

RECORDING

ENGINEER / PRODUCER

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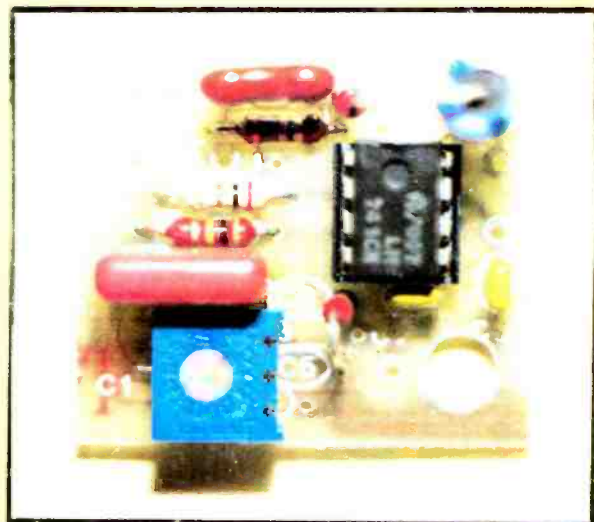
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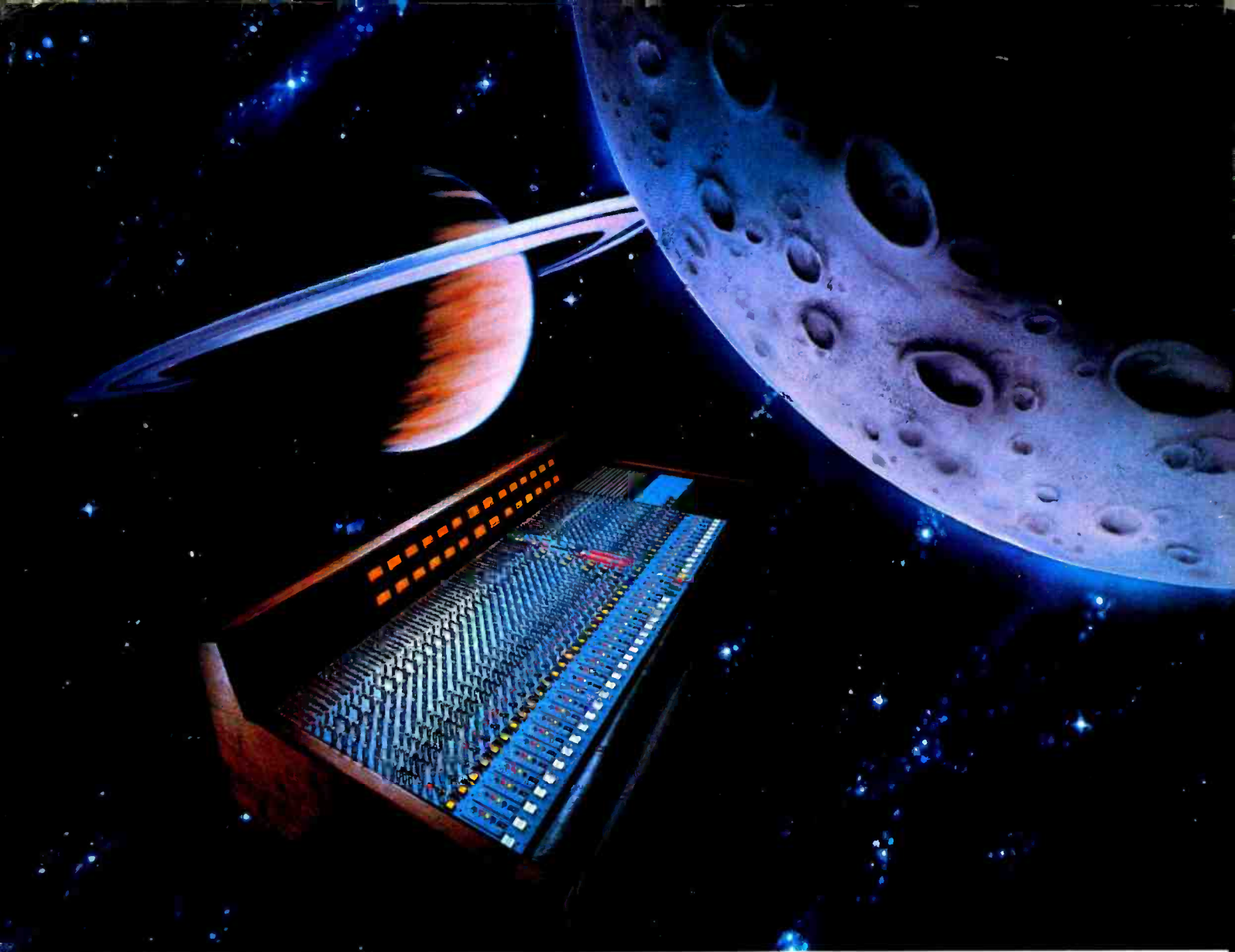


