ISSN0011-7145

THE SOUND ENGINEERING MAGAZINE

NOVEMBER 1977
$1.00

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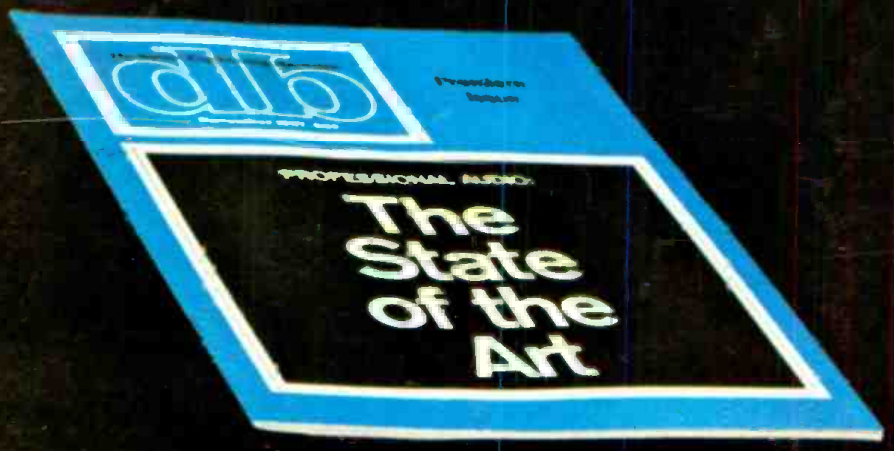

10 YEARS LATER

When you perform in front of a live audience, you put everything on the line.

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At Yamaha, we know that the show must go on. Regardless.

That's why we designed our PM-1000 Series mixing consoles to the highest standard of quality and reliability. Professional.

Whether it's our 16-, 24-, or 32-channel model, the PM-1000 Series is capable of surviving the kind of punishment and abuse that only "the road" can dish out.

Tough isn't enough. Realizing that every job has different sound requirements, Yamaha also designed the PM-1000 Series for maximum flexibility. With features like an exclusive 4x4 matrix with level controls that allows four independent mono mixes.

There's also the complete complement of controls you'd expect to find on the most sophisticated consoles. Transformer isolated inputs and outputs. Dual echo send busses. An input level attenuator that takes the +4dB line level to −60dB mike level in 11 steps. Plus 5-frequency equalization. To give you plenty of headroom for clean, undistorted sound, the PM-1000 can drive a 600 ohm load to +22½dBm.

Get your band on the wagon. All around the world—night after night, gig after gig—you'll find Yamaha mixing consoles the choice of more and more professionals. People who don't regard professional quality as a luxury, but as a necessity. Your Yamaha pro sound dealer can give you all the reasons why you should join them.

YAMAHA

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Coming Next Month

• December will contain a tribute to one hundred years of recorded sound with several articles. OLIVER BERLINER will detail the first microphone made by his grandfather Emile; a reprint of an article in the October 12th 1889 *Scientific American* details the first public demonstrations of the phonograph by Edison; pictures and story describe a museum in Dover, Delaware dedicated to the memory of Eldridge Johnson; and HAROLD LINDSAY's history of his and Ampex's involvement in tape recorders will cover the background leading to the development of the Ampex 200 tape recorder, as well as the problems along the way.

About The Cover

• Just ten years ago, November 1967, **db Magazine** began publishing. Art Director Bob Laurie did our first cover, this cover, and every cover in between.

db

THE SOUND ENGINEERING MAGAZINE

NOVEMBER 1977 VOLUME 11, NUMBER 11

db is listed in **Current Contents: Engineering and Technology**

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db, the Sound Engineering Magazine is published monthly by Sagamore Publishing Company, Inc.

1120 Old Country Road, Plainview, L.I., N.Y. 11803. Telephone (516) 433 6530. db is published for those individuals and firms in professional audio-recording, broadcast, audio-visual, sound reinforcement, consultants, video recording, film sound, etc. Application should be made on the subscription form in the rear of each issue. Subscriptions are $7.00 per year ($14.00 per year outside U.S. Possessions, Canada and Mexico) in U.S. funds. Single copies are $1.00 each. Controlled circulation paid at Brattleboro, VT 05301. Editorial, Publishing, and Sales Offices: 1120 Old Country Road, Plainview, New York 11803. Postmaster: Form 3579 should be sent to above address.

db Letters

In his September, 1977 column, *Monitoring Audio Distribution,* Patrick Finnegan has misled us in his Asymmetrical Modulation paragraph, and in Figure 5, where he suggests that the audio output level from the modulation monitor is dependent upon which peak, positive or negative, is being monitored.

Let's remember that the recovered audio is made up of both the positive-going and the negative-going excursions together, and therefore the instantaneous polarity of the monitor audio has no effect whatsoever on its level; the audio distribution system does not care which way the polarity selector is set! It will sound the same at all monitoring locations except for one—the live d.j. *will* hear a difference in *his headphones.* His own voice will appear to have been affected, and probably more than the suggested 2 dB. But this apparent change in loudness is not due to the modulation monitor level changing with polarity reversal, but rather, it is due to cancellation or reinforcement through "jawbone conduction," a term given to the secondary path by which a person hears his own voice.

This phenomenon is particularly an irritant in situations where automatic polarity reversal is employed in the audio processing chain. Changes in the polarity of the headphone audio while a d.j. is doing a break makes it very hard for him to concentrate on his performance. Apparently, most d.j.s do not recognize this problem for what it is, and will insist that something is *bad* wrong with the limiters or transmitter even though the engineer is sure the station sounds fine to him and to everyone else. The tendency, which many announcers have, to live within their headphone world may be a whole new topic unto itself, but in this case, the d.j. is correct—something *is* bad wrong.

In any situation, particular care must be given to proper polarization of the control room headphones and then, of course—leave the modulation monitor peak polarity selector alone.

BARRY HAYES,
Broadcast Consultant
WDNC Radio
Durham, N.C.

THE EDITOR:

Martin Dickstein's May, 1977 column offered a concise description of a complex subject. But matte projection screens, or more simply, flat white

index of advertisers

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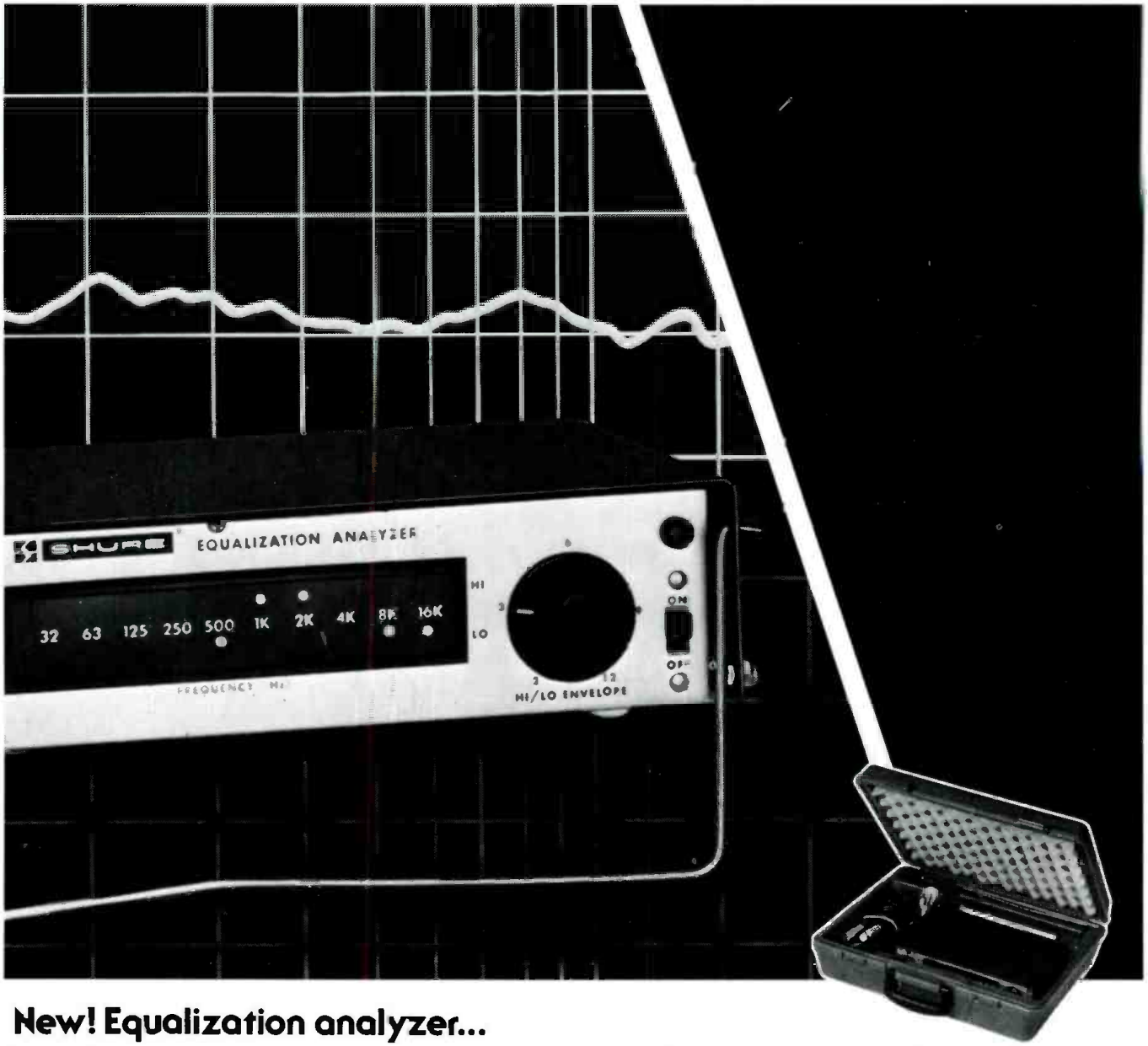

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The M615 Analyzer's display contains 20 LEDs that indicate frequency response level in each of 10 octave bands from 32 Hz to 16,000 Hz.
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letters (cont.)

screens, are characterized by appearing equally bright at all viewing angles, even 89 degrees off axis. Thus these screens are best for use where extremely oblique viewing angles are encountered. Nevertheless, no one should be forced to sit more than 60 degrees off-axis due to reduced legibility caused by picture foreshortening.

The maximum viewing distances from the screen which were given, expressed in screen widths, hold true for reading legibility. Normal pictures can be seen satisfactorily at much greater distances, although the exact distance depends strongly on the clarity of the presentation and the audience's familiarity with the subject matter.

TOM HOLZEL
Sales Manager, Industrial Video Products
Advent Corporation
Cambridge, Mass.

THE EDITOR:

When the schematic of my limiter circuit was redrawn for publication (*An F.e.t. Audio Limiter*, July, 1977, pp. 32-33) several errors crept in. All the errors involve missing connection dots in the schematic. Since there are many missing connections, it is easier to list the crossings of lines in the schematic that are NOT connections. These are as follows:

1. The 100 K resistor from the drain of Q4 crosses the 62 K resistor from the collector of Q7.
2. The 22 K resistor from the emitter of Q7 crosses the 22 K resistor from the base of Q7.
3. The 1 M resistor from the drain of Q4 crosses the 22 K resistor from the base of Q7.

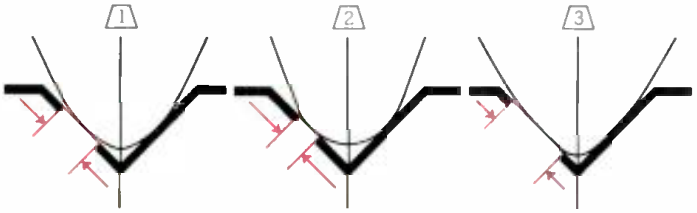
All other crossings of lines in the schematic are connections and should be marked by dots.

DEVLIN M. GUALTIERI

■

1976: ADC CLAIMS THE XLM MK II SHOWS "NO PERCEIVABLE WEAR OVER THE LIFE OF A RECORD." AND PROVES IT.

1977: ADC CLAIMS THE NEW ZLM WITH THE ĀLIPTIC™ STYLUS HAS EVEN LOWER WEAR AND BETTER PERFORMANCE. AND PROVES IT AGAIN.



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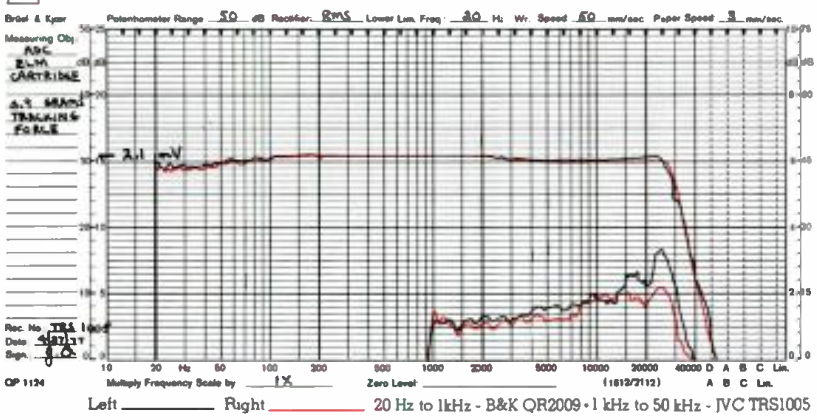

Introducing the ADC ZLM cartridge with the ĀLIPTIC 1 stylus. It's a revolutionary new cartridge design that has taken the state of the art a giant step closer to the state of perfection.

Because of last year's XLM MK II record wear test results, we confirmed our thinking on how to design the perfect stylus tip shape. It combines the better stereo reproduction of the elliptical 2 stylus shape with the longer, lower wearing, vertical bearing radius of the Shibata 3 shape. The result is our revolutionary new ĀLIPTIC stylus.

And that's only the beginning. The ĀLIPTIC shape is polished onto a tiny .004" x .008" rectangular nude diamond shank, which has reduced the tip mass of the XLM MK II by an incredible 50%. This tiny stone is mounted on our new, tapered cantilever, which reduces effective tip mass even further.

The XLM MK II tests also proved the importance of tip polish in reducing record wear. So the ZLM is polished with a new, more expensive, more effective patented polishing method.

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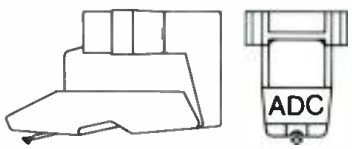

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db Calendar

NOVEMBER

16-19 **Videodisc/Home Video Programming Conference,** Loeb Conference Facility, N.Y.U., New York. Contact: Robert Hamilton, 24 Washington Sq. N., New York, N.Y. 10011. (212) 982-5244.

22-25 **Video Tradex '77** trade exhibit and conference, Heathrow Hotel, London Airport, England. Contact: Video & Audio Visual Review, Link House, Dingwall Ave., Croydon CR9 2TA, England.

29-Dec. 1 **Synergetic Seminar,** Orlando. Fla. See above.

Nov. 30-Dec. 1&2 **State-Of-The-Art Convention,** Marriott Inn, Clarksville, Indiana. Contact: Society of Broadcast Engineers, Chapter 35 (Kentucky) c/o Robert J. Klein, Ket TV, 600 Cooper Dr., Lexington, Ky. 40502.

DECEMBER

3 **Strategies for Starting Your Own Business,** Hartford, Conn. Sponsor: The Wharton School. Contact: Ms. Heidi S. Kaplan, Information Services Manager, NYMC, Dept. 14NR, 360 Lexington Avenue, N.Y.C. 10017. (212) 953-7262.

4 **Starting Your Own Business.** Wharton Seminar, New York City. Contact: See above.

14-16 **Management Seminar.** New York City. Contact: Ms. Heidi Kaplan (see above).

19-21 **Project Management for Engineers,** seminar. Boston, Mass. Sponsored by New York University. Contact: Ms. Heidi Kaplan (see above).

JANUARY

23-25 **Management Seminar.** Houston, Texas. Sponsored by New York University. Contact: Ms. Heidi E. Kaplan, Information Services Manager, New York Conference Management Center, 360 Lexington Ave., New York, N.Y. 10017. (212) 953-7262.

24-27 **Modular VTR Workshop.** Contact: Smith, Mattingly Productions, Ltd., 515 Kerby Hill Rd., Oxon Hill, Md. 20022. (301) 567-9265. Workshop at above address.

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PATRICK S. FINNEGAN

db Broadcast Sound

System Matching

• Whether we are planning a completely new studio facility, expanding a present system, or simply adding a few units to the system, careful consideration must be given to the electrical interface of individual units when they are combined into the system. This month we will discuss some important factors that should be considered when matching a system.

BASIC FACTORS

If we are to select a variety of audio units and connect them together to work as a system, we should set some minimum specifications that this system will meet. There will be many operational and similar factors that must be also considered, but at least we should set minimum specs for system gain, band-pass, distortion, and noise limits.

Since any audio system is primarily designed for the amplification and processing of audio signals, the signal levels throughout the system are important. There must be consideration not only for the anticipated input and output levels of the entire system, but also the input/output levels of each unit within the system.

