kit, the M615AS. We have now had four months experience with this new analyzer and feel that the combination of it and the Shure equalizers provide a most useful training package for those without previous experience with sophisticated (and expensive) test equipment, which makes it an



76-38-12
M615AS

Photo # 1



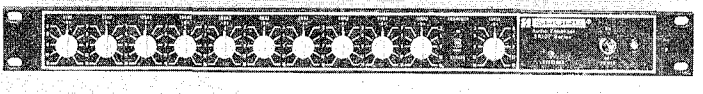

76-38-13
M615

Photo # 2

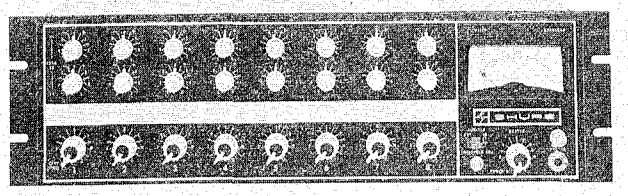
outstanding sales tool.

We now have better photographs of these new products. See Photos 1, 2 and 3.

The Shure SR series has very rapidly established itself as a top professional line of audio equipment. Further enhancement of their reputation will be achieved as users discover the really clean simplicity coupled with functional features of use to a majority of potential operators of the equipment that they have included intotheir new SR 109 mixer and M677 add-on mixer. See photos 4 and 5.



For those everyday, highly profitable, re-engineering of existing systems, the SR series is outstanding. We have found the units extremely rugged as well.



76-38-10
SR 107

Photo # 3

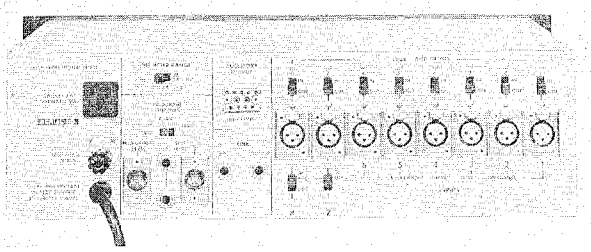


Photo # 4

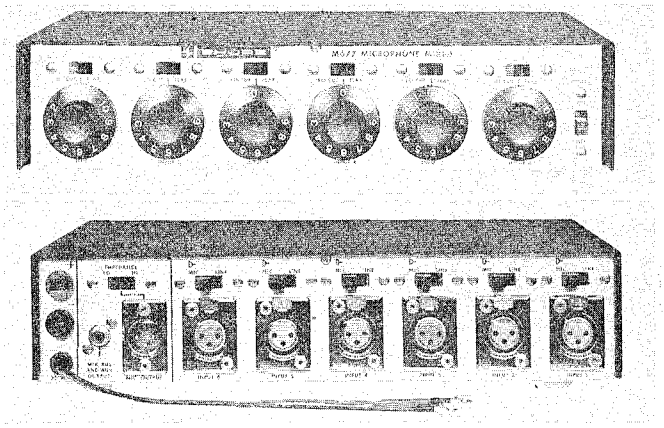


Photo # 5

SPONSOR TOUR (continued)

## DAVID CLARK CO.

Walt Knowles, Product Sales Manager for Communications equipment, and Byron Roscoe, Chief Engineer, joined our Boston class. After the class we visited the David Clark Co. plant in Worcester, MA.

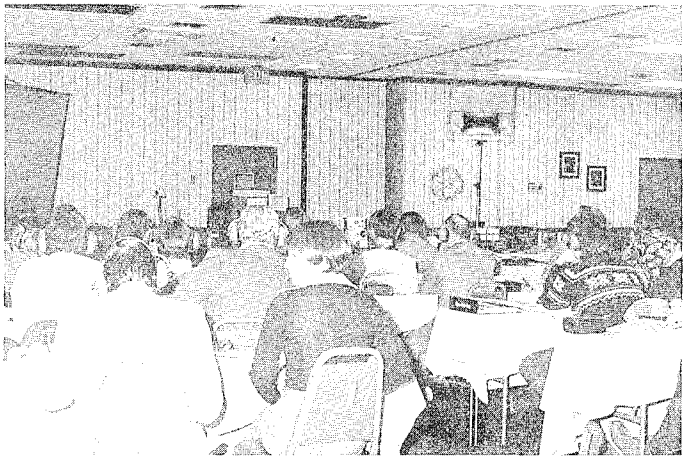
David Clark is the manufacturer of the first ear protectors, designed for the Navy after a visit by David Clark to the aircraft carrier, Franklin D. Roosevelt. The Captain of the ship asked David Clark, then a manufacturer of clothing, if there wasn't something he could do to protect the ears from the brutal assault on the ears by the firing of the heavy guns. And that is when David Clark Co. became a manufacturer of hearing protectors.

We were intrigued by their space suits that they build for the Astronauts and had the opportunity to watch a session where one of the suits was donned for laboratory check. Certainly one of the most interesting factory tours we have had.

David Clark has supplied us with one of their new noise cancelling intercom sets for use during the microphone testing session in class. (This is a still newer version than the one we used during the 1976 classes.) We will be reporting further on these extremely well thought out units in a future Newsletter.

In addition to the noise cancelling intercom sets, The David Clark Co. has provided us with 39 sets of ear protectors for use in the classes during testing sessions .

Starting a young man early to think about protecting his hearing.



It concerned us that Susan Sherry didn't wear her ear defenders during the testing session. We thought maybe she had a hearing loss already. Not so, her audiometer test showed that she had perfect hearing!

We had a chance this summer at the farm in Indiana to actively test the defenders while shooting John Odum's (San Francisco 1975, Nashville 1976) very accurate Model 29 S&W .44 magnum and an exceptionally smooth S&W Model 66 in .357 magnum that John owns. The very large David Clark Model 19A ear protectors are easily the most effective protectors we have encountered.

SPONSOR TOUR (continued)

## WEST PENN WIRE CORP.

While we were in D.C. for our class, Steve Slye, a two-time graduate of Syn-Aud-Con, invited us to visit their very impressive new facility in Arlington. As Steve and his dad, Bob Slye, an early graduate of Syn-Aud-Con, gave us the tour I saw rolls and rolls of West Penn Wire on the back lot.

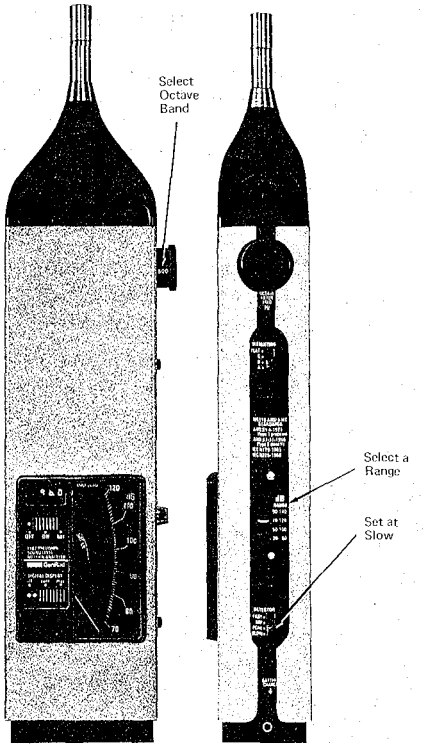
On our way to Chicago from the D.C. class we stopped at West Penn Wire in Washington, PA. Don Hastings was heavily involved in the construction of their new plant facilities.

Large quantities of basic materials back up the modern heavy equipment for fabricating communication type wire products. It is of interest to discover that something we take relatively for granted are highly involved tasks requiring skills not readily available. West Penn Wire demonstrates real capability and capacity to fulfill professional audio cable requirements.

To my knowledge, West Penn Wire is the only manufacturer of wire and cable for the audio-video business.

SPONSOR TOUR (continued)

## GENRAD




In October just before our Boston class we made our annual visit to the General Radio plant at Bolton, Mass. I always come away from this visit with respect for the wealth of engineering and scientific knowledge generated and shared by instrumentation and measurement specialists.