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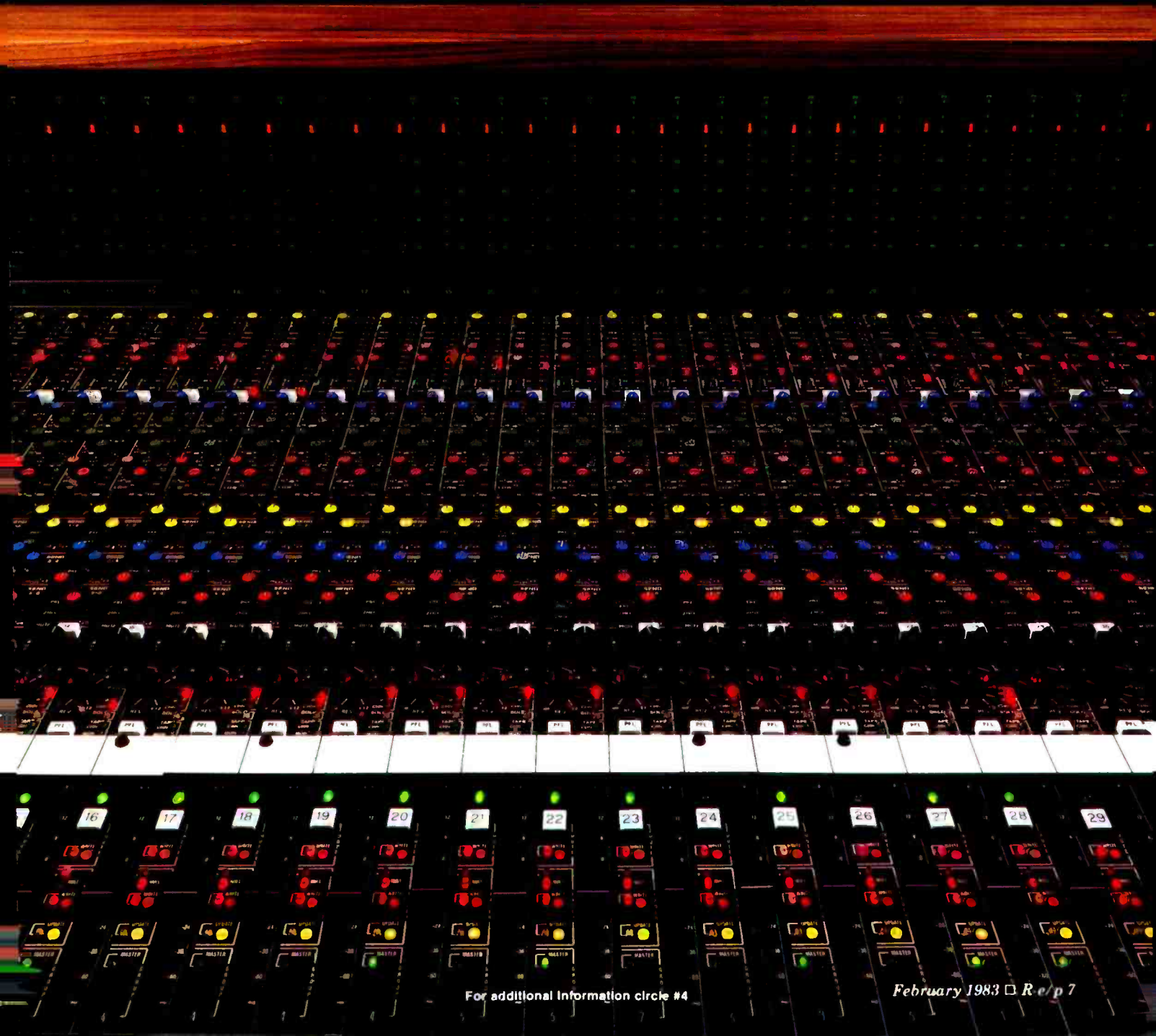
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February 1983 □ R e p 7