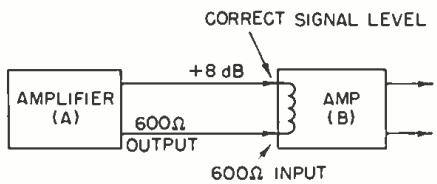
Two other important factors must be considered because they enter into and affect the operation and desired characteristics of the system—the input/output impedance of each unit. and the mixture of balanced/unbalanced circuits. When these two factors are not given proper consideration, the resulting performance can be far below the desired minimum specifications.

PLANNED OBJECTIVES

It is a better procedure to prescribe the minimum characteristics of the system and then select component units that will meet these specifications than simply to select components for other reasons and hope the final assembly will produce the desired specifications. With the first method, you control the results, but using the second method. the results occur by chance.

Most individual audio units designed for broadcast or recording studios do have good specs as far as bandpass. distortion, and noise figures are concerned. But all do not have identical specs and these can be far from the same in different models. When considering a particular model, study *all* the specs for that unit, not only the ones which seem to be most important to you. Even though two different

Figure 1. The amplifier's specifications hold true only if it has a proper load.



Why you should buy a digital multimeter from the leader in digital multimeters.

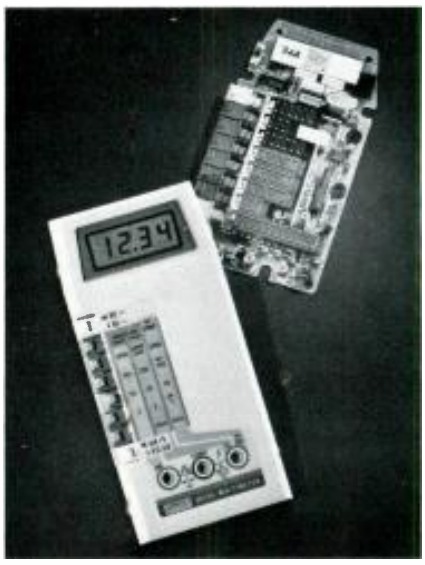
If you're shopping for your first multimeter, or moving up to digital from analog, there are a few things you should know.

First, look at more than price. You'll find, for instance, that the new Fluke 8020A DMM offers features you won't find on other DMMs at *any* price. And it's only $169.*

Second, quality pays. Fluke is recognized as the leading maker of multimeters (among other things) with a 30-year heritage of quality, excellence and value that pays off for you in the 8020A.

Third, don't under-buy. You may think that a precision 3½-digit digital multimeter is too much instrument for you right now. But considering our rapidly changing technology, you're going to need digital *yesterday*.

If you're just beginning, go digital.



Why not analog? Because the 8020A has 0.25% dc accuracy, and that's *ten times better* than most analog meters.

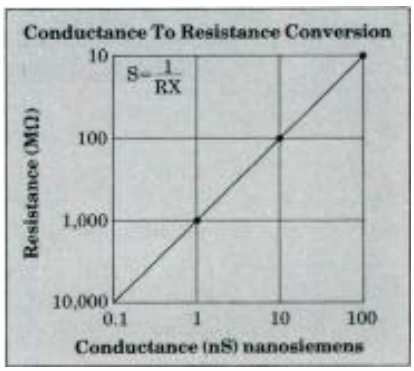
Also, the 8020A's digital performance means things like 26 ranges and seven functions. And the tougher your home projects get, the more you need the 8020A's full-range versatility and accuracy. The 8020A has it; analog meters don't.

If you're a pro.

You already know Fluke. And you probably own a benchtop-model multimeter.

Now consider the 8020A: smaller in size, but just as big in capability. Like 2000-count resolution and high-low power ohms. Autozero and autopolarity. And the 8020A is MOV-protected to 6000V against hidden transients, and has overload protection to 300V ac.

Nanosiemens?



Beginner or pro, you'll find the meter you now have can't measure nanosiemens. So what? With the 8020A *conductance* function, you can measure the equivalent of 10,000 megohms in nanosiemens. Like capacitor, circuit board and insulation leakage. And, you can check transistor gain with a simple, homemade adapter. Only with the 8020A, a 13-oz. heavyweight that goes where you go, with confidence.

What price to pay.

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Of course, you can pay more. Or less. In fact, you could pay almost as much for equally compact but more simplistic meters, and get far less versatility. And, the 8020A gives you the 'plus' of custom CMOS LSI chip design, and a minimum number of parts (47 in all). All parts and service available at more than 100 Fluke service centers, worldwide. Guaranteed, for a full year.

Rugged. Reliable. Inexpensive to own and to operate; a simple 9V battery assures continuous use for up to 200 hours.

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Call (800) 426-0361 toll free. Give us your chargecard number and we'll ship one to you the same day. Or, we'll tell you the location of the closest Fluke office or distributor for a personal hands-on feel for the best DMM value going.

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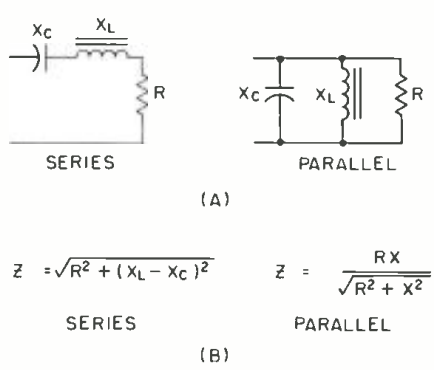

Figure 2. (A) The impedance contains both resistance and reactance. (B) Different formulas must be used for series or parallel elements.

models may appear to have similar specs, there can be differences which change these specs considerably when the unit is connected with other units. Remember that the published specs are *for that unit alone*, not for its operation in a system.

We must be careful to select units that will work together and still produce the desired specs. For example, if we select two units that have generally comparable specs, but overlook the fact that one is designed for hi-impedance circuits and the other for low impedance circuits, when we connect these two together in a system, the published specs for neither of these units holds true any more. The units are now operating in what could be called a "non-conforming" arrangement—we have not matched them up. In another part of the system, we may have selected an amplifier that does not have adequate gain when a higher gain is needed. Consequently, that amplifier must now operate with its gain control wide open and even then, the output level may not be adequate.

SIGNAL LEVELS

The station's audio system will include a wide variety of equipment units that amplify, process and distribute the audio throughout the station for many purposes. The number of units varies, but even the most modest system will have many, many units.

Rather than have a haphazard variety of signal levels routed to various places in the system, the signals should be distributed at a standard distribution level. Some of this distribution will be by D/As as we discussed in an earlier column, but in the main channel, the standard level should still be maintained. Of course, all signals cannot be distributed at the same level, but they should be grouped according

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Ivie just eliminated the power line cord on professional audio test equipment. Our state-of-the-art designs are going portable. You can leave those heavy boxes and their extension cords in the office, because the new IE-10A Audio Spectrum Analyzer puts audio analysis in the palm of your hand.

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Spec Briefs

Frequency Range 22Hz - 22KHz.
45 dB "on-screen" display range.
Ten octave channels w/160 LEDS.
Selectable 1, 2 or 3 dB resolution.
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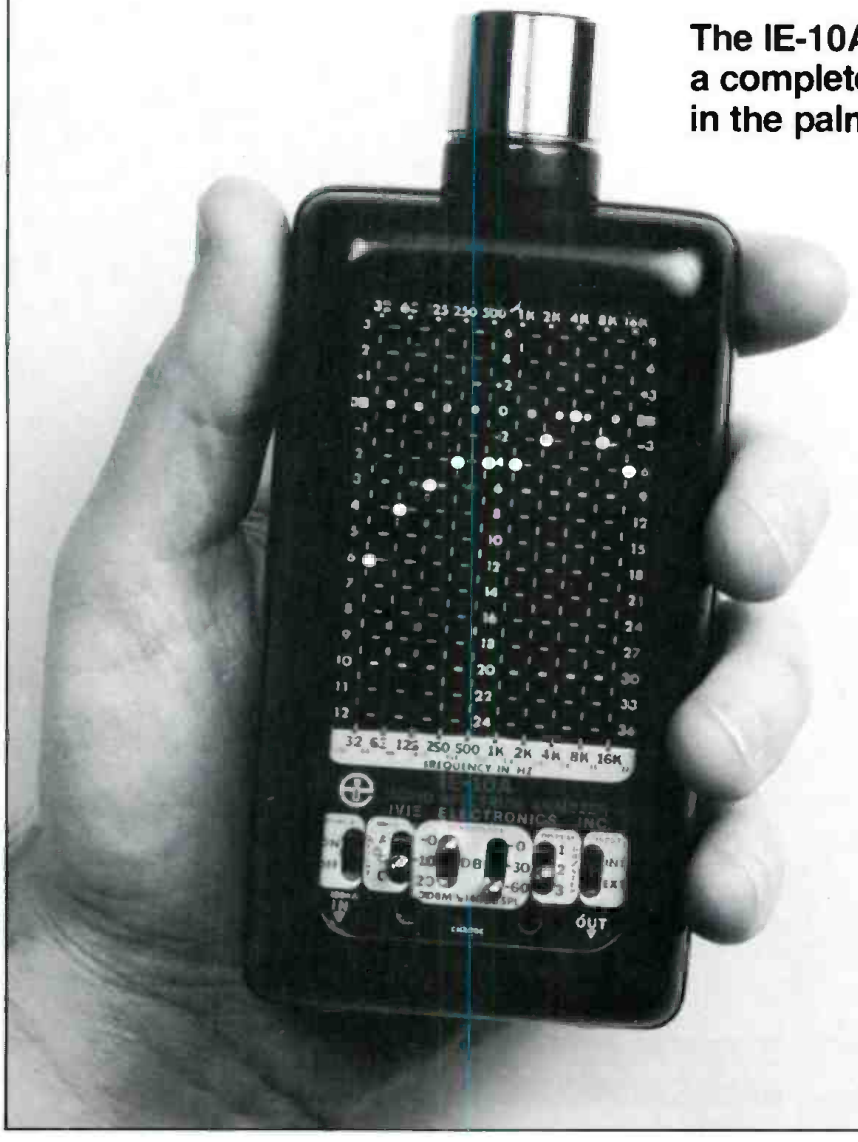
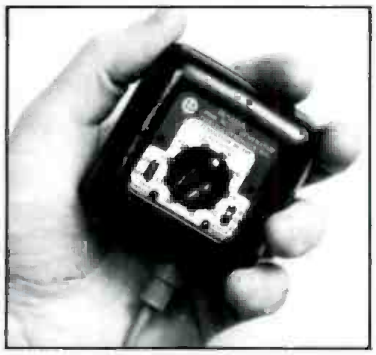
The IE-10A . . . a complete audio analysis system in the palm of your hand.





The Ivie family is growing with a powerful new set of accessories. Pictured above is the IE-20A Pink Noise Generator and the IE-15A Harmonic Distortion Analyzer is shown below.

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to particular needs into standard levels for those sections, achieving greater control throughout the system. When problems arise, or if you need some special switching or routing arrangement for some occasion, the units may be patched in or out or switched in or out of the system without upsetting the entire setup.

Signal levels and systems gain go hand in glove. Each unit in the system should have reserve gain, and when translated to the entire system, it, too, should have reserve gain. Gain controls on individual units should normally operate at only one-half to three-quarters open. In this manner, only one-half to three-fourths of the system's gain capacity will be used for normal operations.

IMPEDANCE

The input/output impedance of each unit is an important parameter of its specifications and also of the manner in which it should operate in the system. The impedances are the design parameters, but the specs hold true only when these impedances are matched with those of other units.

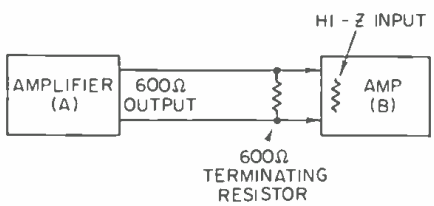
When the impedances between two different units in tandem are not matched (same value) signal voltages will suffer and so will the bandpass. Matching impedances between two units works on essentially the same principles as matching two stages within the unit itself—although the procedure is much less complicated.

WHAT IT IS

Impedance is the load value offered to the a.c. signal at the output of a unit. The internal amplifier design works toward developing a prescribed signal voltage across this load—not just at the output terminals, but across the terminating load. When the specifications state: +8 dB, 600 ohms, this means that it will produce a signal level of +8 dB across its output terminals when those terminals have a 600 ohm load across them.

Although impedance values are expressed in ohms, this is a more com-

Figure 3. This arrangement can be used in some cases. Amplifier (A) is properly terminated, and amplifier (B) acts as a bridging input.



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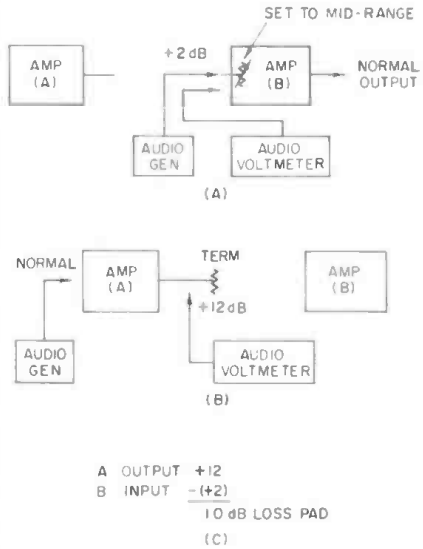

Figure 4. The loss required of the pad can be determined by measuring the signal with an audio voltmeter. (A) First measure, (B) Second measure, (C) Pad required.

plicated value than a simple resistance. A pure resistance load is very desirable, but not always achieved in practical arrangements because there will usually be some inductive or capacitive reactance in the load circuit. This reactive component is frequency-dependant and will have a different value for different frequencies.

The signal current and voltage will be in phase across the resistive component of the load, but the current will lead or lag the voltage across the reactive element, depending upon whether it is capacitive or inductive. This phase angle is 90 degrees, so consequently the instantaneous voltage and current across the combined load is not the same as it would be in a pure resistance load. To further complicate matters, the reactive element may be in series with the resistive element, in shunt to it, or both. To determine the true impedance of this load, we must take into consideration the phase angle through the components. Consequently, we cannot treat the two as if they were resistive elements in series or parallel. It takes a more complicated formula to analyze them.

In a number of trouble-shooting situations, the actual impedance is not as important as the results. We can estimate the approximate impedance by treating the two elements as resistive. This will produce a worse case in many instances, but can get the work moving without much computation. For example, if we have an r.f.i. problem and a few capacitors on hand, we can check a nomograph for the reactance

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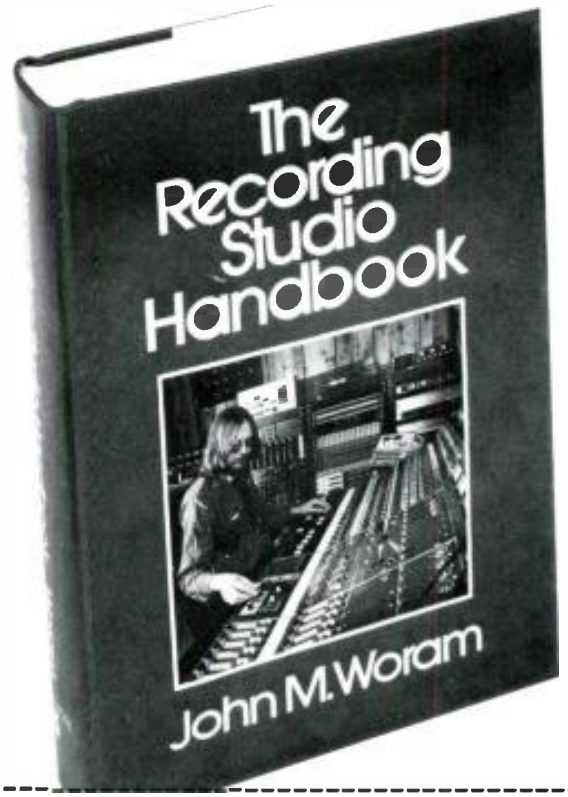

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John Woram is the former Eastern vice president of the Audio Engineering Society, and was a recording engineer at RCA and Chief Engineer at Vanguard Recording Society. He is now president of Woram Audio Associates.

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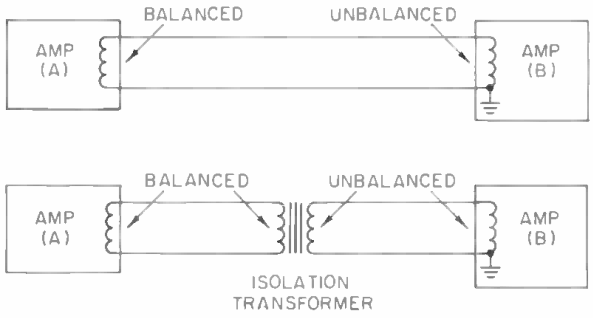

Figure 5. Use a transformer to isolate balanced/unbalanced circuits.

of the capacitors at the rf and the highest audio frequency. Selecting one of these, we can then roughly compute the effect on both the rf and the impedance by treating these as resistances. After attaching the capacitor and finding that it removes the rf, we can make a few quick checks with audio tone and the audio voltmeter to determine what effect there has been on the audio. If we desire to know the actual value of the resulting impedance, we can go ahead and compute the value.