GenRad in particular has been the primary influence in the United States towards improved acoustical measurements and, in the course of pursuing this goal, they have led the way in how to understand the basics of our business.

During the course of the visit I had the chance to walk through the audiometric instrument department and discover just a little of the unbelievable complexity available to researchers in hearing.

Best news from GenRad is the announcement of the precision sound level meter at approximately $1300 instead of the over $2000 of recent years. The Model GR 1982 precision sound level meter and analyzer becomes available this month.

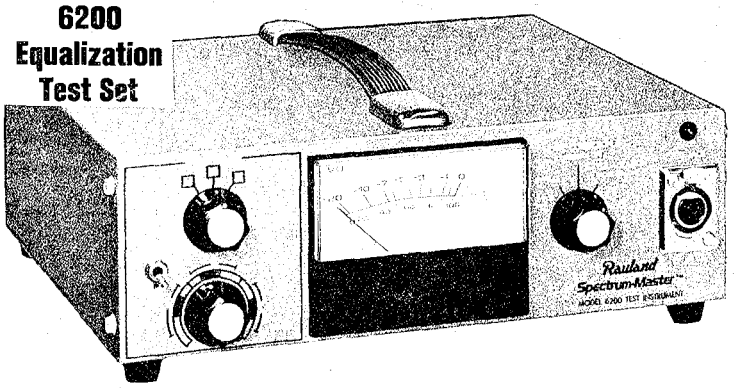
SPONSOR TOUR (continued)

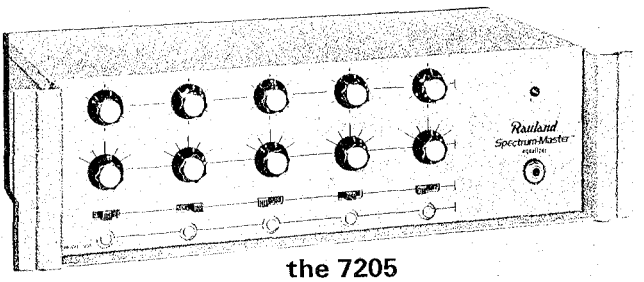
## RAULAND-BORG CORP.

Carolyn and I are particularly interested in the early history of the audio industry. It was with a great deal of pleasure, therefore, that we were guests at the very successful Rauland distributor meeting in November 1976.

E. Norman Rauland, who died in 1975, was an acknowledged pioneer in the communications part of the audio industry as well as a remarkably successful developer of superior television picture tubes after WW II. Harro Heinz, President of Rauland and a Syn-Aud-Con graduate of the Boston 1976 class, related some of the early background of Mr. Rauland to us, including his formative participation in the development of the first radar scope tubes in the late 1930s. Mr. Rauland apparently remained far in advance of his contemporaries as it was his insistence to continue costly experimentation which has given Rauland such a remarkable technological lead over their competitors in Telecom and Intercom equipment via digital techniques.

Rauland has developed several fascinating tools for room-sound system equalization which were demonstrated at this meeting (approximately 400 attendees -- many, many Syn-Aud-Con friends there) including a tuning compressor that holds a feedback mode steady without requiring an operator to carefully "ride" the gain control and a unique 5 tunable notch filter set that operates as an audio oscillator when the filter button is pushed, allowing an accurate zero beat with the feedback tone, and then it reverts to a notch filter when the filter button is released.




the 7205
TUNABLE NOTCH FILTER

Another indication of the serious intent the Rauland Company has towards their entry and progress into professional sound reinforcement systems is their OEM agreement with Emilar. An entire new line of professional performance loudspeakers were introduced at this meeting.

We came away from the meeting impressed with the quality of distributor that Rauland already has, the support they give them, and the uniformly high quality of Rauland people present at the meeting.

SPONSOR TOUR (continued)

## CROWN INTERNATIONAL

We had the opportunity to visit the Crown factory several times during the Fall tour. Of the audio manufacturers we have visited, Crown International is the most computer conscious. They have two of the large floppy disc Wang computers, one for the engineering department and one for marketing and accounting. And there is heavy involvement in programming.

Crown International is a "family" of 300-400 people. One wall of their assembly is devoted to a bulletin board with a color photograph of each person by department with their name and a few personal details, so that one can study pictures and names and know everyone in the plant if one desires - and most Crown people do.

We held a special class for Crown with forty people attending, twenty were factory personnel from the Crown plant and twenty were their representatives from various parts of the U.S.

This was a very enjoyable class that gave us a chance to become better acquainted with a most interesting company and to participate in a sharing between Crown, Syn-Aud-Con and Crown's representatives. During the class we had the opportunity to test Crown's new one-half octave band equalizer. This unit has unusually low noise and distortion. It also includes an excellent idea in tone controls that have variable "hinge" frequencies, thus allowing really useful merging of the equalizer adjustments with the tone controls. The equalizer filters are themselves frequency adjustable rather than contiguous.

The class resulted in much synergetic input and gives us a source of electronic engineering expertise from Chief Engineer, Gerald Stanley and his engineering department, that should lead to many interesting new Tech Topics.

## EMILAR

Arriving back in California we had an early occasion to visit with Manny Mohageri, President of Emilar. They have moved into a new plant. Emilar's new address is: 2837 Coronado St., Anaheim, CA 92806. Phone 714-632-8500. The plant is considerably larger and their sales are BOOMING.

Emilar is to be congratulated for solving the initial difficulties that attend bringing a compression driver onto the marketplace - before putting it on the market; something that is rarely done today but is indicative of the diversity of talents within the Emilar organization.

Syn-Aud-Con graduates tell us that Emilar easily has the best compression driver available on today's market; that is, it is the best compromise between efficiency, power handling and frequency response. It is widely believed that the Emilar driver has the lowest distortion of any available compression driver.

SPONSOR TOUR (continued in the April Newsletter)

We will report on UREI and Sunn Musical Equipment Co. and a new sponsor in our next Newsletter.

Our experience with the UREI Model 200 Level Recorder during 1976 and especially with their warble tone generator is that this is one of the most powerful new tools available to the professional sound engineer in over a decade. We hope to report further on this in our next Newsletter.

Sunn Musical Equipment Co. indicates that they are bringing out a number of new products keyed to the professional sound field. We will be visiting them during our February-March trip to the Northwest.


SUNNBURST

SUNNBURST/A PUBLICATION OF SUNN MUSICAL EQUIPMENT CO. A HARTZELL CORPORATION COMPANY. AMBURN INDUSTRIAL PARK/TUALATIN • OREGON 97062 ISSUE 3 FALL 1976

**Ushering In a New Era of Musical Sound**

With the advent of Sunn's Automated Sound — Generation II, a new era begins for the contemporary musician. The first step, in the mid-1960's, was getting the P.A. system accepted as the most important investment a band could make in its musical future. But along with this acceptance came the attendant problems of sophisticated electronics and high-powered amplification.

Ten years of experience and research at Sunn has enabled us to build-in features that not only solve the typical problems of sound reinforcement that occur in the realm of electronics, but also aid the musician practically — in operation. The term for it is 'human engineering'.

The features of the Sunn-Sensor graphic equalizer, and Auto-Match and Phase-Sync circuitry offer benefits that transcend their technical assets. They combine to help eliminate the stumbling blocks that have prevented musicians from achieving the best performances they are capable of.

We're thankful that we've been capable of solving these problems for the musician with products that reflect sensitivity, awareness, and expertise. And we're especially thankful to all our dealers and customers who took the time to help us make these developments possible.






SUNNBURST

PERSONAL SUBSCRIPTION ORDER BLANK

NAME _____

ADDRESS _____

CITY _____

STATE _____ ZIP _____

Check ONE only

☐ SALESMAN STORE _____

☐ MUSICIAN INSTRUMENT _____

☐ OTHER SPECIFY _____

*Cut out and mail to:* SUNNBURST
c/o Gaer & Associates
22420 Sentar Road
Woodland Hills, CA 91364

Sunn, an early and continuing Syn-Aud-Con sponsor issues an interesting periodical called "Sunburst". Those wishing to subscribe can supply the data requested in the form reproduced above and send to the Woodland Hills address.