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*1981-1982 Billboard Magazine
Brand Usage Survey

For additional information circle #6

February 1983 □ R-e

views letters news

FAIRLIGHT CMI COMPARISON

from: David L. Bross
Fairlight Instruments USA
Los Angeles, CA

We reply to the December 1982 article, titled "Recording Synthesizers and Drum Machines," by Robert Carr, particularly the section headed: "The Computer Connection."

With regard to the implied inference where an E-mu[Systems] Emulator and Apple II can be favorably compared to a Fairlight CMI system for a lot less money. Not only is this simply untrue, but it is also our opinion that Mr. Serafine, who quoted this, cannot possibly be cognizant of the total functionality of the Fairlight, even though he has had some exposure to it under limited application circumstances in the recent and interesting *Tron* movie project.

Simply from technical specifications, the Apple II system, the E-mu with its inherent design capabilities, and other accessory equipment either singly or wholly, do not match the technical specifications of the Fairlight system in any way sufficient enough for the same functionality of software to be applied. That is why the Fairlight CMI is priced considerably above the E-mu/Apple system that Mr. Serafine compares.

Furthermore, this matter came to our attention when, as a result of this article (and perhaps other similar articles originating from Mr. Serafine), certain senior staff of the Emulator company advised us that they were somewhat embarrassed by expectations of recent potential buyers that the Emulator system would equate to the Fairlight.

Both of our companies respect each other's position in this important growth marketplace. Perhaps Mr. Serafine would care to demonstrate to us why he feels these two systems can be functionally compared — at any price.

We have taken the time to write this response because of the credibility of *R-e/p* magazine to its readers.

RECONTOURING AND LAPPING OF TAPE HEADS

from: Robert J. Reiss, Jr.
VP Technical Operations
RESTORATION
Van Nuys, CA

While I found the article by Greg Hanks ["Care and Repair of MCI JH-Series Transports," October and December 1982 issues] to be educational, I would like to inform both Mr. Hanks and *R-e/p* readers that there is another company which can correct

"crown-centering" or improper gap position in relationship to the headface peak. RESTORATION, located in Van Nuys, CA, has corrected the contour shape of audio heads for many of its world-wide customers, along with our standard recontouring service, repair, and new head sales.

I must state that we have never seen either an Applied Magnetics Corporation (AMC) or any other OEM head exhibiting this phenomena. Our corrections have been to heads which have been improperly lapped and not recontoured. Our technical brochure, "Recording Head Failures — Causes and Cures," outlines the difference between proper recontouring and improper lapping. This brochure is available to any inquirer free of charge.