MATCHING

When we match impedances between two units, we simply select the correct impedance tap on the output of the driving amplifier and the correct input tap on the load amplifier. The taps provided may be internal transformer taps, or they may be r-c section compensated taps. If the impedances of the two units are too different or if there are no correct taps, we must resort to external matching by either transformers or resistor matching pads. The transformer is often more convenient to use, but it must be a high quality unit or it can affect the bandpass. When resistors are used for matching, we must be prepared to make up for the insertion loss.

In some cases where the impedances of the two units are very different, we can use another technique, providing the units have enough reserve gain. For example, the driving unit is for a 600 ohm circuit load, the load unit is for high impedance. If we add a resistor load across the input of the load amplifier, the drive unit will see the proper termination and develop its correct signal voltage across that load resistor. The load amplifier then simply bridges this load.

SIGNAL CONTROL

Although the system should provide the correct output level for the correct input signal level, the signal should be controlled all the way through the system. If the level is too high at some particular place in the system, a fixed pad should be used to reduce the level so that the following amplifier can operate with its control at mid-range. To determine the value of the pad, use the audio signal generator to feed the amplifier with its control at mid-range. Make a note of what signal level this requires. Now, feed tone to the front end of the system at normal system level. Measure the signal out of the drive amplifier with the audio voltmeter. The difference between this output signal and the required input signal to the load amplifier is the value of the required pad.

BALANCED AND UNBALANCED

Intermixing balanced and unbalanced circuits indiscriminately will work okay in some cases, but it is also an open invitation to noise, hum, and r.f.i. problems. Since broadcast audio systems use a balanced system, if there must be a unit that has an unbalanced in/out arrangement, the best method is the use of an isolation transformer. The transformer will electrically isolate the two different circuits. A balanced-to-unbalanced pad can also be used if the loss can be tolerated.

SUMMARY

Matching an audio system is more complicated than buying the desired audio units and simply connecting them together. All these units should work together as a system in which the units have been carefully matched in impedances, signal levels controlled, and balanced/unbalanced circuit mixture avoided as much as possible or controlled. ■

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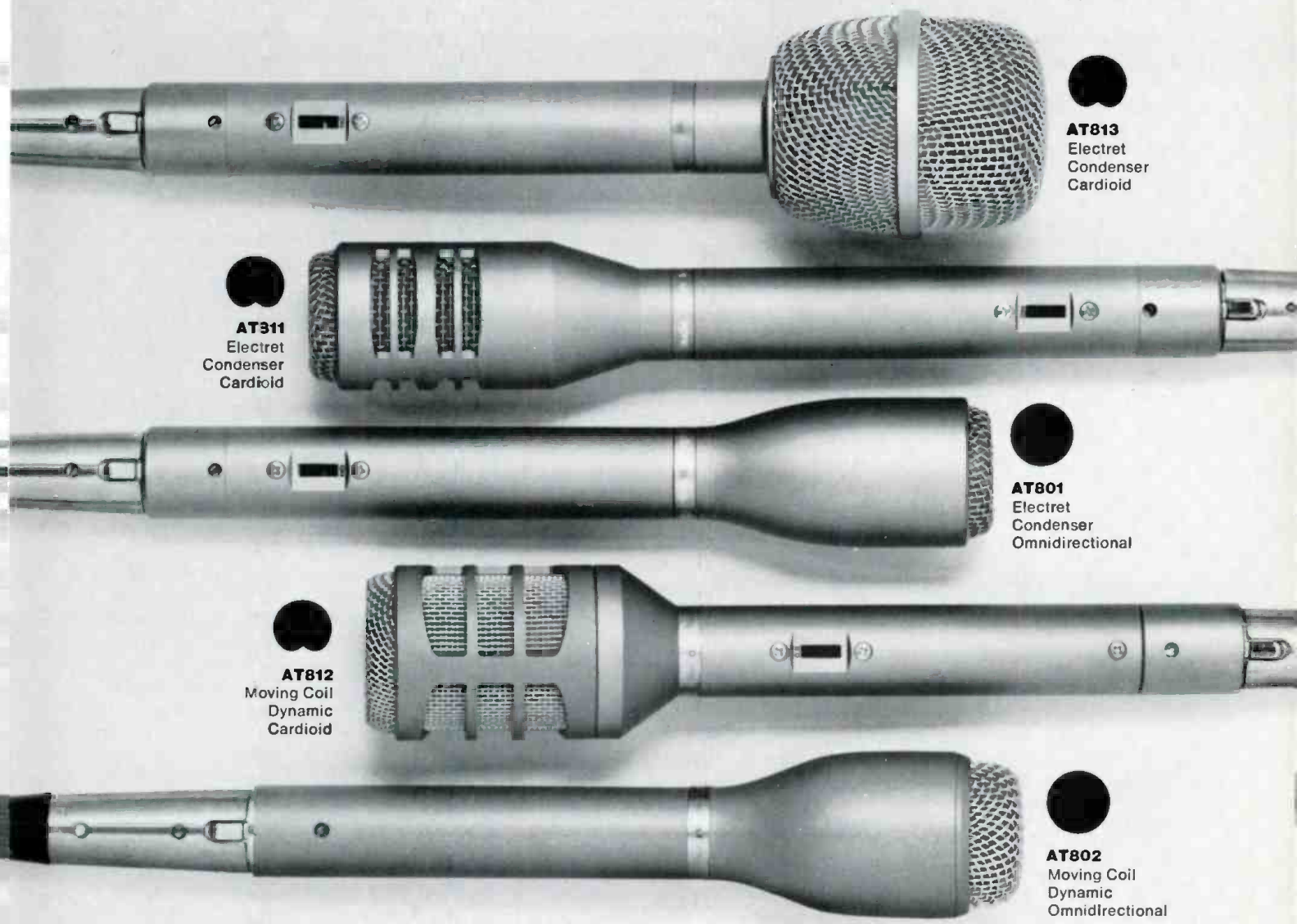

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NORMAN S. CROWHURST

db Theory & Practice

● The tenth anniversary! Elsewhere in this issue, you will find an update of the article I had in that first issue. The idea of a column on Theory and Practice was, for me, the fulfillment of a dream. I had tried a few columns that had not lasted more than a year. Then **db** wanted one and your editor asked me if I would like to try it.

What could I use as a handle on which to hang lots of different things to say—if it lasted that long—year after year? Perhaps a better way of thinking about it was to ask what was the most common denominator to all the various things about which I write and speak. That was how I came upon the idea of theory and practice.

There has always been an idea that theoreticians, or the academic fraternity, and practical people look at things differently—almost live in a different world. From the academic person's viewpoint, the practical man may do the right things, but he either explains them all wrong, or does them for the wrong reasons. And from the practical person's viewpoint, the theoreticians always have their heads in the clouds with the most impractical of ideas.

What has always impressed me about this state of affairs is that we all really live in the same world. And my own experience had gleaned much, even then, from bringing together theory and practice, with the realization that the oft-heard rationalization "In theory it's this, but in practice it's that," is fallacious. In the real world, theory and practice must agree. If they don't seem to, then one or both of them need adjusting.

Having thought of that idea, I sat down and listed some subjects that could be treated that way: in a few minutes I had enough to last well over a year. And once the column started, that list got longer as people wrote in to make suggestions or asked questions that betrayed a need for this kind of treatment.

Response from readers has grown more enthusiastic over the years. I do not know whether my writing style has improved, or whether readers have become used to the style I had. Some have given me grist—more ideas along the same line, that I had missed myself somehow or other. Some have asked questions that led to ideas. And a few have wanted to argue my "facts."

After the column had been running about three years, during which time I had stayed strictly with technical audio matters of theory and practice, your editor suggested that maybe I would like to branch out a little, not stay with the strictly technical.

Till then, I don't think I had thought of theory and practice in any context other than engineering. I had been active in other fields: education, politics, and Christian education. Of course, there are differences of opinion in every field. But only in engineering had I thought of these differences as being related to an alleged contradiction between theory and practice.

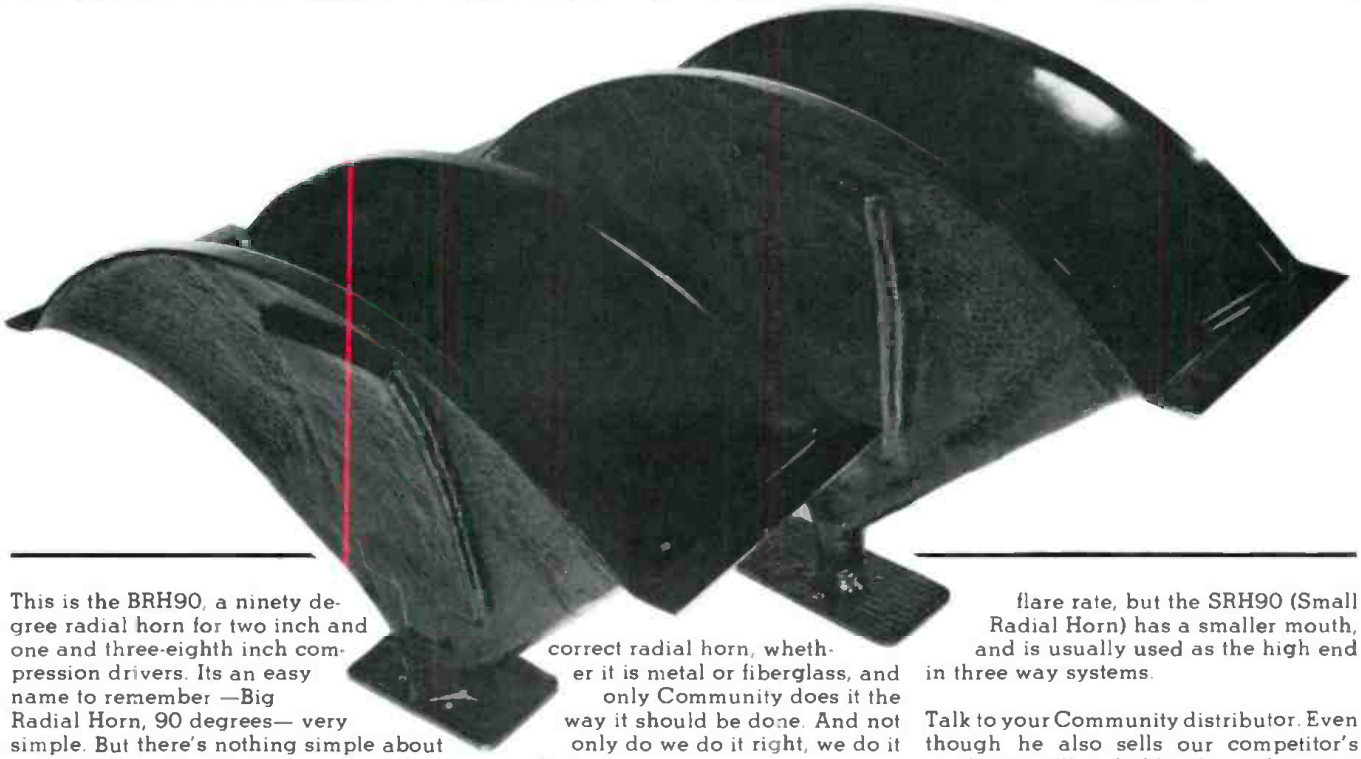
It was along about that time that I succeeded in securing a position with Teaching Research, a division of the Oregon State System of Higher Education, as Assistant Professor. They wanted me because I could bring experience from other disciplines, notably engineering, in research and development. Till then I had not thought of research and development in an educational context.

I could write a book about what I learned on that project and I have told many of my experiences in this column from time to time. But from the viewpoint of seeing fallacious application of theory to practice to get false data, one stands out. It is almost as foolish as this story I heard while on that job.

The story goes that a researcher was conducting an experiment on grasshoppers—his equipment, a grasshopper, a pencil and a lab notebook. He put the grasshopper by the pencil, and said "jump." The grasshopper jumped, clear to the other end of the room. The researcher retrieved it, tore off one of its rear long legs, and set it by the pencil again.

(continued)

BRH90 RADIAL HORNS



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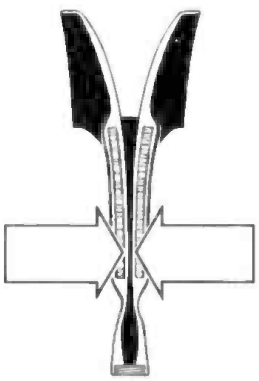

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Operating Range	500Hz up			600Hz up			1,000Hz up		
Size: H.	11 1/8"			12 1/4"			6 1/2"		
W.	33 5/8"			30 3/8"			24 3/4"		
D.	21"			20 1/2"			18 3/4"		
Weight	25 LB			20 LB.			12 LB.		
Finish	Black, High Gloss			"			"		
Horizontal Dispersion	KHz	-3dB	-6dB	KHz	-3dB	-6dB	KHz	-3dB	-6dB
	6	85	95	6	80	90	1.2	95	100
	2	90	90	2	90	100	3	90	95
	10	80	90	10	85	90	10	85	100
Vertical Dispersion	KHz	-3dB	-6dB	KHz	-3dB	-6dB	KHz	-3dB	-6dB
	6	50	90	6	55	100	1.2	50	70
	2	35	50	2	35	50	3	40	65
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He repeated the command to jump. The grasshopper was not so quick to jump this time, and he did not go nearly so far. Finally, he tore off the other leg, and repeated the procedure. But however loudly he screamed "jump" at the grasshopper, he did not jump.

So he picked up the pencil, to write his conclusions in the lab notebook. "A grasshopper's legs are evidently connected with his hearing mechanism. Removing one leg makes him deaf, and removing both of them, stone deaf."

The real life version: a school in the South where a heavily funded black studies experiment was being conducted. My job was to interview the workers on that project, to learn their conclusions. Repeatedly, they would report, "We find that black children . . ." As I listened, I had a picture of my own children in school, back home.

Every problem they described to me as being problems peculiar to black children was identical with a problem my own children had experienced in the school they attended. And in most instances, I had enough experience to know that these problems were common to children almost everywhere, regardless of color, economic background, or whatever.

However, these workers were reporting all these things as being unique "discoveries" about the problems and learning habits peculiar to black children. And because of this, the proposed "remedies" were ethnically oriented, rather than tackled as being more fundamentally associated with the structure of education, as applied to all children.

Of course, the same can be said about other artificial segregations practiced by educators, such as slow learners, differentiation by IQ, and all that nonsense. My point here is that seeing what is wrong in education also answered the questions I was finding in the engineering problems that readers sent in.

SPURIOUS FACT-ORIENTED ED

I could see why certain readers would cite a page in Terman, the electronic engineer's bible for many years —misquoting him, of course—and refuse to believe what I said, or even to set up a simple experiment to verify for themselves. They were suffering from the spurious "fact" oriented education. If it is in the accepted text book, then it must be so. The textbook cannot be wrong (although most often, it was their reading of it that was wrong: the textbook was right).

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One of the years I participated in the Brigham Young University Audio Recording Technology workshop, the student body showed a similar desire for the vitamin pills of engineering: formulas. I was concentrating on conveying principles that would be valuable to them. They wanted formulas they could "plug in."

They were so insistent, that I decided I must show them. So I drew a chalk line down the board, and reserved the right hand side for formulas. For everything I showed them, I wrote an appropriate formula. Presently they asked the obvious, 'With all those formulas, how do you know which one to use, in a given situation?"

Then, after showing them some consequences of picking the wrong one, I got back to developing the principles that would serve them far better than formulas ever would. That year, Bill Putnam, of Universal Recording, visited the class. He told them story after story of people who have made it in the industry, and what it takes to be good. I could not have had a better back-up man for what I had been trying to convey.

So, writing this column has been an ongoing experience. As well as providing the readers with something I know—from the many letters I receive—is appreciated, it has provided me with a discipline, a framework of consciousness that pertains to other areas of life.

Like the small class of high school students studying calculus, that I visited one day—all straight-A, the cream of the crop—people in all walks of life want ready-made answers. The students told me they could solve any kind of problem I would give them *if* I showed them how first. The problem of today is that we are getting ever more of these smart programmable high-class zombies, and fewer of the people who can do the programming.

It gets to be a situation of "the blind leading the blind." Research, today, means seeing what somebody else says. When I was young, there was a party game we used to play: we would form into a circle and whisper a message into the ear of the person on one side of us, who would whisper it to the person next to him, and so on round the circle, until the person on the other side of the person who started it, would whisper the message back to him.

The message that came back was invariably totally different from the one that started out: often no similarity of content, sound of the words, subject matter, anything.

USING WORDS

People hang onto words as if they were facts. Some have tried mediated instruction, using a/v materials. "It's a waste of time," they report. Others have found the device far superior to anything they have seen before. The difference is not in the a/v, which may be the identical system. That is why you will hear people arguing whose report is right. The difference is where the difference always has been—in how it is used.

This is the same problem I had been confronting for years in an engineering context. It is not so much that the theoretician and the practical person have different views on life; they both have the same kind of view, one that is fact oriented. Only what they call facts are not.

The theoretician has the equivalent of his formulas, all in pigeon holes to be used on the proper occasion, mostly half-truths. The practical person has his set of "what-to-do-when" facts, that work, hopefully better than half the time, but still without knowledge of why, or understanding of principle.