## MAGAZINES USEFUL TO THE AUDIO PROFESSIONAL

SUBSCRIPTIONS THAT ARE "MAILED FREE TO QUALIFIED RECIPIENTS IN THE U.S.":

BROADCAST ENGINEERING
Interic Publishing Corp
1014 Wyandotte St.
Kansas City, MO 64105

BROADCAST MANAGEMENT/ENGINEERING
274 Madison Ave
New York, New York 10016

BRUEL AND KJAER
"TECHNICAL REVIEW"
5111 W. 164th St.
Cleveland, Ohio 44142

GR TODAY
GenRad
300 Baker St.
Concord, MA 01742

RECORDING ENGINEER/PRODUCER
1850 Whitley, Suite 220
P O Box 2449
Hollywood, CA 90028

SOUND AND VIBRATION
Acoustical Publications, Inc.
27101 E. Oviatt Rd.
Bay Village, Ohio 44140

STUDIO SOUND
& BROADCAST ENGINEERING
Link House
Dingwall Ave
Croydon CR9 2TA, ENGLAND

TEST
Engineering & Management
61 Monmouth Rd.
Oakhurst, New Jersey 07755

PAID SUBSCRIPTIONS

AUDIO
401 No. Broad St.
Philadelphia, PA 19108
$7/year

db
The Sound Engineering Magazine
1120 Old Country Rd.
Plainview, NY 11803
$6/year

ELECTRONICS
1221 Ave. of the Americas
New York, NY 10020
$12/year

MODERN RECORDING
15 Columbus Circle
New York, NY 10023
$7.50/year

SOUND & COMMUNICATIONS
150 E. 37th St.
New York, NY 10016
$12/year

AUDIO SOCIETY PUBLICATIONS

JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA
American Institute of Physics
335 E. 45th St.
New York, New York 10017
Must be a memeber - $35.00/year

JOURNAL OF THE AUDIO ENGINEERING SOCIETY
60 East 42nd St.
New York, NY 10017
Must be a member = $20/year

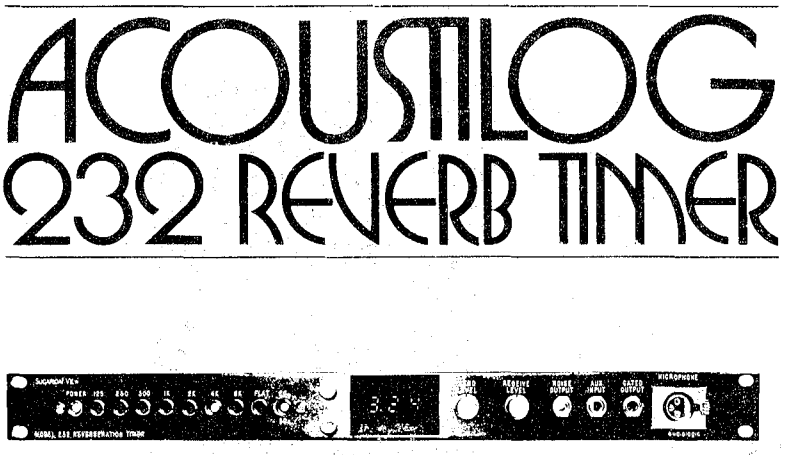
## TWO NEW PRODUCTS BY GRADUATES

We have included in this mailing of the Newsletter, data sheets on two products designed and marketed by Syn-Aud-Con graduates. Both products were demonstrated at our New York 1976 class and we felt that the conception, design and construction was above average and both products fill a definite need in the marketplace:

Steve Schlaff and Mario Maltese, both three time graduates of the New York class, were involved in the design of the NORCON TALK-THRU COMMUNICATOR.


Write Steve Schlaff, Norcon Electronics, Inc.
1260 Ralph Ave, Brooklyn, New York 11236.
Phone 212-451-1112 for further information.
Cost. Approximately $400 less 25% to dealers.

Alan Feierstein's, Acoustilog Model 232 Reverb Timer, was written up in detail in Newsletter, Volume 4, No. 1. Since then Al sent us his new literature to be included in this mailing, and says that the response to his new meter has made him very pleased.




Write Al Feierstein, 19 Mercer St., New York, New York 10013. Phone 212-925-1365

# SEMINARS BY SYN-AUD-CON GRADUATES

This Fall we heard from several Syn-Aud-Con graduates who were planning or had just participated in a seminar to inform the end-user of professional audio equipment. We would like to encourage this activity and are reproducing letters from two graduates who sent in their experience with "seminars" to give you ideas.

From Howard Parker, Sound Investments, Thousand Oaks, CA (Los Angeles class 1976) reporting on his "Church Musician's Audio Seminar". We don't have space to reproduce the excellent "announcement" of the seminar that Howard mailed to 2200 names, but we have reproduced for you the envelope (color: goldenrod) and his report.

*Sound Investment Enterprises*

POST OFFICE BOX 1812 • THOUSAND OAKS, CALIFORNIA 91360 • (303) 233-9300

December 28, 1976

Carolyn Davis
Synergetic Audio Concepts
P.O.Box 1134
Tustin, CA 92680

Dear Carolyn:

Thank you for the letter asking about the results of our Seminar last month.

The concept behind the CHURCH MUSICIAN'S AUDIO SEMINAR was to provide a non-technical training seminar on sound for those in the church community who have a desire to become more knowledgeable about sound systems, their components, and how to properly use and operate them.

The date of November 6, 1976 was set and the location was Magnolia Avenue Baptist Church in Riverside, CA. Our main focus was to the church technician and church musician since that is our main market and interest. From our mailing list we pulled 2200 names that covered California, Arizona, and Nevada.

To our amazement, instead of the 50-60 that we had hoped to draw, we had 175 register...it blew our minds. The registration fee of $20.00 per person allowed us to provide a CHURCH MUSICIAN'S AUDIO SEMINAR Notebook, 20 pages of printed lecture outline, a notepad, a Glossary of Terms, and a Certificate of Achievement for completing the days activities to each person attending.

Those who registered were basically Pastors, Music Directors, soloists, Evangelists, students, laymen, and church sound technicians. And they flew or drove in from Northern to Southern California, Arizona, and Nevada.

SOUND INVESTMENT ENTERPRISES
POST OFFICE BOX 1812 • THOUSAND OAKS, CALIFORNIA 91360

ALWAYS USE ZIP CODE

Don & Carolyn Davis
P.O.Box 1134
Tustin, CA 92680

**AUDIO SEMINAR**
**TO BE HELD SOON**

Address correction requested

We started at 9:00 AM Saturday morning and ended at 9:00 PM that night. The lecture and demonstration sessions covered such subjects as miking techniques, proper speaker placement, how to match components, what to look for when selecting your sound system, controlling feedback, terminology, and methods of soldering and repairing cables.

A local musical group from Riverside's California Baptist College provided us an example of good techniques of microphone use and set up of equipment.

I had requested product literature from quite a few equipment manufacturers. Most every company responded: AKAI, AKG, BOSE, CROWN, EDCOR, ELECTRO-VOICE, FRAZIER, JBL, PHASE-LINEAR, REVOX, SHURE, SWTICHCRAFT, TAPCO, and TOA. (At ALTEC, Dick Forbes' secretary told me bluntly he just was not interested--which hurt my pride a little)

Two young men have said that they have been hired by their churches as sound men as a result of the Seminar. Others have told about returning to their churches and correcting situations that have been a problem for months or years.

Now we are making final arrangements for taking this Seminar to other cities. In Mid-March we will be in Denver, May in Tulsa, and July in San Francisco.

Thank you for the help I received at Syn-Aud-Con last March. I am looking forward to attending again this year. Don has so much information to give and yet it will take me a few sessions to take it all in and then be able to put it into practice.

Sincerely,

Howard Parker, President
Sound Investment Enterprises

Randy Gawtry, Electronic Design Co,, St. Paul (Minneapolis class 1975) participated in the organization of a seminar sponsored by the Upper Midwest Chapter of the Acoustical Society of America. (Sam Bridges, of Electronic Design -- 3-time graduate -- gave a paper among very august company.)