MCI CARE AND REPAIR

from: Gregg Lamping,
Technical Representative,
MCI, A Division of
Sony Corp. of America
Fort Lauderdale, FL

While the article by Greg Hanks on the Care and Repair of the JH-Series Transports [October and December 1982 issues of *R-e/p* — Ed.] should be very informative and useful to MCI users in the field, there are a couple of points that should be clarified:

1) When setting the off-set nulls be sure that the oscilloscope or voltmeter is not grounded to the AC mains. Since we use a star grounding system in the JH-Series tape machines, and much test equipment has the negative side of its test inputs tied to mains ground, this will form a ground loop which will give erroneous readings and cause the reels on the machine to creep.

2) While I cannot say that AMC have never made a head that has a problem with crown centering, we have not had evidence of a large number of heads with this problem. When this phenomena was first called to our attention, during our investigation we found that during the wrap adjustment on the tape machines, technicians in the field very often adjusted the wrap control for a maximum reading at some high frequency, usually 10 to 16 kHz. Depending on the frequency used, the area of maximum output can be 3 to 5 degrees of rotation. If the wrap is set such that the gaps are not centered in this angle of rotation, the wear pattern can be off-set while displaying a maximum high-frequency output. The margin of error also is changed by the particular generation of JH-Series machines, since

newer technologies in head design and electronics have dictated changes in head wrap. The more the wrap, the higher the possibility for error.

I would suggest centering the wrap adjustment between each falloff point of the high-frequency tone used. Barring this, or as an added check, a bit of grease pencil rubbed on the heads and passing tape across the heads to make sure the wear is centered on the gap should suffice.

Greg Hanks replies:

While Gregg Lamping is 100% correct in item #1, in stating that an error will occur when the third pin of an AC-powered instrument is brought to the ground potential of an MCI Analog Torque Board, while setting offset nulls, this situation was included as a "Pit-fall" on page 71 of the October 1982 Issue (the first part of the two-part article).

Regarding item #2, I attempted to explain the reasoning for an offset wear pattern on heads that are correctly crowned. The phenomenon of work hardening is explained on page 44 of the December 1982 issue of *R-e/p*.

THADDEUS CAHILL/ TELHARMONIUM

from: Reynold Weidenaar
5 Jones Street #4
New York, NY 10014

For a book, and possibly a film, on Thaddeus Cahill and his Telharmonium (1892-1911), the first electronic music synthesizer, I would appreciate any information on letters, recordings, or other materials. I would also like to hear from any digital experts interested in reconstructing the sound of the Telharmonium, using its schematics and the written descriptions of earwitnesses.

news

FIRST US SALE OF SONY PCM-3324 MULTITRACK DIGITAL MACHINE

In the first sale outside Japan, the PCM-3324 24-track machine was purchased by Digital Services, a Houston-based audio equipment rental firm. Digital Services, which offers a full range of digital equipment, will base the new multitrack in its Nashville branch. According to John Moran, Digital Services president, the machine will be

— continued on page 28 ...

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DELTA MODULATION . . . FACT FROM FICTION

*A Guest Editorial,
by Richard E. DeFreitas*

Finally! The audio community is becoming very aware of delta modulation as a viable method for converting audio to digital. For nearly a decade Pulse Code Modulation (PCM), because of its understandability, has dominated the audio scene. But now, with the recent introduction of a delta modulation digital tape recorder, this PCM domination is seriously being threatened — and rightfully so. What is this magic technology? Well . . . before you are inundated by the typical marketing hype generated by the numerous manufacturers who undoubtedly will jump on

the bandwagon, each with their claims and counterclaims, please take the time to read on so that you may be well informed about the facts and fiction associated with delta modulation.

Fiction: Delta Modulation is a New Technology

Delta modulation is perhaps the oldest form of digital encoding known. In addition, it is the simplest form of converting an analog signal, such as audio, to a digital signal. In its basic form it simply assigns a "1" if the input

signal is increasing in a positive manner, and a "0" if the input is decreasing in a negative manner. It is not concerned with binary words per se, nor is it concerned with the amplitude of the input signal. Unlike PCM, delta modulation derives its output solely from the slew-rate (rate of change) of the input signal. Its implementation is very simple.