POLITICS AND LAW

In the field of politics and, more recently, of law, I was to learn that the same thing applies. Americans profess to be proud of a form of government by laws, rather than by man. They will exhibit this by the question "What does the law say?"

The law can say anything men want it to say—very nearly. There is no more guarantee of its truth than there is of what theoreticians or practitioners in any other field say. To make the law work, you must look beneath the surface of ready answers to the underlining principles: what motivates men to use laws in the way they do.

In a recent court case, because this is something no lawyer I could find can understand, I represented myself, after much opposition to the idea, in *Propria Persona*, as my own attorney. I conducted the questioning, the cross-examining, the final argument, all myself. When I was through, various officers of the court, including the judge, commended me for a performance that was exceptional, especially for one who was, as the judge put it, "operating in a completely strange milieu."

Although I lost the case, I had gotten into the record all the right facts for review by the Appellate court, where the law can be changed. What I was doing, scarcely realizing it, was applying the principles of theory and practice in yet another context. And it is working there, too. ■

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JOHN M. WORAM

db The Sync Track

• Since we salute the state-of-the-art in this issue, it seems I have a built-in excuse to once again pontificate on the miracles of modern science, and how these miracles affect the recording scene. But before getting to the point, let me digress for a paragraph or two, to supply some background information.

I recall all too well my early days in the recording business. Contrary to popular belief, I did not start out as Thomas Edison's gofer. However, I was around during those days when stereo gradually replaced mono. At about the same time, professional tape recorders made the transition to half-inch tape; first with three tracks and then with four.

Both transitions were made to the raucous accompaniment of the famous old-timers' chorus, chanting the refrain, "Mono's all we need." In fact, one illustrious sage—who has since made millions selling stereos to an adoring public—solemnly proclaimed that the point source of sound was more than enough for anyone.

At the time, I promised myself I would never thumb my nose at the latest state-of-the-art developments, lest I too be branded as an old-timer.

Well, here we are—some 20 years later—and I'm looking over the latest state-of-the-art goodies and wondering, "What the hell has happened to good sound?" Mind you, I did *not* say good music. *That* is in the ear of the beholder, and is quite another subject. In fact, when it comes to recording, music and sound seem to have little or nothing to do with each other. But more about that as we progress.

Getting back a little closer to the point, I find myself thinking that good sound is getting as scarce as fresh air and clean water. So, am I becoming the late-seventies counterpart of the "mono's all we need" school? Maybe good sound, like mono, is old-fashioned and irrelevant, and I'm at last a member in good standing of the old timers' chorus.

WRETCHED RECORDINGS

But maybe no. In the October issue of *High Fidelity*, veteran producer John Culshaw sides with his long time adversary, Conrad L. Osborne, in bemoaning the generally rotten sound on many of today's classical recordings. It seems that classical producers have discovered the miracle of multi-track and are using it to produce some generally wretched recordings. Culshaw cites one major label whose opera recordings are musically ". . . as flat as the proverbial pancake." But take heart, Culshaw and Osborne, you are not alone. Some pop producers are doing the very same thing.

I recall a certain girl singer who surfaced on the Johnny Carson show about a year ago. Her pipes (and other assets) were—and are—sensational, and of course one of the big labels signed her. Believe it or not, her album sounds worse than her t.v. show. For one thing, the brass section sounds like it was miked with a Campbell's soup can. Fortunately for her, she's not with the label anymore, and maybe her next recording will sound better.

On the other hand, maybe it doesn't make any difference what her next album sounds like. When the first one was reviewed, one critic commented on the poor choice of material, but unlike Culshaw, didn't even notice the sound quality. Neither, I presume did her manager, producer, engineer, or

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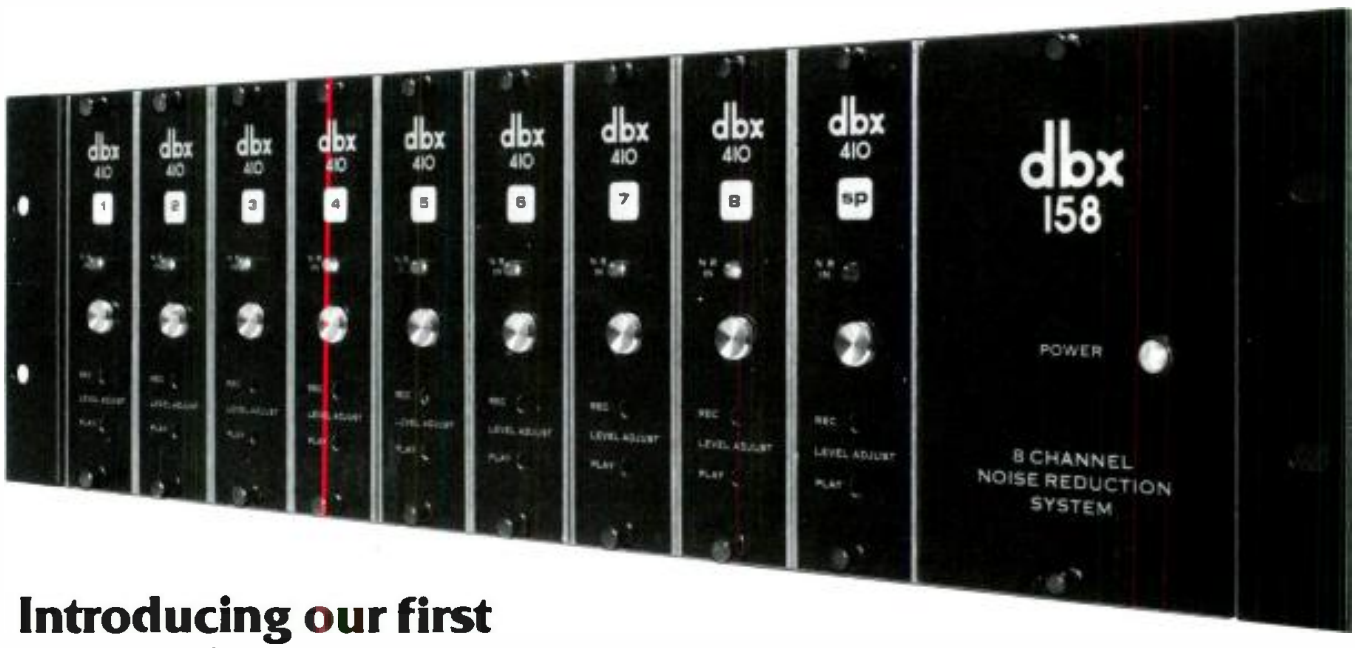

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anyone else associated with the recording.

Of course, she's not the only victim of lousy sound, which now and then gets blamed on the encroaching technology. It just doesn't occur to some anti-technology critics that, by itself, technology is incapable of either hurting or helping good sound. First, the technology has to be manipulated by some human type, and that's where the trouble starts.

Just for fun, I dug out an old Kate Smith album, produced a few years before **db**'s birth, and therefore just before the industry became totally committed to multi-track for everything. It sounds a lot better than most of today's masterpieces, including the album mentioned above.

And so it goes. One well-known super-star began his career with a few albums mentioned above. He now records at the current studio of the stars, featuring super-groovy ambience, incluidng 24 tracks with all the trimmings. His records sound as if they were done in a carpet showroom. On the other hand, he's a millionnaire, and I'm stuck writing this column, so maybe he knows what he's doing after all.

HIGH TECHNOLOGY

I, for one, hope not, and maybe the state-of-the-art will come to my rescue. High technology has found its way into the consumer marketplace, and we now discover $1,000+ turntables selling—and selling very well too. And one company plans to introduce a $4,000 power amplifier early next year. They'll also have a $4,000 preamplifier to go along with it. JBL's new L212 stereo speaker system sells for almost $2,000. There's one problem with most of these high-buck products: there's a long waiting list to get them.

Hopefully, the people who buy these little trinkets will want to get their hands on some records that are worth hearing. When you hear tin-can sound over a super-system, it can be a real sonic disaster. Of course, this market is still a minority one, but sooner or later this technology will find its way into lower priced consumer hardware. In fact, even now one t.v. manufacturer has announced a new set featuring a woofer and a tweeter!

So, as technology brings even greater sound-reproduction capability into the hands of the average record buyer, maybe people will begin complaining about what they hear.

CONSUMER REVOLUTION?

I suppose it's unrealistic—stupid, even—to expect that a consumer revolt will eventually force bad recordings off the market. But maybe as the state of the art gets even more sophisticated, the pendulum will start swinging back towards good sound. Just think of it—microprocessors, digital audio, quad sound (well, why not?), automation everywhere, *and* something worth hearing too. I hope I live long enough. (Another column like this and you might not. Ed.)

Of course, there are a few other areas in which technology gets blamed for man's little stupidities. Like polluted rivers, unhealthy air, noise-polluted neighborhoods and whatnot. But, if you've been watching the battle over SST landing rights, you'll know that now and then the public does make its wishes known. So maybe sooner or later, the public will come down on rotten sound. I hope it's sooner. For given the current state of the art, and the possibilities of the future, we could be in for some sensational recordings. ■

John Woram's The Recording Studio Handbook

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- Magnetic Recording Tape
- The Tape Recorder
- Tape Recorder Alignment
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- The Recording Session
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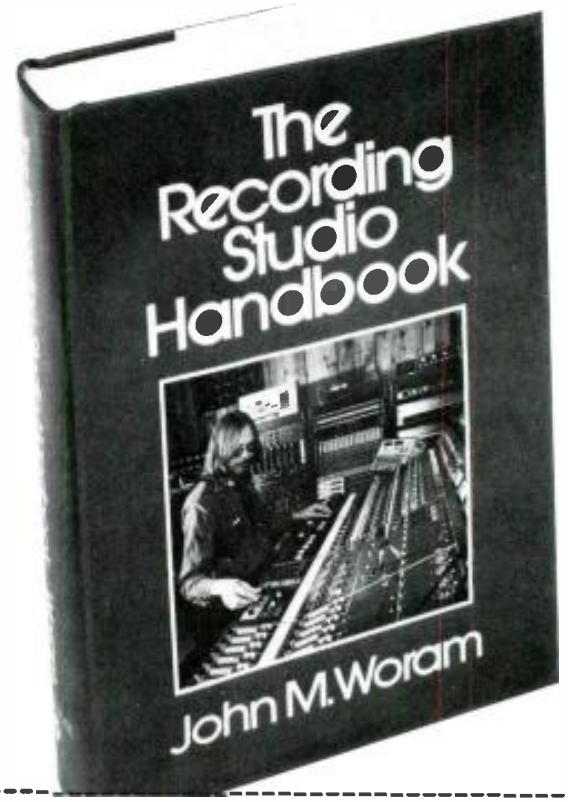

In addition, there is a 36-page glossary, a bibliography and five other valuable appendices.

John Woram is the former Eastern vice president of the Audio Engineering Society, and was a recording engineer at RCA and Chief Engineer at Vanguard Recording Society. He is now president of Woram Audio Associates.

This hard cover text has been selected by several universities for their audio training programs. With 496 pages and hundreds of illustrations, photographs and drawings, it is an absolutely indispensable tool for anyone interested in the current state of the recording art.

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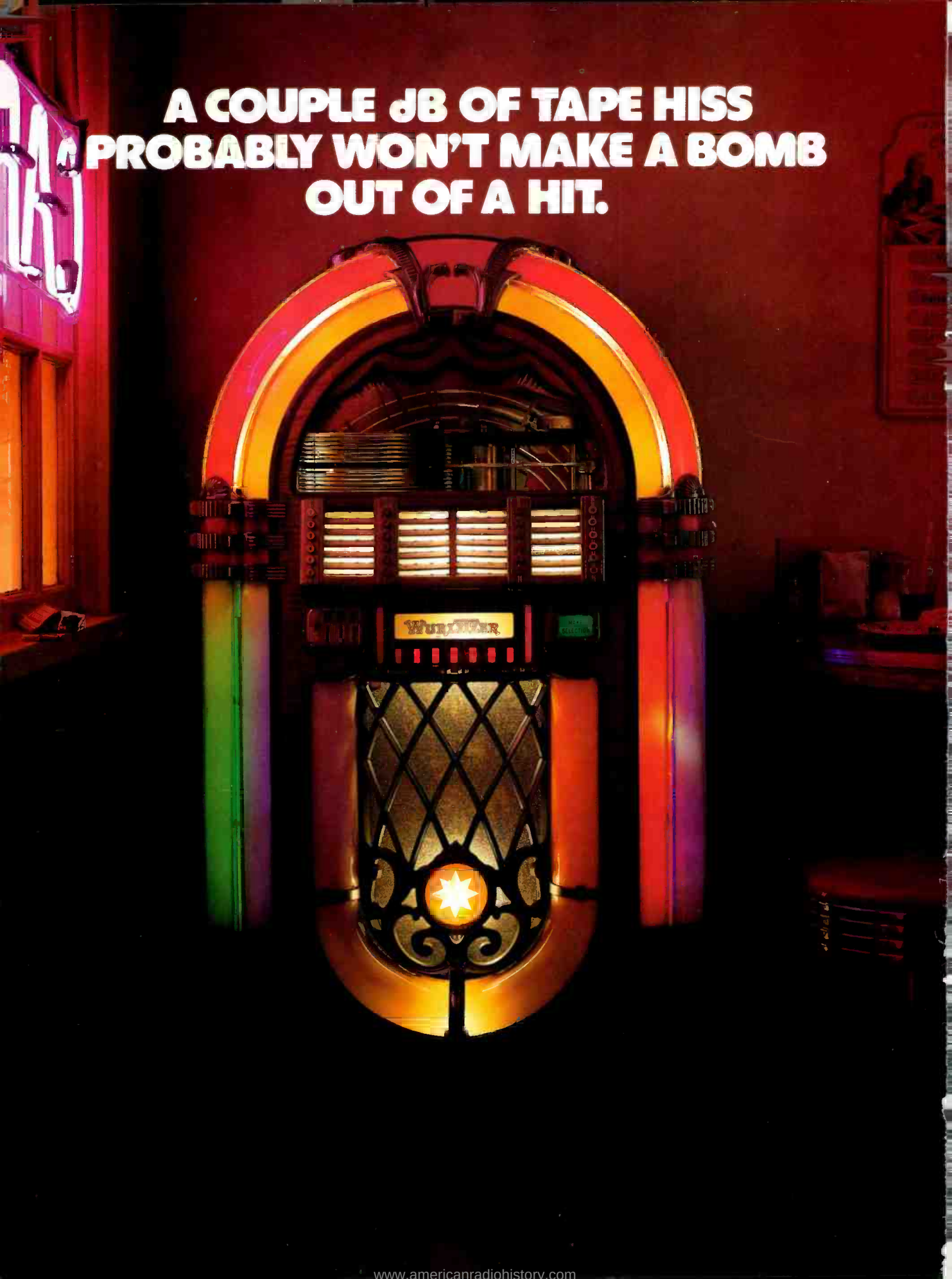
A COUPLE dB OF TAPE HISS PROBABLY WON'T MAKE A BOMB OUT OF A HIT.



BUT SOONER OR LATER YOU'RE GONNA HAVE TO CLEAN UP YOUR ACT.

WHY LIMIT YOURSELF WITH MASTERING TAPE?

You won't catch a professional racedriver putting cheap gas into his Lotus. It's just dumb.

And the same holds true in the studio. With all that heavy machinery and expensive talent, it makes no sense to compromise on your mastering tape.

TODAY'S SCOTCH 250 IS THE STATE OF THE ART.

With 250 you get far less tape noise. Considerably more high end clarity. Our exclusive oxide formulation and application reduces Mod noise. And when you add all that to dbx or Dolby it's positively the cleanest sound around.

SINCE WORDS ARE CHEAP, WE PUT 250 TO A ROUGH TEST.

Whatever the numbers or the meters say, it's your ears you should listen to. So we went to a very fussy, very fine engineer and asked him to devise a test to demonstrate the difference between 250 and our nearest competitor.

The guy first thought we were nuts.

"You're serious?" he asked. "I use 250. What if my test proves the other tape is cleaner?"

We gulped a little, and told him to go ahead. This test was bound to be expensive. But it would also be worthless, if everything wasn't above-board. That's why we chose Tom Jung of Sound 80, Minneapolis, to put it together. You may have heard of him.

THE TEST PROGRAM WAS RECORDED—ON TWIN MACHINES.

Jung, as we expected, left nothing to chance. On April 18, 1977 he recorded an original music program simultaneously on two 24-track MCI's fed by one console. One recorder was carefully optimized for 250. The other, just as carefully, for the competitor's tape.

Jung used NAB equalization at 15 ips. He really packed both tapes at 6db (370 nWb/m) over standard operating level—without a shred of noise reduction.

THE TRUTH CAME OUT FIRST AT THE AES SHOW.

It was May 10, 1977 at the LA Hilton. For playback we set up identical machines (our own M79 24-tracks, this time) with Altec 19 speakers. Then we opened our doors.

For each group of engineers we played not only the full mix, but individual tracks, first on one machine, then the other.

THERE WERE SOME WHO COULD NOT BELIEVE THEIR EARS.

"Play that bass track again," they'd say. And we'd play it.

"Are you sure both tapes were recorded at the same level?" We assured them they were.

"Lemme hear the strings with the horns."