Randy writes: The Upper Midwest Chapter of the Acoustical Society of America has adopted the practice of conducting an annual seminar on some aspect of acoustics. The 1976 topic was "Room Acoustics - Emphasizing Speech Communications and Noise Control". The seminar was aimed at architects and engineers with the intent of initiating them into the art and science of acoustics and speech communications.

The program consisted of lectures followed by demonstrations at the end of the day. The lecturers were selected from both inside and outside the local chapter of the acoustical society and represents a wealth of experience and knowledge in acoustics. Specific demonstrations included a time delay for speech reinforcement and a working noise masking system with real time analyzer display, as well as the various test instruments used in the in-test labs reverberant chambers for acoustical building material tests.

Seventeen architects, engineers and acoustical material sales people paid $55.00 each to attend the seminar, and all gave favorable written comments on the presentation. The UMCASA members felt the program was quite successful and plan to continue these seminars on an annual basis.

Invitation and Program reproduced on the next page.

SEMINARS BY SYN-AUD-CON GRADUATES, (continued)

THE UPPER MIDWEST CHAPTER OF THE ACOUSTICAL SOCIETY OF AMERICA

AN INVITATION

from

The Upper Midwest Chapter of the Acoustical Society of America

to

Architects and Engineers

to attend a seminar on

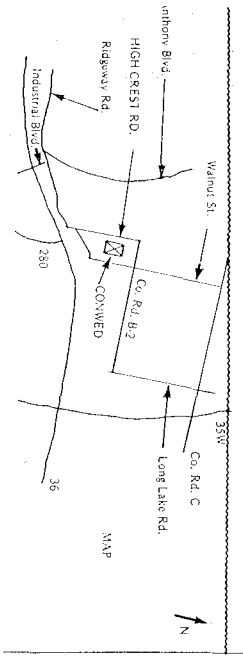
ROOM ACOUSTICS – EMPHASIZING SPEECH COMMUNICATIONS AND NOISE CONTROL

Thursday, September 23, 1976

at Intest Labs, Inc., Conwed Building, 2200 High Crest Road, Roseville, MN

PROGRAM

| | |
|---|---|
| 8:00 | Registration |
| 8:30 | Real World Acoustical Problems<br>Mr. William Siekman,<br>formerly manager of Riverbank Acoustical Laboratories |
| 9:15 | Basic Principles of Sound<br>Dr. Richard Van Doeren<br>Midwest Acoustics & Electronics, Inc. |
| 10:00 | Development of Room Design Criteria<br>Dr. Robert F. Lambert<br>Institute of Technology, University of Minnesota |
| 10:45 | Break: coffee, rolls |
| 11:15 | Room Acoustic Design Principles and Examples<br>Mr. Ian A. Morton<br>Acoustic consultant |
| 12:00 | Speech Communication Design Principles<br>Mr. Sam Bridges<br>Electronic Design Company |
| 1:00 | Lunch<br>Instructor at each table for informal discussion |
| 2:00 | Noise Control Principles<br>Dr. Robert Plunkett<br>Department of Aeronautical Engineering & Mechanics<br>University of Minnesota |
| 3:00 | Overview of test methods<br>Tour of INTEST Laboratory |




Acoustical Society of America, U M C
8015 Jonellen Lane,
Minneapolis, MN 55427

THE SEMINAR –

Room Acoustics, Emphasizing Speech Communication and Noise Control

What will it do for you?

For those of you involved in the design, modification or management of offices, schools, industrial plants – any building with rooms that must function for humans – the seminar is designed to help you become:

- acquainted with the principle of acoustical design of rooms.
- aware of potential problems and general approaches to good acoustic design.
- knowledgeable of the language of acoustics and how to specify for projects.

This program will consist of classroom teaching plus audible creation and illustration in the classroom of many of the phenomena and principles being discussed.

CERTIFICATES AWARDED

HANDOUT MATERIALS

*The purpose of the Upper Midwest Chapter of the Acoustical Society of America is to provide a forum for examining and discussing all aspects of acoustics.*

REGISTRATION FORM

Name _____

Firm _____

Address _____

City _____ State _____

Telephone _____

Mail with check to:

Mr. R. P. Anthony
4813 France Ave., N.
Minneapolis, MN 55429
(612)/533-8631

- Seminar cost, $55.00
- Full refund if your cancellation is received before Sept. 15th. Partial refund between Sept. 16th and 22nd.
- Make check payable to Upper Midwest Chapter, ASA
- Enrollment limited to 40
- Application must be received by September 16, 1976

## HARDWARE "COOKBOOK"

Tom Walton, The Guitar Works, Santa Cruz (San Francisco class 1976) called for a Syn-Aud-Con Hardware "Cookbook" to help those who are new to the professional sound industry. Tom recognizes that it takes years to gather information on "where to" and "how to" that makes a business efficient and profitable.

Tom sent the following names and products for the "cookbook":

Multi-pin connectors and tools

Amp Special Industries
(offices in many large cities)

In Calif.:
Interland Executive Park
3000 Clearview Way
San Mateo, CA 94 402
(415) 573-7722

1840 Wilmington Ave
Compton, CA 90220
(213) 639-1691

Tools and Connectors (some hard to find)

Marshall Industries
9674 Telstar Ave
El Monte, CA 91731

Wire, Cable, and Snakes

California Switch & Signal
Pro-Sound Div.
13717 S. Normandy
Gardena, CA 90249
213/770-2330

Metal Racks, Frames and Enclosures

Home Inc.
500 W. Ninth St.
Hermann, MO 65041
314-486-3111

Hardware (corners, latches, etc.)

J. H. Sessions
Riverside Ave
Bristol, Conn. 06010
203-582-3127

-more-

HARDWARE "COOKBOOK" (continued)

Ken Stoltenberg, Electronic Engineering Services in Rochester, Minn (Minneapolis class 1973 and 1975) sent in the following:

Caddy flange clamp (handy for hanging small speakers, holding cable, etc. One hit with a hammer puts them in place, they hold well.)

ERICO Products, Inc.
34600 Solon Rd.
Cleveland (Sodon)
Ohio 44139

Rivnuts/Plusnuts (Used for rapidly putting threads in blind hole. Waterproof version available.)

B. F. Goodrich Engineered Systems Co.
500 S. Main St.
Akron, Ohio 44318
(They will advise nearest distributor)

Miscellaneous (They have catalog of over 1600 pages and sell everything from bathroom "furniture" to Titanium bar stock)

McMaster-Carr Supply Co.
P O Box 4355
Chicago, Illinois 60680

Please send in your names and addresses of places to locate hard-to-find products and we will share them via the Newsletter.

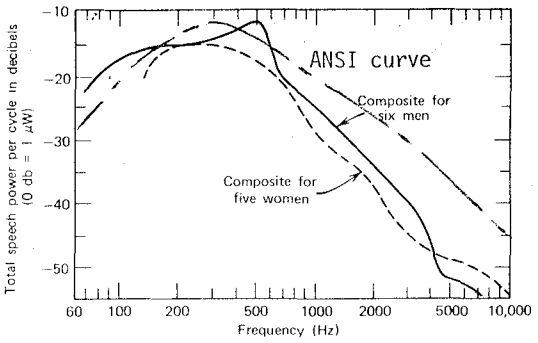
## SPEECH POWER AND ARTICULATION

There are two primary acoustic frequency response parameters of speech that require consideration by the sound system engineer. The first is the speech power as a function of frequency. Figure 1 shows the typical distribution on a per cycle basis over the range 60 Hz to 10,000 Hz for both men and women, and the ANSI curve (the third spectrum available from the GR 1382 RNG) is included for reference.

It is the spectrum shape that is of importance here as it gives an excellent idea of which frequencies will most likely receive the greatest power demands and the differences likely between one frequency and another in dB.