Fiction: Delta Modulation is Quasi-Digital

This is a claim generally made by the designers and manufacturers of PCM equipment. However, any system that converts an analog signal to a digital signal, ie "1"s and "0"s, is a digital system. Just because the digital output does not follow the PCM format of binary words made up of a

A Word About the Author . . .

Richard E. DeFreitas is President and Founder of DeltaLab Research, Inc. He is generally regarded as the father of the modern day delta modulator used in high quality audio applications. DeFreitas holds a BSEE from Lowell Technological Institute (now the University of Lowell) Lowell, Massachusetts. He began his engineering career 20 years ago designing PCM (Pulse Code Modulation) systems while employed at Raytheon Corporation. While at Raytheon DeFreitas was first exposed to digital audio. The PCM systems were designed and built by Raytheon for the US Army, Signal Corps for use in audio telemetry applications.

In a relatively short period of time DeFreitas was firmly established as an expert in the

field of Analog-to-Digital (A/D) conversion techniques, having designed and developed all forms of A/D product lines for such companies as Ditrans — Division of Litton Industries, Teledyne Philbrick, Function Modules Inc., and Hybrid Systems Corporation. While at Hybrid Systems he founded a subsidiary, Audio Pulse, Inc., which used his first attempt at delta modulation: a consumer hi-fi Digital Time Delay System to recover and generate ambience for home playback systems.

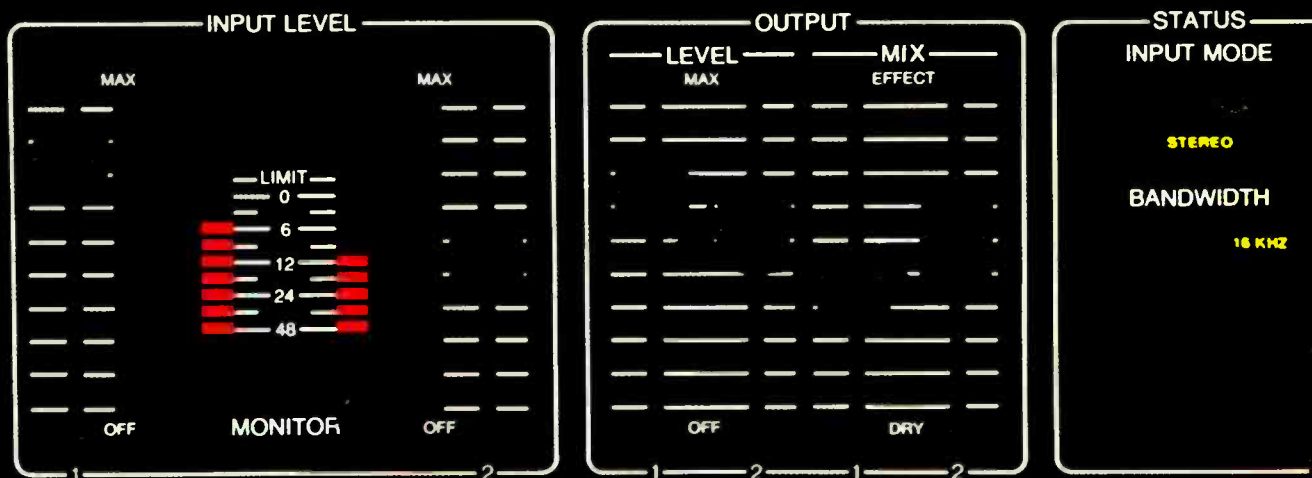
In 1977, DeFreitas founded DeltaLab Research, Inc., and spent the first year developing and subsequently obtaining numerous patents on a state-of-the-art Adaptive Delta Modulator (ADM) suitable for high-quality digital conversion of audio

signals. Since then he has refined this process to such a degree that it is regarded by many audio professionals as the cleanest and most natural sounding form of audio-to-digital conversion in use today.