In three days close to 600 people heard our 20-minute demo.

AND THE TRUTH IS...

We didn't find one engineer who didn't hear the difference in L.A. Ditto in Nashville, where the demo was repeated July 13 and 14.

You can simply pack more sound on Scotch 250 and still stay clean.

So the bottom line is this. Scotch 250 is cleaner tape. Sorry, Ampex.

3M COMPANY

CLEAN UP YOUR ACT WITH "SCOTCH" 250.

Circle 37 on Reader Service Card

MARTIN DICKSTEIN

db Sound With Images

A/V Visuals

● The year 1977 has been a momentous one in many ways. It's the first year of the nation's second bicentennial. It's 50 years since the building of the Cyclone Roller Coaster in Coney Island. It's the last year the open tennis tournaments will be played at Forest Hills, N.Y. It's 50 years since the CBS Radio Network began broadcasting. It's the 50th year since the first public demonstration of long distance t.v. transmission in the U.S. (Herbert Hoover, then Secretary of Commerce, had his image sent by wire over the 200 miles from Washington, D.C. to N.Y.C. and the future of commercial t.v. was in grave doubt.) This is the 100th year of sound recording. It's 50 years since the first movie recording.

And, this month, November, 1977, is the 10th aniversary of the birth of **db**. This column began with the first issue, and, except for a very few misses, has run continuously. Since this corner most usually covers things visual, subjects have ranged from simple slides through complex presentations, from the simple on-location set-up to a more complex presentation room design, as well as touching on equipment and the field of video. What's been happening in the audio visual and video fields during these past years? Where are we now, and where are we going? Let's take a look.

Regarding software, slides have been mounted differently through the

years. The cardboard mounts haven't changed much, but the more solid mounts have. First there was thick glass with metal edging for sturdy support. These were to be used in trays with wide spacing, and even the blank slides were made fairly thick. Then the thickness was cut down, with plastic used around the edges and thin glass supports for the slides. This allowed a tray to be made with thinner slots, and the blanks also were made thinner. Carrying slides became a lot lighter and easier.

Creatively, slides moved from simple words on plain and colored background to multi-image, segmented, wildly colored creations. Alignment slides were made for supered or dissolve slides, and for the high intensity projectors, temperature slides were developed to check the heat in the aperture and keep slides from burning. Then came motion slides made possible by use of polarized art work and a rotating disc to simulate motion on a stationary image. Now a method has been developed to rotate an image on the screen by using a specially prepared slide.

PROGRAMMERS/DISSOLVERS

In hardware, there have been some great strides. From the simple slide projector and a single image on the screen, the desire for greater excitement has led to multi-images, first created either by several projectors or tricky slides, then by simple dissolvers, and now by computerized programmer systems using the latest i.c., chip, memory, and readout technologies. Programmers using multi-channel paper tape are still available, as are those utilizing complex electronic circuitry which permit cues well into the hundreds to be set up on a keyboard, displayed by indicator lights or numbers, put into a memory bank until needed, and counted as programming continues. At the desired time, when all the cues have been checked and found to be correct, they are put on tape and tested again. This permits programming at any speed or in any sequence without slides (off the line, so to speak, or not in real time).

Once the tape has the cues, the memory can be wiped and a new setup can be programmed. The playback of the tape through the programmer at any future time will automatically register in the memory where it can he called up on the console for precise and immediate editing of single cues in the midst of the fastest action, after which it can be put back on tape for use or future recall. The only limit to the complexity of the possible showings is the imagination. Even animated action of people or things to simulate film motion can be programmed fairly easily.

Dissolvers have also been made more complex with various adjustable dissolve time intervals, quick cuts, freezes, flashing, and super capabilities. Between the multi-channel outputs of the programmers and the dissolvers, environmental controls are also available automatically to fit into the presentation. Lights can be dimmed, curtains drawn, film projectors and tape recorders started and stopped, and multi-screen slides made to do almost anything desired.

According to Charles Spataro, an expert in the sale and rental of audio-visual equipment, both sales and rentals of programmers and dissolvers have gone up. This can also be seen in the increase in the number of companies offering such equipment. Each is developing a complete line of small-to-large models with few-to-many features, each unit varying somewhat from the competition. Since none is

compatible with any other maker's similar models, it is necessary for the user to determine the features needed or desired, and then stay with that line, either in purchase or rental. Thus, rental and sales organizations are finding it necessary to hook up with one or two programmer/dissolver manufacturers since it is almost impossible to deal with all of them due to extensive financial and inventory investment requirements. The increase in complexity of presentations and shows has also boosted the sales and rental of slide projectors correspondingly.

PRESENTATION DESIGNER

Another aspect of the audio visual industry that has grown with the improvement and development of new and more complex control devices has been that of the presentation designer. Jim Sant'Andrea of Jim Sant'Andrea Productions in New York sees a "rebirth" in this industry, with companies who had originally purchased projection equipment for internal installations coming back for bigger, more intricate, shows for sales meetings, new product roll-outs, and so on.

Jim had some comments on his booming industry and new possibilities.

"What's new and unique? For example, you have people like AVL coming out with new equipment like the Show-Pro V. The state-of-the-art has really begun to make designers like us excited because it helps us answer the call for that kind of sophistication.

"We just completed one of the big productions in our industry. We mounted four road show units featuring magician Mark Wilson, live and on screen, touring the country, doing 14 shows—3 shows per day. Each had slide and film sequences and live performers. All of the segments that included Mark Wilson were put on film. He played from the screen to four assistants, live on the stage. We also had four look-alikes for the girl who was in the film with Wilson.

"It played beautifully; therein lies the dimension I'm talking about. That is, multi-media with film, playing with people live on stage introducing slides as an additional effect. Some special lighting I designed for the show using black lights and color gels over them provided us with a very unique look. I also used some colored screens for projections and this gave us another unique look. I'm not talking, incidentally, about pastel colors. These were punchy, solid, deep blues and deep magentas, which provided some very exciting effects."

PERMANENT INSTALLATIONS

In the field of audio/visual system design for permanent installations there has been little change in the visual end, according to Mr. Hubert Wilke of Hubert Wilke Associates of New York City. Major conference and board rooms are making use of visuals in a rather staid fashion generally, using single images, side-by-side slides, overhead projection, and sometimes three slides shown at the same time, and usually in rear projection. Remote control systems allow presenters to activate environmental facilities from a portable consolette placed near a seat at the conference table. Windows can be darkened, protective doors in front of the screen opened automatically, lights dimmed to a predetermined level for slides, and perhaps a lower level for film. There is usually minimal utilization of complex programming equipment during the initial installation, and only a small number of locations planning to add it later. Except, of

course, where the facility is used for special presentations involving multi-image flexibility.

The big problems have been with sound in some of these huge rooms. During a conference, with all the participants seated around a large table, it is necessary for each of the individuals to hear all the others clearly and to be heard by them, without any possibility of acoustic feedback between the table microphones and speakers. The innovation developed for this situation by Mr. Irv Wood of Wilke Associates is to locate microphones in front of the participants in a totally inobtrusive location to provide excellent pickup yet allow for as much possible room on the table for papers and books and writing space. In one installation, tiny microphones were located at the center of the circular table, recessed in the side of a slightly raised core, the top of which could be used for small desk implements. In another situation, mics were placed flat on the table and covered with a foam rubber enclosure.

The mixing/amplifying system is carefully balanced and equalized with 1/3 octave equalizers to prevent feedback, with enough gain to feed as many microphones as needed (sometimes over 50) to the speakers. These transducers are recessed in the side of the conference table at each chair position. This way each of the people at the table can hear all the others very clearly at good level without even realizing in some cases how this is accomplished.

VIDEO

In the field of video, there have been huge steps forward in the past few years. The introduction of the integrated circuit and tiny chip technology has opened the doors to numerous developments. Tiny light sensors have provided the means to video camera miniaturization to the size of a cigarette pack. Video recorders started as 2 in. quads having four heads and using tape 2 in. wide for professional applications, then moved down to 1 in. tape with two heads, then ¾ in. and ½ in. tape, and even ¼ in. tape, for capturing images and sound. At first, the narrower tapes were not acceptable for broadcasting or other professional use due to electronic system limitations. Now, with time base connectors in the system to eliminate some of the technical inadequacies of the less expensive electronic systems developed for the narrower tape machines, all tape formats can be stepped up to broadcast-acceptable standards.

Video tape editing used to be done electronically on the 2 in. format. The editing block-and-razor method was used for the non-professional formats. Now, complex tape editing is possible for either inserting or adding on with or without sound at precise frames with ¾ in. cassettes. In fact, this ¾ in. with computer-assist technology has been developed to such an extent that it is used most often now with complete reliability and exacting accuracy and at much less cost than the 2 in. system. The quality is also totally acceptable, and the method used even for t.v. programs. With the addition of special effects generators, image enhancers to sharpen poor pickups, chroma keying, and a matting process similar to that used in film, there is almost nothing the video format cannot do, giving producers a completely satisfying medium to work in. The 1 in. is back again, much improved, and good enough for broadcasting.

Electronic games have come into the picture. These have become a multi-million dollar industry in a very short time and are presently being considered for and applied in learning and

training situations. The use of the microprocessor has allowed the home user to program his own games on the t.v. set.

VIDEO RECORDING

News in video recording include home recorders in the ½ in. format. which have made their inroads. Japanese and American companies have teamed on opposing sides of the battle screen. Each combine has its own approach, and again, its own format. The race is now on to get to the market place quickly at the proper price with as long a playing cassette as possible. Time has come up from one hour, to two, and now, to four hours on a single cassette, in some instances with compatibility between models of the same manufacturer. This equipment has also entered to some extent into the industrial and educational fields to supplement the existing systems, and in some cases, instead of the previously available formats. It is expected that this vtr/vcr business will go to the one billion dollar mark in sales in the next few years, in spite of the legal questions of recording off the air, the greatest use to which this technology has been applied.

WORLD-WIDE COMPATIBILITY

The world-wide use of video equipment in offices and schools, as well as in remote locations has provided an excellent means for communication between organizations and affiliates in foreign countries. When necessary, video cassettes are sent throughout the country and throughout the world to keep in touch easily, and interestingly, without having to put top executives on a plane for minor occasions. However, since video standards vary around the world, there was a need for a way to provide at least a play capability so that tapes in one standard could.be played in countries with another standard.

Such a system was developed by Sony, and now there are video cassette players made which can be switched to play either through the European format (PAL) or the American (NTSC). Recording capability is still limited to the country of origin so that units used in Europe record in PAL and those in this country record NTSC. The switchable units are the players. Special monitors have to be used, but they are capable of showing either the PAL or NTSC pictures without switching. Now, there is even a development to provide machines with the third standard (SECAM, used in France and the iron curtain countries).

The tremendous need to have tapes transferred from one format to another to permit sending to locations where the interchangeable machines were not yet available gave one reason for the growth of Devlin Productions in New York. Sandra Devlin started the company on a small scale and provided a unique but vital service. The organization which recently moved to larger quarters, has the capability to work in the Philips format (used widely throughout the world) and PAL-m, a variation of PAL. According to Ms. Devlin, whose background includes theater and technical training, even a unique service like format transfer was not sufficient. Duplication of tapes, working from any medium like reel-to-reel to any other, and video editing along with provision for a video studio for recording purposes were also included in the new location. And, for outside work, a remote video facility on wheels can also be provided.

PREVIEWS

Several recent technological developments have great prospects for the future. Fiber optics, for instance. which started out as an interesting and eyecatching technique in displays (like illuminated cities seen from very high up) at places like World's Fairs. is now being applied to long distance communications and video transmission and has been found to be better than cable. Hundreds and hundreds of different signals can be sent in a glass fiber thinner than a human hair for long distances before requiring amplification—this is being improved daily.

Large screen video projection is finding greater application than just sports arenas and local bars. Development of screens like the Ektalite unit and more powerful projectors will soon provide the home viewer, as well as the industrial user, with images the size of walls, and possibly the use of plasma layers or other similar chemical achievements will make the screens thinner. T.V. sets are going both ways with a 25 in. screen coming out, and a set with a 2 in. screen already on the market.

Other developments are also on the way. The most immediate is the video disc. With two (or three) major factions, there are two distinct technologies and variations. One is to have the needle actually run along the record to provide the image. The other is to use a small laser to read the indentations on the disc without any physical contact. It would seem that the latter system has some strong advantages, such as ability to play a disc indefinitely with no wear on the sur-

face, permitting unlimited viewing of a still-frame image, ease in handling because the light will focus on the signals imprinted below the surface (or on the reverse side, in one variation), and passing through surface dirt and marks. The video disc is claimed by many to have the greatest future of any recording medium up to now because of the immense density of storage that is possible and the sheer quantity of information that a disc will hold.

Speaking of a/v, designer Sant' Andrea says "I have another thing I call the inner sphere theater that I developed when I came to realize that the people didn't have to be in the dark. The picture did. I blow-molded a flexiglas sphere of two hemispheres about eight feet in diameter and set that on top of a pedestal which contained a projector and a convex mirror. The top half of the sphere was a concave screen and you had little portholes around the sphere. It's like the old hole-in-the-fence at a construction site concept. People just cannot walk past it. For one of our clients, we had four of these modules all in sync with one sound system and one audio track. They looked like a mushroom patch because they were set up in a seemingly random design. This patented device attracted more visitors than any other exhibit."

LASER, 3-D HOLOGRAPHY

Laser technology and 3-D are still in the development stages, but discos are making tremendous use of the laser beam to cast weird but interesting patterns on the walls, the ceilings, the performers, and the audience, or dancers. In some cases, the lasers are programmed to follow the music and by using them in combination with the music, the shapes cast around the hall can take on the same visual effects that electronic instruments can perform on the music itself. 3-D film has still not come into its own for the general public, but holography has, even if in small examples such as contained advertising projections.

Mr. Sant'Andrea has experimented and thought of how to use these developments for a.v. presentation. "We find holography trying to make its way into our industry and have been talking with a couple of artists who are well into that. The problem is, of course, not only the budget, but the state of the art is not quite there yet. But what excites me is that I see it on the brink. Having more practical mechanical methods with which to produce the hologram is putting us closer to practical application. The imaging is still a little sketchy, but it's better than it was.

"Just a few months ago, I applied for a patent for a 3-D screen. We got the patent, and right now we're using it with slides and film. It's not 3-dimensional as 3-D implies. It's an artificial 3-D, but to the audience the dimension of projection over various depths of screens coming at them, each individually being projected upon, looks like 3-D. It allows us to create background projection, middle ground projection, and foreground projection, all of which gives the illusion of 3-D. After all, what is 3-D? It's an illusion."

So, it seems, were many of the present state of the art developments to those of the past who couldn't see in more than one, or even two, dimensions. What does the future hold in store? "Star Wars" on a wall sized screen with the viewer able to control his own effects? "Close Encounters of the Third Kind" with the viewer in the theater being able to touch the beings from outer space? Or are these mild illusions compared to what is really forthcoming? ■

The best audio recorder in the world.

Buy an Ampex ATR-100 for your studio, and you'll have the finest audio recorder ever offered for sale. Use it for monaural, two-channel and four-channel work, and you'll produce recordings (and playbacks) that simply cannot be matched by any other machine.

The fully servoed transport with automatic tension control and dynamic braking nails down tape speed for unprecedented timing accuracy. By eliminating the pinch roller and employing a unique tape path design, Ampex found a way to greatly extend tape life and reduce transient stresses. Spin the capstan, and both reels follow suit. Try to start the transport with the tape loose, and nothing happens. Kick out the power cord during fast rewind, and the machine slows gradually to a programmed stop.

The lift-out control panel has LED indicators for status on every channel, and control is a matter of touching calculator-like buttons. Search-to-cue arms at a touch and stops on a dime. You even get a choice of 60 or 120 ips shuttle speed under capstan control plus a superfast rewind speed.

Mechanical features of the ATR-100 are important, but don't overlook audio performance. Many specs are a full order of magnitude better than anything else on the market, and *every* performance measurement is the world standard. ATR-100 is what Ampex knows about sound recording.

Get the complete story on this ultimate performance recorder by requesting a free brochure on the ATR-100. The best audio recorder in the world.

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EDITORIAL

Ten Years! Time does fly.

This is not an attempt to look back. Looking back smacks of back patting, and that I will not do. I will say that **db Magazine** has come a long way since November 1967—a look at the early issues will certainly tell that. But there is still a long way to go, looking toward the next ten years as being even more exciting as the past has been.

Thinking about what will happen in the next ten years is speculative fun and it is abetted by the knowledge of what is happening in laboratories now.

Digital Recording: This has been promised so long that it is becoming almost a myth. But the fact is that a working unit will be exhibited at the current AES Convention. Other units are in operation in Japan already, though this is not to suggest that a flood of machines is on the way.

But digital recording is coming. Not this year, perhaps but come it will, and we will be watching and reporting.

Perhaps more significant than digital recording is the microprocessor. An article in this issue tells some of where it's at, but there is more. I've had talks with manufacturers of consoles whose interest in automation systems is high, but present day console automation systems are involved and sophisticated circuits indeed, costing many kilobucks. A single chip is now available around which a small microprocessor can be built. I believe that a control system using such chips as the CPU will permit a fully automated console to be built in the near future for very low cost involving the automation aspects.