The second parameter is the relative contribution to intelligibility of each 1/3-octave band expressed as a percent of contribution to the articulation index. Adding the percent contribution of each of the bands shown between 200 Hz and 4000 Hz equals 91.5% of the total contribution with the largest percentage, by far, 11% contribution in the 1/3-octave band centered on 2000 Hz. It can easily be seen why the telephone with its limited response works so well as do small radios with well-designed 4-8" loudspeakers covering the range of 125 to 5000 Hz.

It is of much greater importance to provide very smooth frequency response rather than extended frequency response and to control or eliminate specific non-linearities in transducers that give use to resonances, distortions and other forms of coloration. When comparing a wide range High Fidelity music system to a table-model radio, few realize how little difference the increased frequency response makes as compared to the differences in smoothness of response through the very critical area from 250 Hz to 5000 Hz.




Relative speech power as a function of frequency, for men and women. (From H. K. Dunn and S. D. White, *J. Acoust. Soc. Am.*, 11, 278 (1940)

Figure 1.

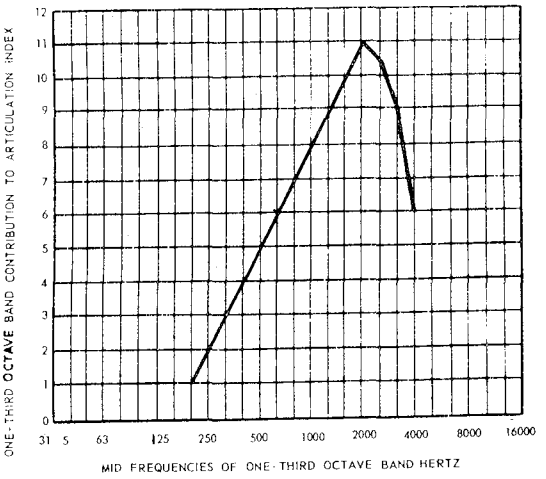



Figure 2. Variation of articulation index contribution with speech components in one-third octaves.

Finally, one glance at Figure 2 confirms why we say in class that if you can have the Q, $RT_{60}$, or sabins at only one frequency, that one frequency should be the octave or 1/3-octave band centered on 2000 Hz.

## D. B. KEELE'S EFFICIENCY EQUATION

Don Keele, while an engineer at Electro-Voice (now at Klipsch and Associates) published an interesting efficiency equation in his recent AES preprint, No. 1127(M-1) entitled "An Efficiency Constant Comparison Between Low Frequency Horns and Direct Radiators."

Don's formula assumes the following:

1. The loudspeaker system receives an input signal of 4 volts RMS
2. That the *minimum* impedance in the bandpass is known. (The CCIA method can solve this easily.)
3. That the directivity factor Q is known for the frequency of interest.
4. That the SPL measurement is made on the same axis as the Q measurement and is taken at 10' (3.05 m)

All of these parameters are not difficult to obtain with reasonably accuracy in the field.

The electrical to acoustical power conversion efficiency then becomes:

$$\% \text{ Effic.} = 7.0 \times 10^{-10}\left(\frac{R_{min}}{Q}\right)\left\{10^{\left(\frac{SPL}{10}\right)}\right\}$$

Where: $R_{min}$ is the lowest impedance in the bandpass of interest
Q is the directivity factor for the frequency of interest
SPL is the on-axis 10'SPL

Example

4V across 16Ω = 1 watt; therefore, in order to compare Keele's method with the Equation 5-41 in *Sound System Engineering* Page 85, we would need to assume, for the comparison, 16Ω because our equation required 1 watt of electrical input power to obtain the measured SPL

$$\underset{SSE}{\text{Eq 5-42}} \ \%\text{Effic.} = 10^{\left(\frac{89 - (10 \log 3) + 107.47}{10}\right)} \times 100 = 0.47\%$$

$$\text{Keele} \quad \%\text{Effic.} = 7 \times 10^{-10}\left(\frac{16}{3}\right)\left\{10^{\left(\frac{81^*}{10}\right)}\right\} = 0.47\% \qquad *89 \text{ dB at } 4' + 20 \log\left(\frac{4'}{10'}\right) = 81\text{dB}$$

This paper is of real interest to Syn-Aud-Con graduates as it shows the Qs for typical folded horn woofers vs direct radiator configurations that are helpful in evaluating what to use in a large array.

**********

## DERIVATION OF OHMS LAW FOR AC CURRENTS

In *PRINCIPLES OF ELECTRICITY*, 1953 edition by C. F. Meyers and L. S. Crosby, published by AT&T, two fundamental alternating current (AC) relationships are given. These are:

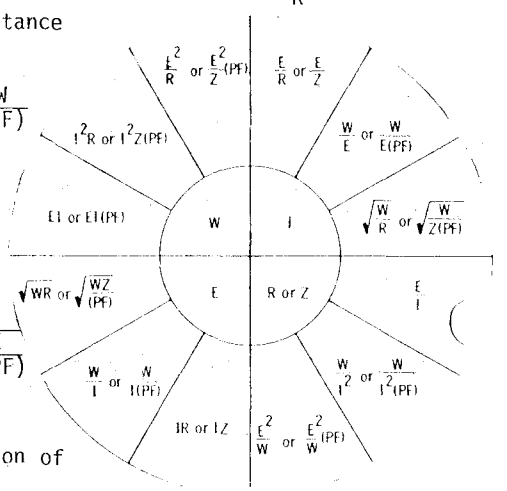
$$W = EI(PF) \text{ and } Z = \frac{E}{I}$$

Where: W is the power in watts
E is the electromotive force in volts
I is the current in amperes
Z is the impedance magnitude in ohms
PF is the power factor (dimensionless)
PF = COS Θ (Θ is the phase angle between E and I). Θ is also equal to $\text{Tan}^{-1}\frac{X}{R}$
Where: X is the total reactance and R is the AC resistance

These two basic equations can be rearranged as follows:

$$W = EI(PF) \qquad Z = \frac{E}{I} \qquad E = \frac{W}{I(PF)}$$

$$E = ZI \qquad I = \frac{W}{E(PF)} \qquad I = \frac{E}{Z}$$




And, by combination of these two sets of equations, we can write:

$$W = E \times \frac{E}{Z}(PF) = \frac{E^2}{Z}(PF)$$

$$W = ZI \times I\,(PF) = I^2Z\,(PF)$$

$$Z = \frac{W}{I^2(PF)} \qquad Z = \frac{E^2(PF)}{W} \qquad E = \sqrt{\frac{WZ}{Z(PF)}}$$

Notes

R = Z cos Θ; X = Z sin Θ; $Z = Z\angle\Theta = R + jX$. Thus, $Z\angle\Theta$ is a complete description of impedance since all constituents can be derived from it.

# FINDING THE PHASE ANGLE FROM AN IMPEDANCE CURVE

In the curve we have measured the total impedance (magnitude) $Z_T$. The AC resistance (ACR) of this tranducer is approximately 8Ω.

At Point (1) the $Z_T$ is composed of the ACR plus an essentially inductive reactance (rising Z with increasing frequency.) At Point (2) the $Z_T$ is composed of the ACR and the motional impedance $Z_M$. Both the ACR and the $Z_M$ are essentially resistive at this frequency because the curve has no slope ($Z_M = Z_{MR} + Z_{MX}$). $Z_{MR}$ = the resistive component and $Z_{MX}$ the reactive component in $Z_M$. At Point (3) the $Z_T$ is composed of the ACR and an essentially capacitive reactance (decreasing Z with increasing frequency). At Point (4) the $Z_T$ is again essentially resistive (no slope). At Point (5) the $Z_T$ again contains an inductive reactance as the Z increases with increasing frequency.