Throughout the years he has published many articles in electronics trade journals on the subject of A/D conversion. In 1979 he co-authored a paper with Peter Mitchell, and presented it at the Los Angeles AES Convention in May of the same year. The paper presented his form of delta modulation, and compared ADM to PCM; perhaps the first such comparison to seriously threaten PCM as the only acceptable method for converting audio to digital.

It is against this background and expertise that this article is written.

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fixed number of bits, does not mean that it is not digital. Delta modulation is perhaps more digital than PCM since it is, in essence, a one-bit system — pure and simple. All of the digital benefits normally associated with PCM apply equally to delta modulation; these include “noise immunity” and “frequency response degradation immunity” in digital tape recorders, and other storage mediums. Also, since delta modulation is a one-bit system, it is not as sensitive as PCM to losses of information such as tape dropouts — more will be said on this later.

Fact: Delta Modulation is Not Suitable for Audio

In its purest and simplest form, delta modulation cannot adequately convert audio to digital over the full audio frequency range, unless the digital clock rate is set to an intolerably high frequency. While this is possible in theory, it is nearly impossible in practice. Therefore, another approach to delta modulation is required; the delta modulator must be taught to adapt to the audio signal by using psychoacoustic phenomenon — we must fool the ear! This form of delta modulation is known as Adaptive Delta Modulation (ADM). Many attempts had been made in the past, but it wasn't until DeltaLab developed and marketed this technology that a successful ADM converter suitable for high-quality audio was made available in a professional audio product.

Fiction: Adaptive Delta Modulation is not Simple

Not so! Although ADM is electronically smarter than basic delta modulation, it need not be difficult nor complicated to implement. In fact, an equivalent PCM encoding system usually cost at least 10 times that of an ADM system. ADM systems do not require the type of expensive precision components associated with PCM. Also, because ADM is still a one-bit system, its sample rate and clock rate are synonymous, thereby eliminating the need for exotic anti-aliasing filters.

The basic elements that appear in a basic delta modulator also are used to create an Adaptive Delta Modulator. The additional circuitry used to create the adaption, although very clever, need not be expensive at all.

Perhaps the biggest reason that it took so long for ADM to mature was that PCM was an already established method of analog-to-digital conversion, and was quite easy to understand. Look at all those neat little binary-weighted words — Wow! So why even consider an approach that is based on slew-rate; slew-rate is difficult enough to comprehend in this world of amplitude and frequency. But alas! You can't keep a good man down forever. High performance at a low cost with high reliability will always make you sit up and take notice, every single time!

Fiction: AMD Systems are Slew Rate Limited

Like any other electronic systems, an ADM circuit must be carefully designed. Poorly designed ADMs, as well as poorly designed PCMs, are both susceptible to slew-

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For additional information circle #8

YES . . . THEY ALL BUT LISTEN SYNCLAVIER® II

TOM MOODY

Creative Director, Executive Producer, N.B.C. Television,
Los Angeles

Well, it's hard to talk about any one aspect of the Synclavier II because everything about this instrument is so unbelievable; but if I had to boast about one area of its capability, it would be its speed and ease of use for composing new ideas. I find my scratch tracks suddenly become finished tracks, right out of the Synclavier II's 16 track digital sequencer to tape. This feature alone has increased my production output at least 300% in the last two years. Plus, the additional ideas you receive from the great number of Synclavier II owners who trade programs and innovative ways to use the system always keep the creative juices flowing.

When you combine those musical features with the fact that the instrument, through new software and options, keeps expanding and getting better, what I first thought was a major expense has paid for itself many times over.