New tape formulations are in the labs waiting for a new generation of tape decks that will give yet a new lease on life to analogue recording. These metal particle tapes may begin to appear this year, or early next year.

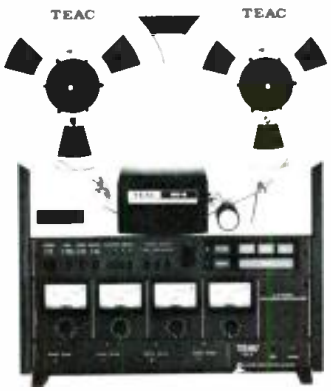
In fact, to review my earlier comment on digital recording, I can't help but wonder if analogue will continue to become better every time there is a likelihood of a digital machine at reasonable cost.

Whatever the future holds. **db Magazine** will endeavor to be the first to tell you about it. Ten years ago, we dedicated ourselves to the practical aspects of audio engineering. In 1977 we rededicate ourselves to this task. Larry Zide

db New Products & Services

FOUR-TRACK RECORDER

● Three-head 40-4 four-track recorder/reproducer features full integrated circuit logic with motion sensing and a memory stop function. The unit has a combination record/reproduce head, erase and monitor heads, function and output select buttons, l.e.d. overload indicators, and accessible calibration controls, a dual-speed, hysteresis synchronous capstan motor and two eddy current induction reel motors. Claimed wow and flutter is 0.05 per cent at 15 in./sec. and 0.07 per cent at 7½ in./sec; frequency response is 50-20,000 Hz at 15 in./sec. and 50-15,000 Hz at 7½ in./sec. with a weighted s/n of 65 dB. The unit takes up to 10½ in. reels, recording at 15 and 7½ in./sec. Optional features include four-channel dbx, remote control, and a mic preamp module.



Mfr: TEAC Corporation.
Price: $1,600.
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DISTORTION ANALYZER/OSCILLATOR

● An addition to this manufacturer's group of measuring devices, the IE-15A distortion analyzer, is battery-powered with an a.c. adaptor/charger that provides continuous line information. The unit contains an overlay screen, phono-to-clip lead input cables, and two phono plug patch cords. The device measures distortion of less than 0.02 per cent to 100 per cent, in 9 ranges. It comes in a vinyl carrying case with a belt loop. Other items in the coordinating set are Model IE-10A real time audio analyzer, and Model IE-20A, pink noise generator.

Mfr: Ivie Electronics Inc.
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NOISE REDUCTION

● Tascam and Otari eight-channel recorder owners can use Model 158 noise reduction system to upgrade their master tapes. The unit provides eight channels of record/play/noise reduction in a modular rack housing. It contains a 2:1 mirror image compander which compresses the signal's dynamic range of the tape recorder, providing 30 dB of noise reduction and 10 dB of additional recorder headroom. At playback, the original signal is recreated, minus audible tape hiss. Model 158 has one channel of independent record/playback electronics in each module, permitting simultaneous monitoring of the noise-reduced program while recording is in progress. The system comes with a spare-plug-in module.

Mfr: dbx
Price: $2,400.
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MIC DISTRIBUTION AMPLIFIERS

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NORMAN H. CROWHURST

Tests and Measurements

More precise testing should lead to realizing the potential capabilities of both a.m. and f.m. transmission.

WHAT HAS CHANGED MOST in tests and measurements over the last ten years? Perhaps the most obvious change is the replacement of analog meters—you know, the ones where a needle used to move over a calibrated scale—with digital types, that give you a readout in clearly readable numbers. With that change has come an increase in precision we would not have believed, ten years ago and improvements in other directions.

Not the least of these has been the convenience that all kinds of solid state devices have made possible, particularly in the direction of packaging. Over the ten-year period, people with vision have written to ask me about spectrum analyzers. At first, these did not seem too practical for audio applications. It was not practical to take a frequency response quite as quickly as a spectrum analyzer entailed. Developing a logarithmic frequency sweep was a tremendous step forward, but still, if the response was expected to have wide variations in amplitude over comparatively small frequency changes, the frequency must be swept quite slowly to give the device time to follow and measure those variations.

What made this a practical technique was the advent of the storage 'scope. Now you can scan frequency as slowly as may be necessary to get the information: the 'scope will hold it for you until it is all there. Thus you can now take such a response as rapidly as is physically possible. Of course, for many purposes, such as checking equalizers, loudness controls, etc., such slowness is not necessary.

OVERVIEW

Ten years ago, stereo was definitely here to stay, after almost a decade during which a decreasing number of people continued to ask if stereo was worth it. Today, quadriphonic is, perhaps, not quite as well established as stereo was then. But tests and measurements are still concerned with determining, and committed to finding ways to determine, how well systems do what they are supposed to do.

In audio, while systems continue to get more sophisticated, the same basic requirements need to be met: frequency response, freedom from distortion, and separation in its various forms. Ten years ago I wrote about these aspects, and they are still relevant.

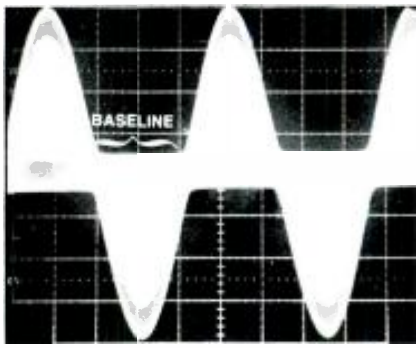


Figure 1. The classic pattern used for aligning f.m. stereo multiplex systems for separation.

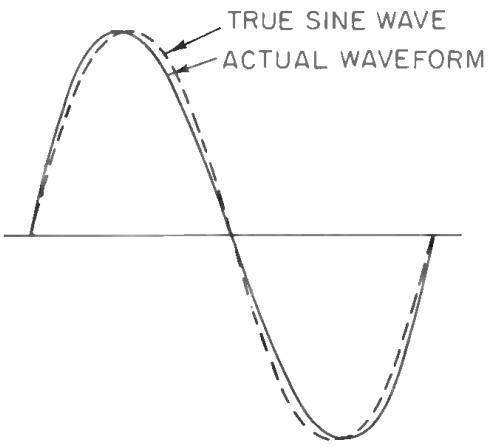
Ten years ago, some new audio equipment made fantastic claims about low distortion which today have become commonplace. But even now, the significance of such low distortion capability is far from universally applied. Amplifiers, particularly power amplifiers, are built with such low distortion figures, but other items of equipment fall far short of reaching the same standards much of the time.

Years ago, I talked about the advantages of f.m. for radio transmission. Then came f.m. stereo multiplex and everyone seems to have assumed that the advantages of f.m. would automatically inhere in the new system. Ten years ago, multiplex was already well established. Today, you can receive f.m. stereo anywhere in the country. But what is the quality like?

Fantastic separation is possible, as has been demonstrated, but too often is not realized. The low distortion that has always been touted as f.m.'s advantage over a.m. has not always been noticeable when listening to stereo f.m. broadcasts. Perhaps it is pertinent, before getting down to brass tacks, to comment on why.

Long before ten years ago, nobody would dream of measuring something without looking at it on an oscilloscope. Also, more than ten years ago, the 'scope had started to find use as a measurement tool as well as for seeing what you measure. But today, a new application for the 'scope, which has now become a tool in itself, is the spectrum analyzer.

Figure 2. How a sine-wave type oscillator typically departs from sinusoidal (exaggerated for clarity). This shows the effect of second harmonic in one phase relationship.



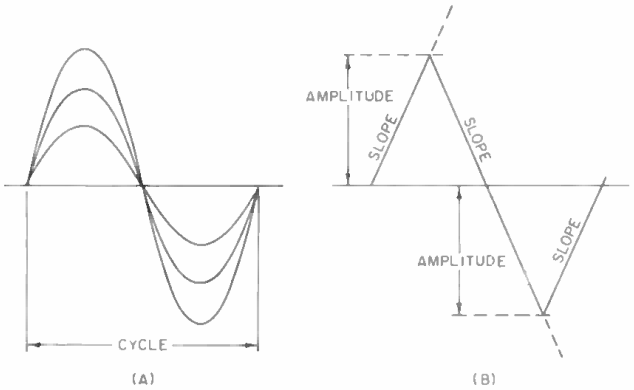


Figure 3. Comparison of the method of generating a sinusoidal output, by a sine-wave oscillator, and by a function generator: (A) the sine-wave oscillator determines frequency, or the cycle duration, regardless of amplitude; (B) the function generator determines the slope and amplitude of a triangular wave.

Taking the f.m. multiplex problem, the standard test pattern, primarily for establishing separation, is well known (FIGURE 1). It looks so nice and precise, doesn't it? But have you thought about how well it really does the job? Can you see 40 dB separation, for sure, on that trace? Or the equivalent in distortion? You need a very clear trace and very critical observation to get that far, don't you?

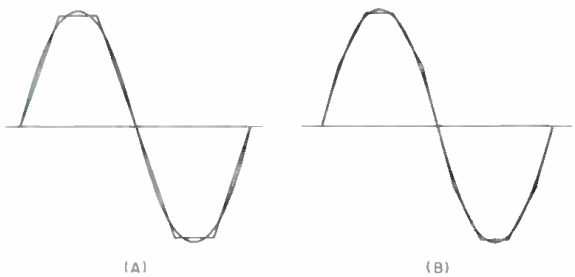
More critical measurements require quantitative readings of different frequency components, which can be separated out by more sophisticated test equipment. However, they can be explored far more simply, and with less chance of overlooking something, by means of a spectrum analyzer. As a spectrum analyzer is capable of displaying 80 dB range, it should be obvious how much such a method improves the inherent precision capability of the measurement method.

SIGNAL GENERATORS

Let us start with the signal source. Purity of reproduction relies on lack of distortion. While it may be possible some day to explore transfer characteristics independently of frequency, to date at any rate, one or more frequencies representative of those to be reproduced are still the most common measurement vehicle. The measure of their purity rests with how close to a perfect sine wave those frequencies come.

Any departure from the perfect sine wave is a form of nonlinear distortion. Ten years ago, most signal generators used sine wave oscillators, although function genera-

Figure 4. How a function generator obtains a sine wave from its basic triangular wave: (A) first approximation; (B) second approximation. Each successive approximation reduces error, but increases the order of distortion.



tors were already creeping into the picture. Today, function generators have almost taken over the scene. So let us take a look at the relative merits of these two types of generators.

SINE-WAVE OSCILLATORS

A sine-wave oscillator uses a frequency-selective circuit to determine frequency. This can take the form of a tuned circuit, some variation of the Wien bridge, or a phase discriminative feedback. Whichever is used, the principle is that the circuit will oscillate only at its chosen frequency.

Oscillation amplitude is then determined by precise control of feedback, so that amplitude neither builds up nor decays. However, this condition is usually achieved only at the expense of some small amount of waveform distortion as the device adjusts its operating point, or gain, during each cycle, or wave (FIGURE 2).

Consequently the kind of distortion that predominates with a sine-wave oscillator is a low-order harmonic, usually second or third. The higher the harmonic for which you check, the less of it is present from a sine-wave oscillator. Fortunately, this is representative of the kind of tone generation encountered from musical instruments, but there are sometimes other reasons for preferring low order components in test signals.

Another feature characteristic of a sine-wave generator is its inherent lack of stability. When you switch it on or off or change its frequency, it always exhibits a slight delay in arriving at a new stable condition. This is inherent in its design, whichever circuit it uses, although some are better than others.

In use, this deficiency can be overcome to some extent by keeping the oscillator in a stabilized condition, and using electronic switching of its output at some later stage after adequate buffering, if that is what the test requires. This is a factor of which you need to be aware in using sine-wave oscillators.

FUNCTION GENERATORS

The function generator, on the other hand, generates a waveform, rather than a frequency. It starts essentially with a triangular waveform, whose slope and amplitude, rather than the frequency (FIGURE 3), are adjustable; frequency is derived from slope and amplitude. The result is that the first cycle generated is duplicated by every subsequent cycle. There is no delay in stabilizing the waveform output of a function generator.

A function generator gets a sine wave by successively "filing off" the corners from this triangular wave start (FIGURE 4). Thus, getting a lower harmonic content in a function generator requires a more precise shaping circuit to reduce the error by which the wave departs from the sine form, while obtaining a lower harmonic content in a sine-wave generator relies on increasing the precision with which its operating condition is controlled.

So in a function generator, the more closely the wave adheres to the sine form, the more frequently it will deviate by the small residue by which it departs. Thus, although a function generator can produce a more stable output and at much lower total harmonic content, the frequency of that residual content is at much higher order harmonic concentration than from the sine-wave type.

When you are measuring down to tiny fractions of 1 per cent, this distinction can be important. In an article ten years ago, I described a method that was then in common use but not in commercial production, intended to overcome some of the residual-harmonic-at-source problem. This measured output against input, rather than analyzing the absolute frequency content of the output.

This is still a valid way to get distortion measurements of lower levels than are possible by absolute harmonic content methods. Suppose you are looking for a measurement down to 0.01 per cent or lower, and your oscillator has 0.03 per cent harmonic. How can you measure distortion of 0.01 per cent when you have ± 0.03 per cent combined with it, of the same or different harmonic?

If you null output against input, you can adjust out the 0.03 per cent harmonic components as well as the fundamental. Then any residual must be due to the equipment under test, not to content of the original test signal. This enables more precise readings to be taken that are an order of magnitude better than by the absolute method.

To do this, you need a bridge that is basically non-frequency selective and that can be balanced at fundamental and the prevailing harmonic frequencies simultaneously. Fairly obviously, this is much easier to do when the prevailing harmonics are second and third than when

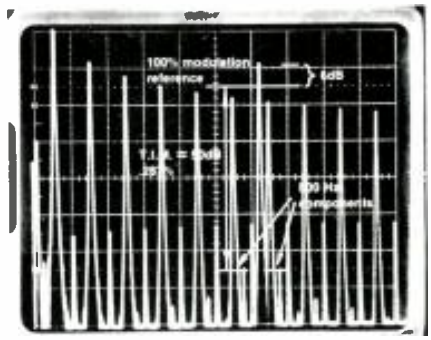


Figure 6. A typical analyzer display of TIM test results.

Figure 5. The test signal used for the TIM test.

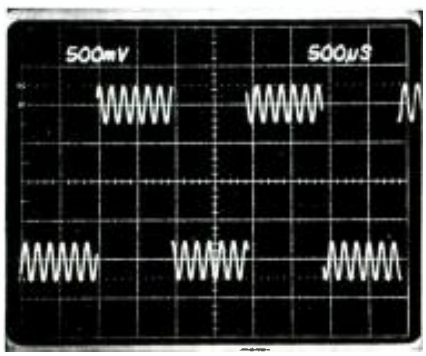
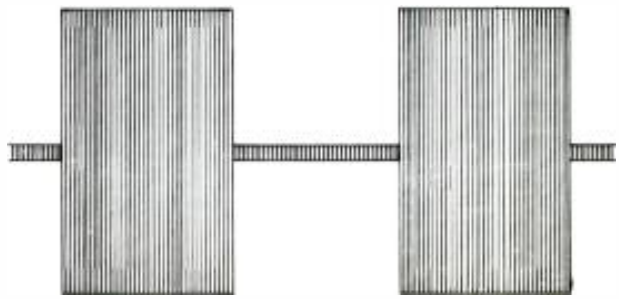


Figure 7. The test signal envelope for a tone burst test. Note how it differs from that of Figure 5.



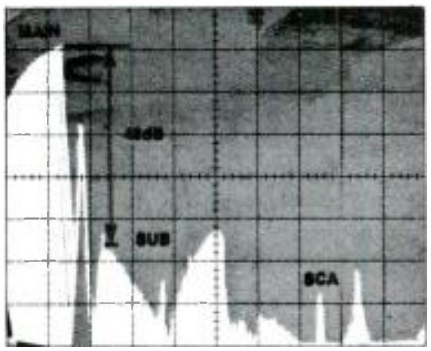


Figure 8. The result of a check for main-to-subchannel crosstalk, showing better than 48 dB crosstalk isolation.

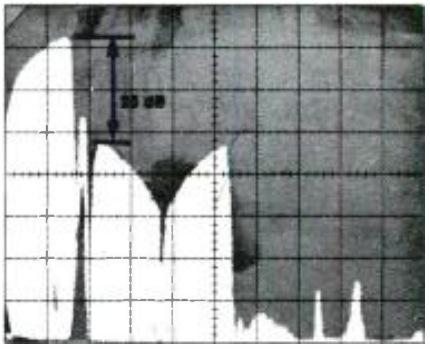


Figure 9. Increase in crosstalk (compared with Figure 8) due to a gain error of 2 dB.

they are of some higher order, usually odd-numbered, as is the case with function generator outputs.

SPECTRUM ANALYZER

We should stress that whether you are measuring total harmonic distortion or one of the standard intermod forms, SMPTE or CCIF, the spectrum analyzer does a better job than the equipment specifically designed for either job, which is not what you might expect. How so?

As I commented before, the SMPTE test will not detect frequency or phase modulation of a higher frequency by a lower one, while the spectrum analyzer doesn't know the difference, any more than our hearing does. Thus it measures that form the same way we hear it.