$Z_T = Z_B + Z_M + Z_X$

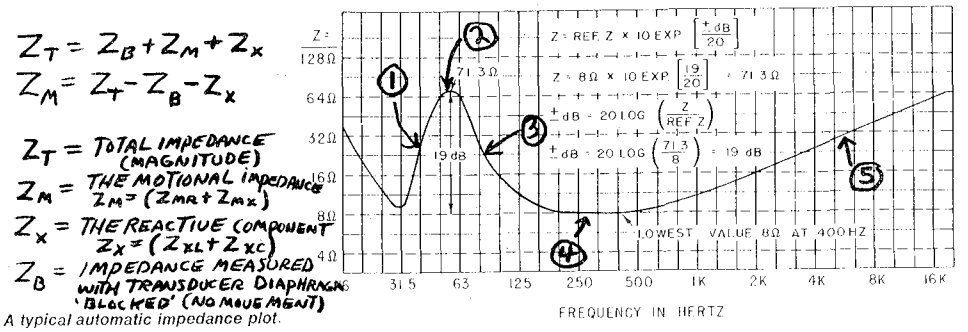
$Z_M = Z_T - Z_B - Z_X$

$Z_T$ = TOTAL IMPEDANCE (MAGNITUDE)

$Z_M$ = THE MOTIONAL IMPEDANCE $Z_M = (Z_{MR} + Z_{MX})$

$Z_X$ = THE REACTIVE COMPONENT $Z_X = (Z_{XL} + Z_{XC})$

$Z_B$ = IMPEDANCE MEASURED WITH TRANSDUCER DIAPHRAGM 'BLOCKED' (NO MOVEMENT)




*A typical automatic impedance plot.*

An Illustration

At Point (5) the $Z_T \simeq 32\Omega$. Knowing that the ACR ≃ 8Ω, we can calculate:

$$X_L = \sqrt{Z_T^2 - R^2} \quad \text{or} \quad X_L = \sqrt{(32)^2 - (8)^2} = 30.98\Omega$$

X in this case is written as $X_L$ because of the rise in Z with increasing frequency at Point (5).

The phase angle θ will then be:

$$\theta = \text{Tan}^{-1}\frac{X}{R} = \text{Tan}^{-1}\left(\frac{30.98}{8}\right) = 75.52^{\circ}$$

And the power factor will be:

$$(PF) = \text{Cos}\ \theta = \text{Cos}\ 75.52^{\circ} = 0.25$$

We can, therefore, describe Point (5) on the impedance curve as follows:

$$Z_T = 32\Omega;\ X_L = 30.98\Omega;\ R = 8\Omega;\ \theta = 75.52^{\circ};\ (PF) = 0.25$$

If we were to assume that this loudspeaker was an 8Ω system (this is the logical value for this unit as a manufacturer normally assigns the lowest value on the curve as the "nominal" Z), we could then calculate for 1 watt into an 8Ω resistor:

$$E = \sqrt{WR} = \sqrt{1(8)} = 2.83V$$

And, when we then substitute the loudspeaker in place of the resistor we would calculate:

$$W = \frac{E^2}{Z}(PF) = \frac{(2.83)^2}{32}(0.25) = 0.06W$$

This would be the maximum power available at the loudspeaker at Point (5) from our test amplifier generating one watt into 8Ω.

Thus we might expect the response to be down 10 log $\frac{0.06}{1}$ = -12.2 dB at this frequency compared to 400 Hz.

# HOW MANY DECADES IN A GIVEN BANDWIDTH?

In an earlier Newsletter (January 1975, Vol. 2, #2 on Page 18) there appeared an incorrect set of equations relative to finding the number of decades in a given bandwidth. The correct form is given below:

$$\frac{H.F.}{L.F.} = 10' = 1 \text{ decade; therefore, } \frac{H.F.}{L.F.} = 10^{(x \text{ decades})}$$

Thus,

$$\ln H.F. - \ln L.F. = \ln 10 \times X \text{ decades}$$

Further,

$$e^{(X \text{ decades} \times \ln 10 + \ln L.F.)} = H.F.$$

and

$$e^{(\ln H.F. - (X \text{ decades} \times \ln 10))} = L.F.$$

Examples

The bandpass 500 to 12,500 Hz contains $\frac{\ln 12{,}500 - \ln 500}{\ln 10} = 1.39794$ decades, or if we had 12,500 as a H.F. limit and and wished to know the low frequency that would give us approximately 1.4 decades, we would calculate

$$e^{\ln 12{,}500 - (1.39794...\text{decades} \ln 10)} = 500 \text{ Hz}$$

If we had the L.F. limit and wished to know the H.F., then

$$e^{(1.39794...\text{decades} \ln 10 + \ln 500)} = 12{,}500 \text{ Hz}$$

## FINDING THE QUALITY FACTOR (Q) OF A FILTER

To find the "quality factor", Q, of a single tuned electrical circuit such as used to equalize sound systems, you may use

$$Q = \frac{\text{resonance frequency } (f_C)}{\text{-3dB bandwidth } (B_{W-3})}$$

Alternatively, you can use the electrical parameters.

For a coil in series with a resistance, $Q = \frac{X_L}{R}$ ; For a capacitor in series with a resistance, $Q = \frac{1}{X_C R}$ ; and

for a capacitor in parallel with a resistance, $Q = X_C R$

Finding a Filter's Bandwidth

This may be accomplished by direct measurement with an oscillator and voltmeter or by calculation where the fractional octave bandwidth is known. For example, one successful combining type band rejection filter approximates a 1/10-octave bandwidth at its -3 dB points. For a filter tuned to 1,000 Hz, the bandwidth in Hz becomes:

$$B_{W-3} \text{ in Hz} = (2^{0.5(1/10)} \times 1000) - (0.5^{0.5(1/10)} \times 1000) = 69.33 \text{ Hz}$$

Therefore this filter's Q would be:

$$Q = \frac{f_C}{B_{W-3}} = \frac{1000}{69.33} = 14.42$$

## THE NEPER UNIT

In Europe, the "neper" is often used in place of the decibel which is familiar in the United States.

$$X \text{ nepers} = 0.5 \ln \frac{P_1}{P_2}$$

Where: nepers is the name of the power ratio expressed as a natural logarithm
ln is the natural logarithm to the base "e" (e=2.71828...)
$P_1$ is the power measured
$P_2$ is the reference power

Therefore, just as we do with the decibel we can find the antilogarithm form when we wish to know the power ratio. If:

0.5 ln (power ratio) = 1 neper

then

power ratio = $e^{1/.5} = 7.38906....$

And for this same "power ratio" we could calculate

10 $\log_{10}$ 7.38906... = 8.686...dB

1 neper = 8.686..dB

We further can calculate:

10 $\log_{10}$ (power ratio) =1 dB

power ratio = $10^{1/10}$ Thus 0.5 ln $10^{1/10}$ = 0.1151 nepers

1 dB = 0.115 nepers

Therefore:

0.1151 x dB = nepers

8.686 x nepers = dB

## POWER LEVEL, SOUND PRESSURE LEVEL, AND INTENSITY LEVEL

Power level ($L_P$), sound pressure level ($L_p$), and intensity level, $L_I$, are interrelated.

$$L_P = 10 \log \left( \frac{\text{acoustic power in watts}}{10^{-12} \text{ watt}} \right)$$

$$L_p = 20 \log \left( \frac{\text{sound pressure in newtons/m}^2}{0.00002 \text{ newtons/m}^2} \right)$$

$L_I = L_P - 10 \log S \text{ in m}^2$ (in a free field $L_I = L_p$)

$L_P = L_p + 20 \log r \text{ in ft.} - 10 \log Q + 0.7 \text{ dB}$

$L_p = L_P - 20 \log r \text{ in ft.} + 10 \log Q - 0.7 \text{ dB}$

$L_P \simeq L_p$ when r = 0.925 ft (0.282 m) and Q = 1

$$S \text{ in m}^2 = \frac{4\pi(r \text{ in ft})^2}{10.76\ Q} \qquad S \text{ in m}^2 = \frac{4\pi(r \text{ in m})^2}{Q}$$

Intensity in $w/m^2 = 10^{(L_I/10)} \times 10^{-12} w/m^2$ $\qquad (10^{-12} w/m^2 = 10^{-16} w/cm^2)$

Intensity in $w/cm^2 = 10^{(L_I/10)} \times 10^{-16} w/cm^2$

## OF INTEREST

CONCERT NEWS, October 3, 1976: "In order to accommodate as many people as possible for the concert (Elvis Presley), extra seats will be added to the Arena's normal north-end stage set-up. Since the Elvis show "flies" their sound (i.e., suspends all speakers and electronics above the stage, rather than on the sides of the stage), seats normally blocked by such speakers will also be sold."