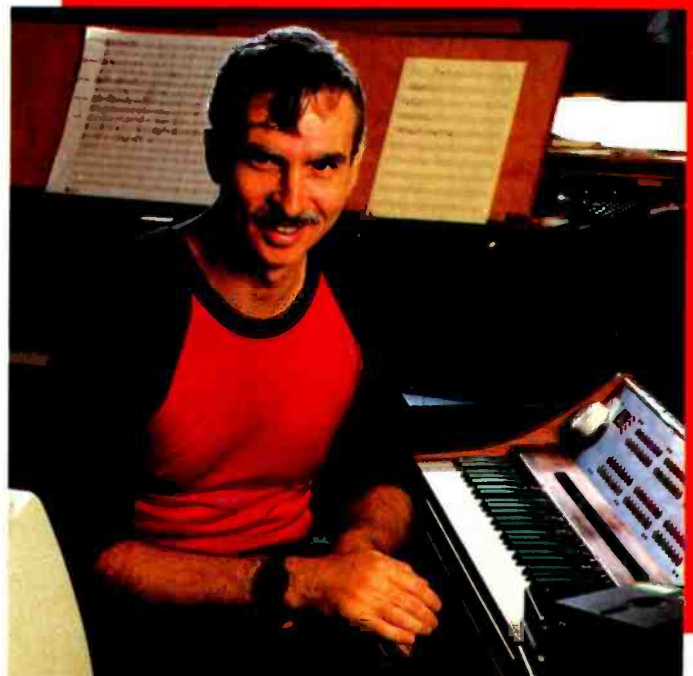


PAT GLEESON

Synthesist/Producer, San Francisco

I used to own \$85,000 worth of analog synthesizers, but I sold them all to buy one \$40,000 Synclavier II which, by the way, paid for itself on my first Synclavier II project. The director of that particular film wanted to hear the music before committing it to tape, so how else could I do that except by using the Synclavier II's 16-track digital recorder.

Even more important is the attitude of the company. Over all of my years in the music business, N.E.D. is the first company that sincerely pays attention to its users. In fact, the great thing about the Synclavier II is that it's better today than when I purchased it, due to user input and software updates. I've heard about people who don't own one saying that in a year the Synclavier II will be half the price. The funny thing is, I've been hearing that for three years now.



HESITATED AT FIRST, TO THESE OWNERS NOW!

OSCAR PETERSON

Toronto

A renaissance in music is happening right before our eyes and ears; and the Synclavier II is leading the way. This instrument saves many of my spontaneous compositions which before were lost. Then, to be able to automatically print out the music is just short of a godsend for me. What used to take two hours of transcribing music, now takes five minutes. Also, if there is a small feature which you think would improve the useability and musicality of the program, just inform the company and eventually you will have it. The printing feature gets better all the time. It sure is a pleasure to learn one instrument and grow with it. I have been more than satisfied with my investment and convinced it is one that will last as long as my first love, the piano.



ALBHY GALUTEN KARL RICHARDSON

Karlby Productions, Miami (Producer/Engineer for Bee Gees, Barbra Streisand, Dionne Warwick and many others.)

I think we purchased the first or second Synclavier II built back in 1980 and without a doubt, it has been the best investment we've ever made for any computerized musical instrument. Recently we added the Sample-to-Disk™ option to the Synclavier II, which has opened up an immense amount of musical ideas while also saving valuable production time. For example, we were recording an artist and we wanted to change where the person sang and also correct a slight intonation problem. Instead of re-recording or splicing, we just sampled the performance to the Winchester of the Sample-to-Disk™. We then rolled back the tape, and played the phrase where we wanted to and corrected the intonation problem with the Synclavier II's pitch wheel. We also use it to precisely analyze the meter of any music. Of all the choices available to us, we're glad we choose the Synclavier II because we feel it's going to be the standard for every studio.