The standard CCIF method only finds second harmonic distortion, while the spectrum analyzer will find any spurious components from that form of test signal.

TIM

An area I discussed quite frequently ten years ago was transient distortion. How does the presence of a transient effect distortion of other components present at the same time?

A form of measurement on which considerable work has been done, virtually replaces the lower frequency test signal of the SMPTE-type intermodulation test, with a square wave instead of sine wave (FIGURE 5). This form of test, called the Transient Intermodulation Test (TIM) which lends itself to analysis by spectrum analyzer, is growing in popularity (FIGURE 6).

TONE BURST

There is another cause of distortion that still concerns me and maybe TIM is a step toward tackling it. We have had tone burst tests with us for a long while. But quantitizing their results has not been easy. What a tone burst finds that the present TIM misses, are changes that occur in the equipment due to sudden alterations in signal level.

The TIM test uses a relatively small sine-wave signal, typically in the region of 6 kHz, with a larger square wave, typically in the region of 500 Hz. What I here propose, as a different test, is to use a square wave, possibly at a frequency lower than 500 Hz, to modulate the amplitude of the sine wave (FIGURE 7).

I suggested, back there, that the sine wave should not be switched on and off by the square wave, but that it should have its level changed by 30 or 40 dB, so that, rather than going off, a small signal was still present to show what was happening in the amplifier immediately after the big signal ceased.

PHASE-LOCKED GENERATION

An advantage of the newer generation techniques is that phase-locking is possible, so that the test signal is very precisely repeated every so many cycles of the lowest frequency present. For the TIM test, some advantage is claimed to making the lower frequency not an exact integral submultiple of the higher one. Rather, it should be locked so the test pattern repeats exactly, say every three cycles of the square-wave frequency.

For the tone-burst test, the same kind of thing is possible today. The modulating frequency can be locked so the higher frequency has so many cycles, whether 5, 50 or whatever, at the higher level, and so many at the lower level.

Ten years ago, the only thing to do with any such test would have been to look at the output on a 'scope, maybe

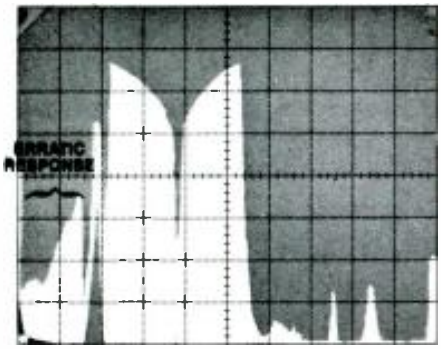


Figure 10. The result of a check for subchannel-to-main-channel crosstalk, showing erratic response due to phase problems.

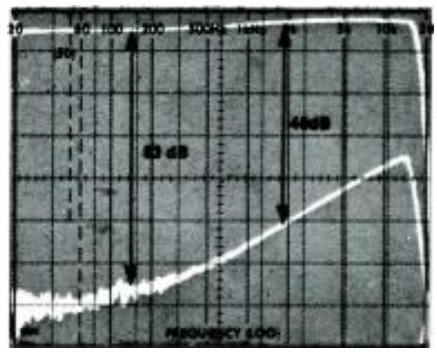


Figure 11. The test that really counts, having optimized adjustments: separation. This is made with comparison runs, using a storage 'scope.

to photograph it. Now the spectrum analyzer allows it to be looked at in a way that enables much more precise measurements to be taken, as well as enabling spurious components of much lower order of magnitude to be seen and measured.

Further questions particularly in the wind today relate to f.m. stereo multiplex, a.m. stereo, and quadriphonic.

FM STEREO

Whatever claims may have been made. f.m. stereo multiplex has not prevailingly achieved the high performance of which the system itself is capable. The average received quality is what anyone with hearing better than a tin ear would describe as crummy. Frequency response and separation may be passable—not up to capability, but passable.

Distortion is something else, quite obviously. You do not need measurements, in many instances to become aware of that! This results from using the classic alignment patterns (FIGURE 1), which are not exactly capable of use for precision alignment. They are still the best quick way to get in the ball park, but that is all.

For precision adjustment of performance, the spectrum analyzer does a far superior job because of its far superior dynamic range. I should here point out the difference between separation and crosstalk. As presently used, separation applies to the ability of the system to separate the stereo, "left" and "right."

Multiplex does this by using direct signal for L + R and multiplexed signal for L − R. Crosstalk is the leak-through from direct signal to multiplexed signal, or vice versa. What crosstalk can do to the final reproduction is far more complex than merely deteriorating separation. Presence of intelligence intended for the multiplex signal in the direct signal, or vice versa, can result in various distortions as well as in reduced separation.

Using the spectrum analyzer to look at various signals processed in different ways extends the capability for precision measurement and adjustment so that performance obtained by more precise adjustment and alignment is improved tremendously (FIGURE 8-11).

If the pilot signal is incorrectly phased, relative to the multiplex subcarrier which serves as a switching frequency reinserted at the receiving end by reference to pilot phase, then quite obviously separation will suffer. This can be improved, often simply by listening while you adjust the pilot phase.

However, if in addition to incorrect pilot phase there is leak-through from direct to multiplex modulation, or vice versa, no adjustment of the pilot phase will completely correct the error and the best separation will be accompanied by distortion. Following a sequence that gets first the transmitter, then the receiver, correct in these successive respects, will result in almost unbelievable improvement in performance.

A.M. STEREO

A.M. stereo applies similar principles to lower transmission frequencies. Perhaps the pressure to bring stereo to a.m. would not have been so great had f.m. stereo sounded better, on average. But the fact is that for some time now, to most listeners, a.m. has given better sounding quality than f.m. Few people are sophisticated enough to realize that f.m. has better quality capability than is being used. Even when they are told this, their response is apt to be, "So why don't they use it?"

A.M. stereo, like f.m. stereo, will undoubtedly have its problems although hopefully correcting f.m. stereo's problem will get a.m. stereo off to a better start. Perhaps when this has been done, the true capability of the two systems will show up in more realistic perspective. However, a.m. will still have the advantage for distance reception, so it will win a place in the field that f.m. can never occupy.

QUADRIPHONIC

What about quadriphonic? Can the spectrum analyzer help here? The first reaction is to say no. Quadriphonic achieves its separation by means—phase relationships—that the spectrum analyzer is not directly equipped to measure.

But wouldn't you have said the same thing about f.m. stereo multiplex? Phase is one of the things critical to successful stereo multiplex. Yet the spectrum analyzer can be brought to bear by using various aspects of the processing to enable quantitative measurements to be made at various points. Isn't the same thing possible for quadriphonic? Why not?

ACOUSTIC MEASUREMENTS

Another example where use of time and amplitude has proven invaluable is while exploring the performance of acoustic parts of the system. If you make an exact comparison between input and output content, with a precise time delay inserted into the input measurement equal to the time taken for sound to travel from loudspeaker to microphone pickup (FIGURE 12), you can ignore standing wave effects, ambient noise—everything except the sound direct from the loudspeaker.

This enables you to simulate with a measurement system, very close to what human hearing does in a listening situation, concentrating only on what comes from the

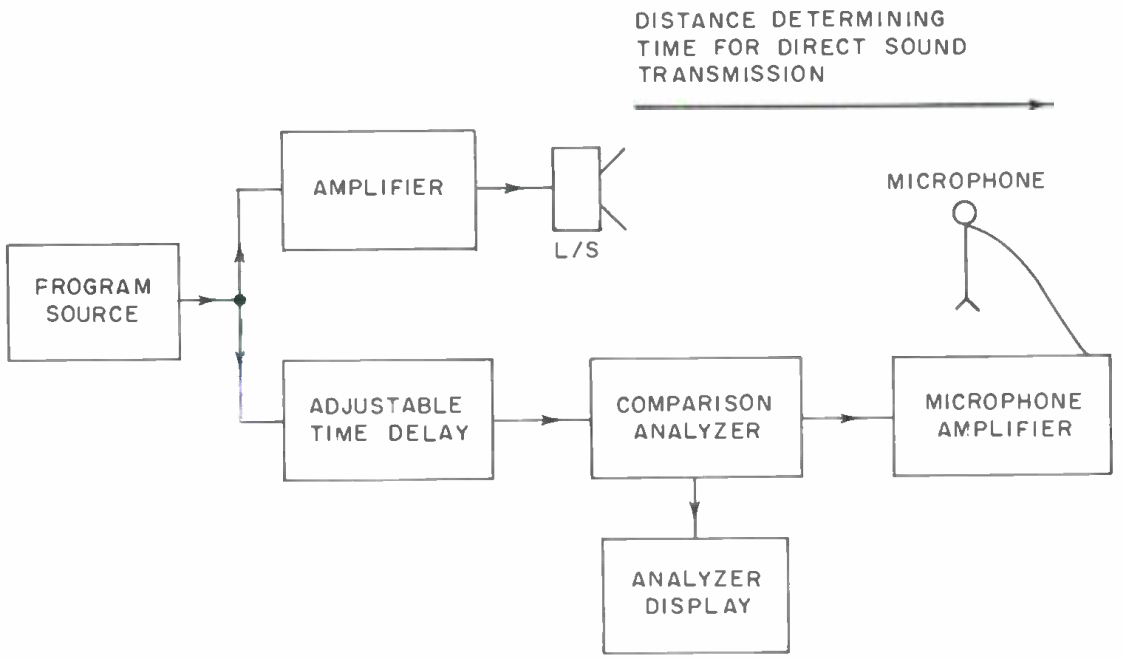


Figure 12. Setting up to measure direct listening performance in a typical room or auditorium with a spectrum analyzer. If a gliding tone is used, this system will eliminate standing wave effects because the tracking of the analyzer will measure only direct sound waves.

loudspeakers. By changing the time delay, you can explore other elements to a degree, although like with your hearing, the most valuable information comes from that direct distance comparison.

COMBINING CONCEPTS

Now, if this can be done with an acoustic link in the measurement chain, which has always been figured as virtually impossible, doesn't that hold out some hope for checking out the purely technological-electronic and digital—aspects of quadriphonic?

Perhaps, as with f.m. stereo multiplex, we shall find means for checking quadriphonic that will revolutionize its capability, making what we accept today as being adequate quad seem pretty primitive against what can and will be done when the appropriate measurement methods are developed and made available.

Perhaps stereo f.m. is not inappropriate as an illustration of potential. When Armstrong first introduced f.m. for these radio frequencies, in the effort to utilize the radio spectrum more efficiently, he was looking at sideband utilization.

A.M., at best, uses sidebands no wider than the audio spectrum. On what thus became known as f.m. frequencies, with their 200 kHz separation between carriers, as against the 9 kHz on frequencies assigned to a.m., even going out to 15 kHz as "top audio" represented considerable waste of radio space.

F.M. converted that space so that 75 kHz deviation on either side of a carrier could be used for the 15 kHz audio range. That was the basis on which f.m. improved quality over a.m. If the demodulator circuit was adjusted to good linearity, f.m. could also better a.m.'s performance on distortion measurements. But the big improvement was in frequency range.

When stereo came, the primary concern was to utilize the f.m. band's superior capability without sacrificing too much in quality and, I believe, a good decision was made with that end in view. But in the main, the users who installed and applied f.m. multiplex have not so far fulfilled that promise.

Does not the same thing keep happening, in different contexts? We recall some early demonstrations of what was then called the "Westrex" system, now known as "Stereodisc." "Crummy" would have been complimentary of those early demonstrations! But today's stereodisc far outperforms the best mono of those days.

The key to bringing about this kind of result is always found in better measurement techniques, whatever may be required for that. This is what makes pushing out the state-of-the-art, in tests and measurement, so challenging. ■

Credits: Figures 1, 5, 6, 8, 9, 10, 11, courtesy Tektronix, Inc.

WAYNE B. GRAHAM

The Audio Tape Transport Today

The sophistication of today's audio analogue tape recorder transports may someday be challenged by digital machines, but here is where they are now.

SOME AUDIO ENGINEERS are still wondering about the avalanche of new techniques, while others are already debating relative merits to determine the best "conventional" audio recording system with noise reduction and the yet-to-be-universally tested digital recording techniques. Audio tape recorders are reaching the point of development where people are starting to look to digital recording as the next breakthrough toward continued perfection.

Conventional recording has undergone continued development in tape material, coating formulation and magnetic particle size, noise reduction systems, improvements in electronic amplification (from the vacuum tube, through the transistor, to the integrated circuit), and head configuration development providing improved life and multitrack capabilities. One of the most recent areas of improvement is the method used to move the tape past the heads—the mechanical tape handling system. Many audio engineers still do not fully understand the distinction between and the relative merits of recorders with *Constant torque* versus the newer, more costly, *Constant tension* machines.

CONSTANT TORQUE?/CONSTANT TENSION?

An example can best illustrate the important difference between constant torque and constant tension. If we imagine making a simple tape recorder using three motors, we can configure them as shown in FIGURE 1.

One motor is used in conjunction with a pinch roller to propel the tape at a certain speed past the heads. This we will call the capstan motor. Its speed and the diameter, in contact with the tape, determine the tape speed. This can be closely determined as follows:

$$\text{Tape speed (in./sec.)} = \frac{\text{RPM}}{60} \times \pi \times \text{capstan diameter}$$

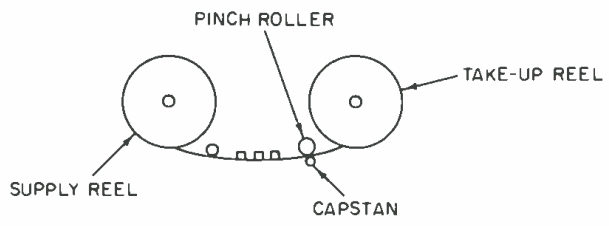
The second motor, used in conjunction with the supply reel, tries to pull the tape in the opposite direction from the capstan—this is what provides the holdback tape tension. (We could have substituted a passive cork or felt clutch on the supply reel to provide drag or holdback tension.)

The third motor is used on the take-up reel and pulls in the same direction as the tape travel, thus taking up the tape spewed out of the capstan.

This is the basic system; it has been essentially the same since pre-World War II German machines were developed. But recently improvements in the other areas—tape, heads, electronic noise suppression, amplification and reproduction—allowed designers to become aware of pitch errors resulting from the continual tension changing of our simple three motor tape transport.

We can clearly determine that the pinch roller has less work to do with a full supply reel, since it is pulling on the supply reel with a longer lever (the full pack). As

Figure 1. The basic tape transport configuration.



Wayne B. Graham is general manager of Tentel, in Campbell, Ca.

Figure 2. The Tentelometer, manufactured by the author's company, Tentel, is a simple device for the actual measurement of dynamic tension as the tape moves on a transport. By using such a device several times during depletion of the supply reel (as illustrated), tension on a constant torque or constant tension machine can be determined.

the reel becomes exhausted, the "lever" with which the capstan is pulling is shorter and thus it must pull with more force (tension) against the same holdback motor. It is this change in pulling force in a constant torque recorder which causes the tape to stretch (much like a rubber band) varying amounts along its length. A pure tone recorded on the beginning and again at the end of a reel would show a pitch change if spliced together at a later time. A constant *tension* machine keeps changing its torque so that a constant force (or tension) is applied to the tape along its entire length.

Torque and tension are related by the "lever arm" of the tape pack or:

$$\text{TORQUE} = \text{TENSION} \times \frac{\text{TAPE DIAMETER}}{2}$$

Constant tension machines have solved several important problems inherent in the less sophisticated constant torque machines:

Skew error and cross talk (on multi-track heads) is eliminated since the tape maintains a consistent path across the heads. Changing tension would cause the tape to wander to various positions across the heads.

Pitch error is eliminated since tape is not being stretched more at the end of a reel than at the beginning; constant tension maintains a constant force.

Head, guide, and tape wear is reduced since constant tension allows the optimum head-to-tape contact to be maintained, whereas a constant torque machine requires the minimum tension to be the optimum and thus the tension increase causes closer head-to-tape contact and increased wear of all rubbing parts.

A properly designed constant tension system will also reduce *wow and flutter problems*, since normally a servo monitors and feeds back a tension signal, thus providing smooth non-oscillating supply tape tension. Many constant torque systems utilize felt or cork brakes (clutches) which cause tension oscillations when worn or dirty.

Most professional audio recorder manufacturers are now supplying machines equipped wtih constant tension of the supply reel. Take-up tension is relatively unimportant since the tension at the heads is normally isolated from the take-up side by the pinch roller/capstan. Only when take-up tension is of sufficient magnitude to cause slippage at the capstan does it cause an audible problem.

MEASURING TAPE TENSION

Most audio engineers are familiar with the fish (spring) scale and string method. A string is wrapped around an empty tape hub, the engineer pulls against the machine at the "appropriate" tape speed and measures the force on the fish scale. What is normally not realized is that this force is only close to being correct when the tape pack is the same diameter as the diameter where the string is attached!

An in-line tension gauge can be used to monitor tension for either a constant torque or a constant tension machine. The rule of thumb for "proper" tape tension is: one to three ounces of tension (measured at the heads) per 1/4 in. of tape width. Proper tension varies by the design parameters of specific manufacturers, which include the angle of wrap of tape around the head(s) and desired head-to-tape contact. Insufficient tension will normally result in high frequency losses and high tension will cause premature wear of tape and parts in contact with the tape, not to mention gross problems of tape stretch and destruction.