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SKI MAGAZINE, October 1976: "Under the platform is the noise center - three Craig tape consoles and Shure microphone mixers--rated for 800 watts. The machines have builtin heat units so that they will not malfunction at low temperatures. On the course (The Stowe Winter Carnival Colgate World Trophy Women's Freestyle Ski Tour and Ski America Classic) PA speakers are spaced every 50 yards angled carefully to avoid *the Doppler effect.*"(Italics mine)

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WHAT'S GOING ON IN ORLANDO, November 1976: (Writing of the scheduled opening of the Great Southern Music Hall in early December), "A completely new sound system from *ENGLAND--'the best available'*--(Italics mine) and new lighting will enhance the overall effect."

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ELECTRONICS, September 30, 1976: "A division of Rockwell International began delivery this month of a prototype bubble-memory system to a number of customers. Called the POS-8, the system is composed of eight 100,000-bit chips. They are laboratory-evaluation units 'to provide potential users an opportunity to obtain hands-on experience with the devices'"...These units, priced at $5,000 each to cover the cost of building them in a pilot-production facility are one-of-a-kind products to enable customers to get a feel for the technology....Timing of the introduction of a commercial bubble memory system will depend on the feedback. The Autonetics group also has contracts from government agencies to develop bubble memories. One from NASA is for 100 million-bit satallite recorder. A prototype is to be delivered in early 1977."

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There's One Born Every Minute: From an ad - "Growing use of the 'dbw' power rating makes an intelligent assessment of amplifier power far easier. The 'dbw' (decibel/watt) is a measure of relative sound pressure per watt power. This measure helps clarify the relationship between the amplifier and what is audibly perceived." It seems a shame to mention loudspeaker efficiency at this point. (Ted Uzzle of Cambridge, MA shared this gem with us)

The second entry in the TOBEM department is an ad for a sound lectern we are told "will efficiently cover an audience of 3,000". An audience of *what* or *where* is not mentioned. Further on it states a "power output of 30 watts IPM" (which we suspect means impossible to measure). Mort Larsen, our three-time graduate in Winnipeg, sent in the ad with this comment, "I don't know why I spent so much time learning how to design a sound system properly when this item is supposed to do it all for me." (We hope to have a Tech Topic by Mort next issue proving that he does indeed know how to design a sound system.)

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AUDIO TIMES, August 1976: "Quad Labels Shrink. One sign of just how badly four-channel is doing is the size of quad identification on record albums. While RCA is still using its Quadradisc emblem, it has shrunk to about half the original size. Likewise, Columbia's SQ label and the one on Warner's four-channel albums are smaller. A Warner exec here recently grieved that hardware manufacturers aren't putting the promotional thrust they should behind four-channel and observed that quadrophonic software is 'in trouble, serious trouble'."

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AUDIO TIMES, August 1976: "Time Delay Looks Like Industry's Next Rising Star. Time delay devices, a relatively new breed of high fidelity component designed to recreate the ambience of virtually any space from jazz club to concert hall in the home listening room, don't appear to be encountering any delays in making an impact on the audio marketplace."

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STUDIO SOUND, May 1976. "Although the code of practice finally adopted by the GLC (in England) is more liberal than the draft code almost universally criticised it could still put a stop to some of the longer, louder events if enforced. Says Martin: 'Whereas you can drive a car at exactly one mile per hour under the legal speed limit, the dynamic nature of music makes it quite impossible for a band to play at 1 dB under the proposed GLC peak limit of 102 dBA. So groups will have to average around 10 dBA under the legal maximum to cope safely with drum breaks -- which means the decidedly low average level of 92 dBA for a live concert'. The BBC, it now emerges, 'fully support the basic premise of an equivalent continuous sound level of 90 dBA'."

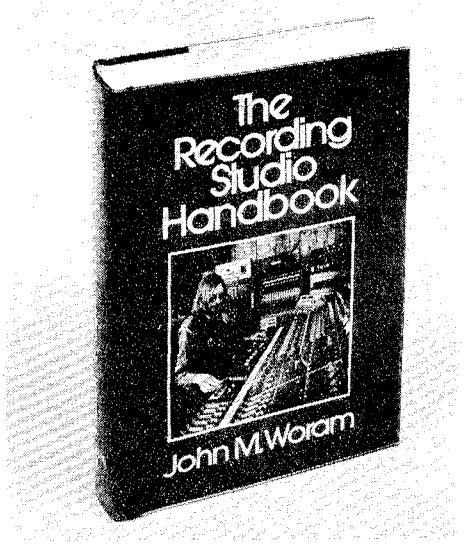
## BOOKS OF INTEREST

"NUMBERS: SHORTCUTS & PASTIMES" (Tab Book #675) $9.95 hardbound; $6.95 paperback. The late Jack Gilbert wasn't afraid to tackle the impossible with fervor. To quote from the publisher's prewritten review sheet: "If this doesn't prove to be the most entertaining of textbooks, it's sure to be the most educational funbook of numbers and math games -- and it's loaded with easy-to-learn tips for making even complex numbers mentally manageable. Even with the advent of pocket calculators, being able to mentally calculate is a valuable asset. Even those people who've always had trouble with math, will feel comfortable and self-assured with this remarkable text -- it shows how to use a few basic mental exercises to perform highly involved (seemingly) mathematical calculations without a calculator...and without pencil and paper!"

In looking over the book, I felt that these promises were largely kept. I enjoyed the author's approach, enthusiasm, and professional skill. At a paperback price of $6.95 (ISBN 0-8306-5675-8) it represents an excellent buy and continuing entertainment.

# BOOKS OF INTEREST

"THE RECORDING STUDIO HANDBOOK" by John Woram. Sagamore Publishing Co. 1120 Old Country Rd., Plainview, New York 11803. $35.00 496 pages.




John Woram has exercised a great deal of good judgement in his "Recording Studio Handbook". In scanning several of the newer books on recording with pretenses to academic stature, I have found voluminous misstatements, errors and omissions. Woram avoids this trap by not entering the door. His book contains information on techniques and equipment that he is familiar with and in the process gives the reader a good idea of the tasks to be performed around a modern recording studio.

Written without pretense and with realistic appreciation of the craftsmanship and artistry that a successful recording engineer should embrace, the book serves as a useful survey of the present day studio and those most likely to use it well.

I found the book interesting reading and a worthwhile addition to an audio engineer's library. To the serious recording engineer the combination of John Woram's book for equipment and techniques with the classic "SOUND RECORDING" by Frayne and Wolfe (circ 1949) for the engineering basics essential to deserving the "engineer" part of the title "Recording Engineer", join to make a very practical package.

No recording technician deserves the shift of title to engineer that doesn't have a thorough familiarity with Frayne and Wolfe's chapters: Chapter 1 - Nature of Sound, Sound Waves, and their Perception; Chapter 2 - Electrical, Acoustical, and Mechanical Circuits; Chapter 3 - Microphones and Their Uses; Chapter 6 - Network Theory; Chapter 7 - Attenuators; Chapter 8 - Filters; Chapter 9 - Equalizers; Chapter 12 - Electrical Measurements; Chapter 30 - Loudspeaker Systems; and Chapter 32 - Stereophonic Sound.

Woram's chapters on Echo and Reverberation, Flanging and Phasing, Noise and Noise Reduction Principles, Studio Noise Reduction Systems, The Modern Recording Studio Console, The Recording Session, and The Mixdown Session are all valuable updatings that added to the basic allow a knowledgeable engineer with really well TRAINED hearing to start his apprenticeship in a real studio. While I am aware that a majority of people called Recording Engineers do not have this depth of background, I'm also aware that they are the primary cause of so much misuse of today's technological promise that results in poorer quality recordings than those of twenty years ago while surrounded by equipment that could deliver remarkably better recordings if properly maintained and adjusted.