It would appear that with constant tension, the last major area for improvement in conventional audio recorders is being provided. It will indeed be interesting to hear the digital audio reproduction with its high-frequency difficulties *versus* the clean, conditioned sound of an Ampex ATR-100, Studer A-80, or other high quality tape transport incorporating state-of-the-art design features. Is digital the next step for the ultimate sound? ■

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Introducing the Microprocessor

Small enough to cup in the palm of your hand, the chip computer is revolutionizing data-keeping.

IT'S A PRETTY SAFE BET that the word *microprocessor* was not in the audio man's vocabulary when our premier "State of the Art" issue went to press some ten years ago. It's just as safe to bet that well before our twentieth-year issue sees the light of day, the word will be in *everyone's* vocabulary. And, while we're taking on sure things, we can safely proclaim that the **db** reader who thinks this whole computer thing is going to blow over soon is a guaranteed loser. Let's face it folks—technology marches on, with or without us.

To try to keep up with the times, we thought it would be nice if someone would tell us a little something about what's going on out there. Irv Diehl obliged by answering a few of our basic questions, such as:

WHAT'S A MICROPROCESSOR?

In simple terms, the microprocessor (often abbreviated, μP) is a sort of electronic "housekeeper." As the name suggests, it processes something (data), while performing various arithmetic and logic chores in its ALU (arithmetic and logic unit). The ALU output is temporarily passed on to an *Accumulator*, from which it may be easily retrieved for further processing—again within the ALU.

To supervise operations, the μP will contain a *Control* section, which turns on various sub-sections as required. A *Data Bus* links these sub-sections together and allows interface with the outside world. And all of this may be contained in a package small enough to cup in the palm of your hand.

HOW MUCH IS THIS GOING TO COST?

You can buy a microprocessor chip for about $20, but of course there's more to it than that. The chip is the heart of a *Microcomputer System*, which contains the necessary support hardware, such as memory storage devices, power supplies, and operator-interface devices. These may consist of typewriter keyboards, print-out systems, tape recorders, and cathode ray tubes—usually called CRT terminals.

A complete microcomputer system with modest memory capacity and simple operator-interface may cost as little as $300. More sophisticated systems offer expanded memory capacity, typewriters with CRT terminals, and perhaps a tape recorder/player. Still, such sophistication may be available for less than $2,000.

WHAT'S THE PURPOSE OF THE TAPE RECORDER?

Within the microcomputer system itself, the tape recorder is used to store data and instructions for later use. Even in the microcomputer system, programming instructions must first be translated into computer language. Although the computer may obey these instructions with lightning speed, it is a sometimes-tedious chore to write the desired program. The tape recorder allows the operator to record his instructions, make corrections if necessary, and then feed this program into the computer again and again, without worrying about errors.

WHAT'S ALL THIS GOT TO DO WITH AUDIO?

The hobbyist is already using the microcomputer to balance his checkbook, file phone numbers and keep track of other home (and business) management tasks. From here, its a logical progression into the world of audio. Although the microprocessor is not up to the task of running a completely automated 24-track studio (not yet,

This microcomputor system from Radio Shack is currently available as shown for $600.

that is), there's no reason why it can't be used for less demanding chores.

For example, consider a μP-plus-CRT in the control room. Upon request, it will display a "take sheet" stored in memory. As you add, subtract and change track assignments, the computer will keep score, and furnish you with a printed readout at the end of the session. It could also remind you of the equalization settings used on last week's session. Or tell you how much money the producer owes the studio.

Why, it could even help you select the right microphone for the job! Let's assume you had taken the time to store the characteristics of all your microphones in memory. (Before the session, of course.) Now, you discover that the mic on the acoustic guitar doesn't have enough presence. Just tell the computer your problem, and it will furnish a list of microphones that might be more suitable. (Of course, it's up to you to write a program that will give the microcomputer the power to interpret your questions and come up with the right answers.)

In tape-to-disc transfer work, the microcomputer might help keep track of record levels, equalization, pitch (lines-per-inch) settings and such, with subsequent operator-updates stored in memory. There are immediate possibilities for this application, as well as many others in even the smallest studio operation.

SYNTHESIZERS

In a slightly different area, there are already a number of electronic music synthesizers designed around the microprocessor. Some permit a type of electronic over-dubbing by storing, say, a 32 bar note sequence, then reproducing the sequence while a new line, in a different voicing, is added. This can be repeated a number of times to create an entire composition, without once introducing an audio tape recorder in the process.

We may expect a number of microprocessor-based audio systems and devices to be introduced in the future. The ideas expressed here are only a suggestion of the possibilities. Each reader can add at least a few more to the list. And for those who would like to get some hands-on experience right away, a modest microcomputer kit can be purchased for as little as $300. Such a kit would allow learning-by-experimentation and perhaps a little implementation in simple applications. Be aware though that software—not hardware—is the most difficult aspect of the microcomputer. The program for a relatively simple application may take several weeks to create.

If you'd like to gain a better insight and understanding into this new technology, the following bibliography and list of μP manufacturers should be helpful. ■

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2. Guzenian, David J. *Microcomputer Applications Handbook. IASIS Inc.*, 815 W. Maude Ave., Sunnyvale, Ca. 94086.
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5. *BYTE Magazine.* BYTE Publications, Inc., 70 Main St., Peterborough, N.H. 03458.
6. *Kilobaud Magazine.* 1001001, Inc., Peterborough, N.H. 03458.
7. *Personal Computing Magazine*, 167 Corey Rd., Brookline, Mass. 02146.

MANUFACTURERS

1. Heathkit Computer Systems, Benton Harbor, Mich. 49022.
2. MITS, Inc., 2450 Alamo S.E., Albuquerque, N.M. 87106
3. MOS Technology, 950 Rittenhouse Rd., Norristown, Pa. 19401.
4. South West Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216.
5. Radio Shack, 2617 W. Seventh St., Fort Worth, Texas 76107.

JOHN WORAM

Picture Gallery

ON THESE PAGES, we present a micro-directory of the "State of the Art." Before any eyebrows are raised over our choices (and over our omissions), we hasten to point out that these products may not all be "revolutionary break-throughs in recording technology." In our eyes, they are simply—and commendably, we might add—examples of where it's at today. Another small point—anyone predicting most of these items just ten years ago would probably have been dismissed as a dreamer.

SOUND WORKSHOP 1280B

12 in/8 out, and the "bottom line" is about $4,000, with all the trimmings. The console has already seen action in many professional applications; Columbia Records' *Greatest Hits of 1720* was recorded on the 1280. This kind of music will beautifully show up any little glitches in any console. Enough said?

AMPEX ATR-100

Already reported on in our December, 1976 and February, 1977 issues, the ATR-100 is truly in a class by itself. The waiting line stretches around the block, despite its block-busting price tag. But, you get what you pay for. (By the way, the Columbia album mentioned above was recorded on the ATR-100, which may be one of those few occasions when the tape recorder cost more than the console.)

IVIE IE-10A

People don't usually tuck spectrum analyzers in their pockets. But here's one that will fit nicely. Despite the diminutive size, the IE-10A will display a dynamic range of up to 45 dB, using 16 l.e.d.s in each of ten one-octave bands (160 l.e.d.s in total). An accessory distortion analyzer measures thd to less than 0.02 per cent.

CROWN IOC (Input/Output Comparator)

A new circuit provides self-monitoring of distortion for Crown D150A and DC300A power amplifiers. When an output waveform does not match the input waveform, a front panel l.e.d. indicates the trouble. Standard on all new models, this is available as an inexpensive retrofit ($60) for earlier versions of these amps. When will this be applied to a complete recording console? Before the next ten years, we'll bet.

dbx 3BX

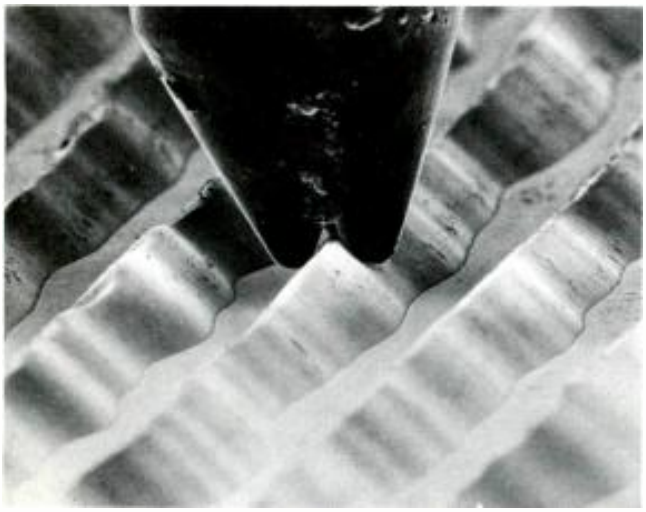
For those recordings with a dynamic range that is flatter than the frequency response, dbx comes to the rescue with a three-band expander and dynamic range enhancer, complete with a graphic display (30 l.e.d.s) of the action. The 3BX allows the user to get up to 1.5 times the dynamic range found on his records and tapes—or from broadcasts for that matter.

ELECTRO-VOICE SYSTEM "C"

Microphones with interchangeable head capsules are not new. However, here's a complete system with four heads, two sets of electronics and a handful of accessories. With a system "C" or two, the recording engineer should be able to handle just about any last-minute "surprises," especially the kind that always crop up on those far-from-home remote gigs.

ACCUTRAC 4000

Toy or tool—you be the judge. But here's a turntable that allows you to resequence your records, or skip that wretched tune in the middle that drives your dog up the wall. Just the thing for producers who can't decide on the right sequence when checking test pressings.



STANTON 681BPS

A state-of-the-art phono cartridge? Would you believe playback stylus? The idea of playback of a metal stamper and matrix has always been a goal. and this stylus for Stanton's 681 series cartridges will play them, and play them well. In fact, a version called the BPSM, which tracks at 3 to 7 grams. will burnish the groove (mountain?) nicely. Of course you must spin the turntable the other way and mount the arm in reverse as well if you want to play stamper/matrices.

TECHNICS 1500

A two-track tape deck, which was also reported upon in these pages earlier, this unit sets new performance standards for consumer-type machines. particularly in the area of tape handling. The electronics are also exceptional. except that you have to take the manufacturer's positioning of one of three possible bias and equalization settings.

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RAZOR BLADES, single edge; tape editing. **RALTEC, 25884 Highland, Cleveland, Ohio 44143.**

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AMPEX 354 2-track tape recorder, 13 years old; under 300 hours use. $1,200. **(914) 471-4620.**

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db People/Places/Happenings

• Sound engineer **Linda Feldman** has been appointed manager of the training department at the **TEAC Corp.** of Montebello, Ca. Previously, Ms. Feldman had been involved in staging videocassette and multi-media presentations throughout the country. She is in charge of the TEAC in-house recording studio.

• **Barbara De Angelis** has been appointed sales administrator for the **Leader Instruments Corp.** of Plainview, N.Y. Ms. De Angelis comes from an electronics component firm. where she focalized traffic and sales.

• A combination of music at the source and output was achieved by the decision of **Superscope, Inc.,** of Chatsworth, Ca. to acquire the famed **Aeolian Corporation,** the world's largest company engaged exclusively in the manufacture and distribution of pianos. It is planned to utilize the merger to distribute Superscope's Pianocorder Reproducing system, which automatically records and plays, through cassettes, on any piano.

• In charge of acquisition of products to be sold in their retail stores, **Carroll B. Ray, Jr.** has assumed the post of corporate development for **Radio Shack.** of Fort Worth, Texas. Mr. Ray previously had been operating out of the British office, where he served as financial director for the retail division.

• **Craig A. Lynch** has joined **L & M Stagecraft, Inc.,** of Cleveland, Ohio as account executive of the audio-visual division. Mr. Lynch was previously associated with **United Torch Services.** creating multi-screen a/v presentations.

• British producers of broadcast and public address equipment, **Audix Ltd., of Essex,** has recently acquired **Barkway Electronics, Ltd.,** of Royston. Herts. Barkway specializes in audio communications.

• Western sales at **Harman International,** of Northridge, Ca., are in the hands of Mike Pontelle, who recently assumed the post of western regional sales manager, consumer audio products. Divisions in Mr. Pontelle's bailiwick include **Bolivar Speaker, Harman Kardon, JBL, Ortofon,** and **Tannoy.** in 22 western states.

LAYN

• The newly created position of eastern regional manager at **Studer Revox Ameria, Inc.** has been filled by **Fred Layn.** Mr. Layn, who has been with the firm since 1973, will be working out of the factory office at 155 Ave. of the Americas, New York, N.Y. Another new appointment is that of **James Woodworth** as manager of sales for Revox brand products, operating out of the Nashville, Tenn. office.

• The Professional Systems Products Division of **Adelman-Pinz Sales Corp.** of Yonkers, N.Y. has been appointed by the Modular Audio Products division of **Modular Devices, Inc,** Bohemia, N.Y. as its Metropolitan area sales representative. The territory covers northern New Jersey, New York City, Westchester, and Long Island. **Paul A. Pusecker** of Adelman-Prinz is in charge of the operation. The rep firm is located at 570 Yonkers Ave., Yonkers, N.Y.

• **Andrew M. Hilliard** has been promoted to the position of manager, advertising and promotion, for **RCA's** Broadcast Systems and Mobile Communications businesses, based in Camden, N.J. and Meadow Lands, Pa., respectively. Mr. Hilliard has been active in advertising creation at RCA for the past 18 years.

• Catalog and custom sales activities at **Atlas Sound,** of Montvale, N.J. is now in the hands of **Howard M. Berke,** newly appointed director of marketing. Mr. Berke has been with Atlas since 1972.

• The office of president of **ARP Instruments** has been assumed by **David Friend.** Mr. Friend comes from the position of executive vice president and chief operating officer. He has been with the firm nearly since its founding by **Alan R. Pearlman** eight years ago.

• All manufacturing and production testing of **Dataflux Corporation's** fixed-head disc systems is now being focalized by newly-appointed **Don Kildebeck,** director of manufacturing. Mr. Kildebeck had previously been test manager at Dataflux.

• The new position of director of training and services at **Telex Communications,** of Minneapolis, has been filled by **Richard D. Larson.** Mr. Larson will supervise preventive and corrective service training for technicians through audio visual seminars and training literature.

• **Deluxe Laboratories,** of Hollywood. Ca., has announced the appointment of **John T. Shafer** to its marketing department. Mr. Shafer comes from **Foto-Kem Industries.** where he was process supervisor.

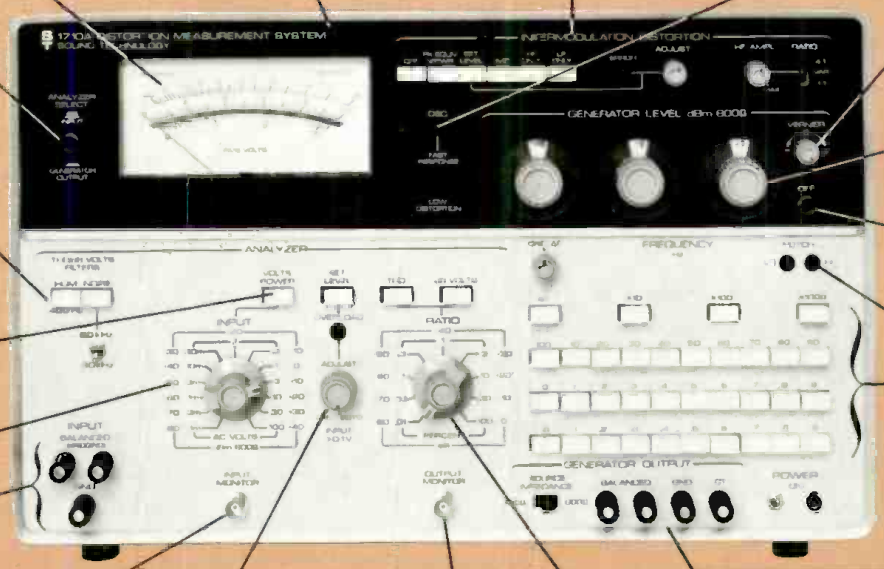
• The acquisition of a third plant has enabled **Elec-Trol, Inc.** to move its molded line and reed relay production to a new building near Saugus, Ca. The facility includes three clean rooms for critical switch requirements.

• Consolidating its corporate and divisional management, the **Altec Corporation** has moved its corporate headquarters from Dallas to Anaheim, Ca. The address of the new office is 1515 S. Manchester, Anaheim. Ca. 92803.

• Expansion at **Frap,** of San Francisco, has added two new employees. **Stu Weiss** has been appointed vice-president of engineering and **Bob Walker** as consultant on sales and marketing. Both men have impressive records in electronic design. Bob Walker was one of the founders of **Clear-Com.**

• Speaker rings are being manufactured by newly formed **Texas Fine Magnetics, Inc.,** Box 7983, Waco, Texas 76710. President of the firm. which will be involved in high-energy ceramic permanent magnetics, is **James H. Snowden. Theodore Q. Dziemianowicz** is technical supervisor.

Here's how useful a distortion analyzer can be



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