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"COMPENDIUM OF MATERIALS FOR NOISE CONTROL", HEW Publication NO. (NIOSH) 75-165. Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402. Stock # 017-033-00088-3. $4.50

The Illinois Institute of Technology Research Institute, Chicago, Ill., under the direction of W. Ernest Purcell performed the work involved in this remarkably useful 341 page (8½x11" format) book.

In addition to a very well written section on Acoustic basics, it lists acoustical laboratories, manufacturers of acoustical materials and their addresses, all types of materials - glass, folding partitions, sound absorbing concrete blocks, etc.

There are sections of the book composed of Tables: Sound absorption materials, sound absorption systems, sound barrier materials, composite system for sound absorption and transmission reduction, sound barrier systems, and specialized items.

This is *the* source book for everyone who ever asked "where can I get a set of absorption coefficients?"

*Compendium of Materials for Noise Control* meets a real need of the professional sound engineer and it belongs in his library.

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If you have ever wondered what those acoustical giants, on whose shoulders we all stand, looked like, there are two remarkable photographs than 20 years apart in "THE COLLECTED PAPERS OF VERN KNUDSEN".

"COLLECTED PAPERS FROM VERN O. KNUDSEN": Harvey Fletcher of Fletcher-Munson loudness curves; J. P. Maxfield of the "liveness concept"; F. R. Watson, founder of the Acoustical Society of America; H. C. Harrison of matched impedance fame; I. Wolff of Wolff and Malter, who in 1931 described directivity, sound columns, horns, etc. in their famous paper; L. J. Sivian of Sivian Dunn and White who first measured the spectral power of a live orchestra; J. C. Steinberg of Steinberg and Snow of Auditory Perspective fame; and E. C. Wente of the team Wente and Thuras who in the 1920s designed the condenser microphone, the compression driver, and the multicellular horn. They are all there in the *Collected Papers from Vern O. Knudsen*, JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA, available from the Acoustical Society of America, 335 E. 45th St., New York 10017.

This tribute to Knudsen's life work spans his papers over a 60 year period and includes "Selective Amplification in Hearing Aids", "The Effect of Humidity Upon the absorption of Sound in a Room, and a Determination of the Coefficients of Absorption of Sound in Air", and "Modern Acoustics and Culture".

A most useful reference in an attractive format. Cost $10.00

## ARTICLES OF INTEREST

CHRISTIAN SCIENCE MONITOR, December 22, 1976: There was a fascinating article by William R. Frye in the December 22 issue which contained the following quotes:

"There is no known tradition attached to what I have called the capernaum 'amphitheater'....Yet it could very well be the place where Jesus addressed the multitudes from a 'ship' offshore...I stood perhaps 50 to 75 yards up the hill while Mr. Crisler at the shore, read aloud....I could hear him perfectly...I moved another 50 yards back up the hill and could still hear, well enough so that I could and did, get a perfectly audible tape recording of his voice.

"Mr. Crisler later returned to the site with an acoustical engineer, Mark Myles of Bolt, Beranek and Newman..and proved with instrumentation that the site is indeed one where, if a speaker stands in a boat offshore, he can be heard by 5000 to 7000 people. Interestingly, if the speaker stands on shore he cannot be heard by as many people."

This site is said to be 8.7 miles north of the present city of Tiberias and just "beyond a turning point in the road" from the traditional site of Capernaum.

"The shore front at this point seems to shape itself into a natural amphitheater. It rises in a gentle crescent from a horseshoe-shape inlet at water level and spreads out rather like the floor of a theater balcony as it climbs to an elevation of several hundred feet."

All in all, a beautiful description of what to look for in a natural amphitheater and where to stand to address the audience.

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NATIONAL GEOGRAPHICAL, December 1976, The article entitled, *Exploring the Lives of Whales"* (sent to us by Bob Irvin of the 1974 and 75 Los Angeles class) states that frequencies as high as 256,000 Hz can be produced by whales and that one measurement of a sustained sound from a blue whale off the coast of South America was rated at 188 dB. This was stated to be the "most powerful sustained sound from any living source."

Since in underwater acoustics the acoustic reference level is 1 dyne/cm$^2$ whereas in air it is 0.0002 dynes/cm$^2$, we can calculate the following conversion

$$20 \log \frac{X}{1 \text{ dyne/cm}^2} = 188 \text{ dB}$$

$$X = 1 \text{ dyne/cm}^2 \times 10^{\left\{\frac{188}{20}\right\}} = 2.51 \times 10^9 \text{ dyne/cm}^2; \qquad 20 \log \frac{2.51 \times 10^9}{0.0002 \text{ dynes/cm}^2} = 262 \text{ dB-SPL}$$

This ideal "Rock" star has dimensions of from 20 to 40 feet long and can operate at depths of 3700 feet or more. (Obviously these stars experience "lows" rather than "highs" and can definitely be said to be able to communicate under pressure.)

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BRUEL AND KJAER, "TECHNICAL REVIEW NO. 1, 1976": I have just finished reading what I believe is the best written, most to the point, and more than likely the most accurate article I have read on how and why hearing losses occur.

*"Do We Measure Damaging Noise Correctly?"* is an outstanding discussion of what is known, not known, and needs to be known, regarding how to measure sources likely to damage hearing. Mr. Bruel clears the mystery from why a racing car enthusiast or a rock band fan can *safely* experience the apparently high levels they are exposed to while it is absolutely necessary for users of firearms, trip-hammers, and communication system headsets to take special precautions to preserve their hearing.

This article clearly demonstrates the ability of sharp impulse sounds to get into the ear *before* the Stapedius muscle can operate. Integration time constants are given for (1) the outer ear - 50 μs; (2) the middle ear - 35 μs; (3) the Stapedius muscle - 300 ms; (4) the inner ear - 30 μs; (5) the brain - 35 ms.

Extensive time based as well as spectrum based amplitude information is provided. In my opinion it is the most useful article on the subject in the audio literature.

To receive Bruel and Kjaer's "Technical Review" write, 5111 W. 164th St., Cleveland, Ohio 44142.

## CLASSIFIED

FOR SALE: GR 1450-TB Decade Attenuator $150.
GR 2490A Decade Inductor $150.
Ampex 403R 2-track stereo playback deck
Altec 9844 speaker
Make offer.
Al Firestein, 19 Mercer St., New York, New York 10013. Phone (212) 691-8181

FOR SALE: General Radio 1933-9714 Precision Sound Level Meter and Analyzer. Complete with ½" and 1" calibrated microphones and GR 1562-A Sound Level Calibrator, all in carrying case.

Bob Runstein, 44 Dinsmore Ave, #610, Framingham, MA 01701. Phone (617) 254-9200.

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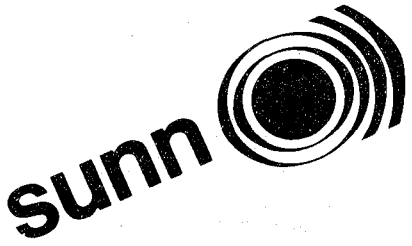
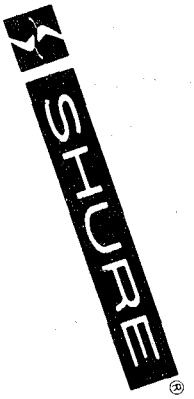
SYNERGETIC AUDIO CONCEPTS





# EMILAR CORPORATION

Syn-Aud-Con receives tangible support from the audio industry, and nine manufacturing firms presently help underwrite the expense of providing classes in many different cities in the United States and Canada. Such support makes it possible to offer the classes in a convenient location at reasonable prices and provide all the materials and continuing support to the graduates of Syn-Aud-Con.




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

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

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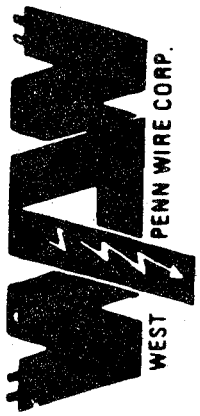



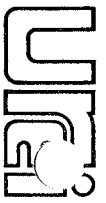


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