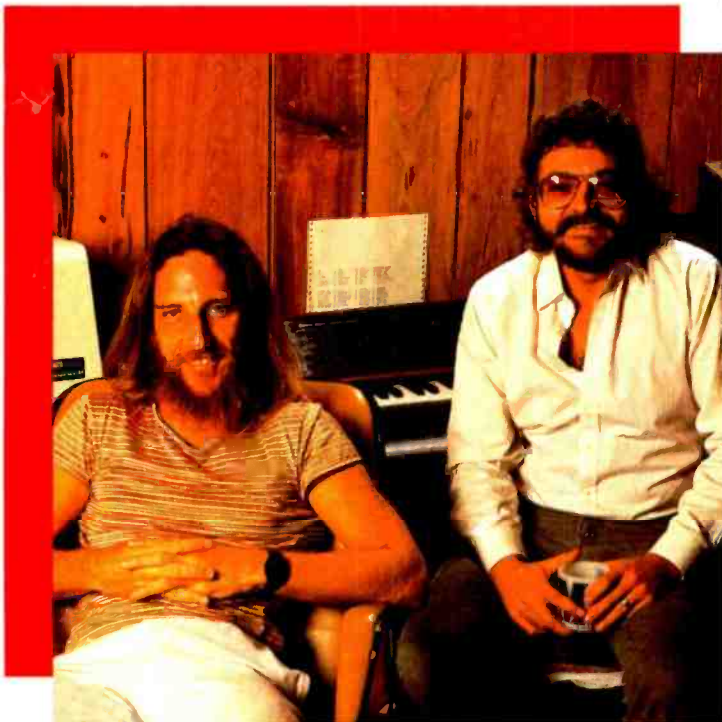
New England Digital Corporation

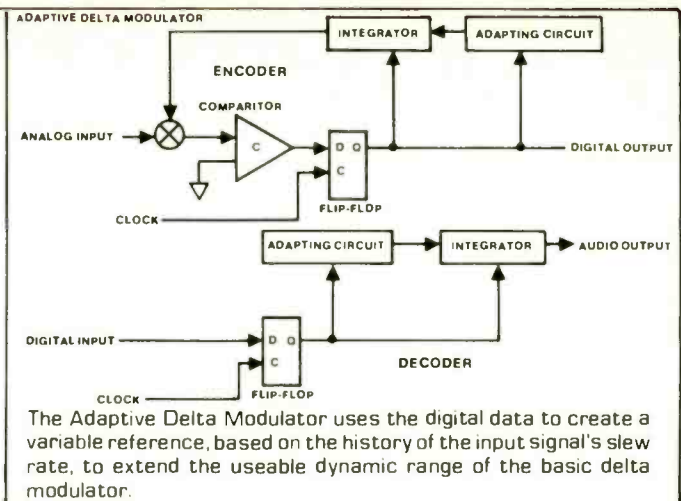
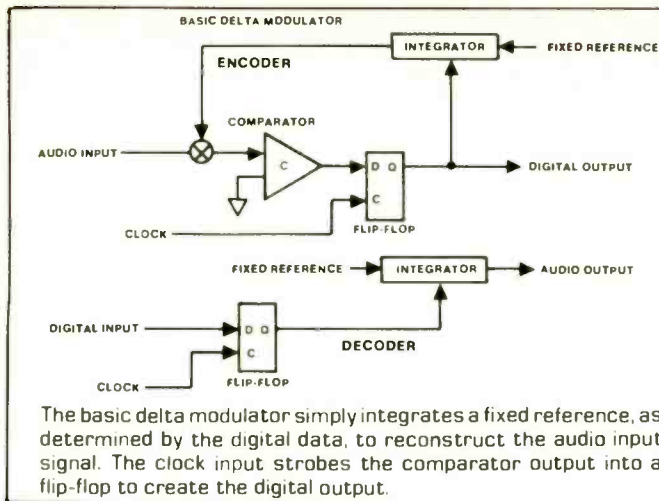
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For additional information circle #9





rate limiting. Properly designed ADMs are quite capable of providing full-power bandwidth with no slew-rate limiting whatsoever. Sometimes the question is not *what* the technology is, but rather, "whose technology is it?" The circuit design is just as important.

Fact: ADM Sounds More Natural Than PCM

This is where the controversy begins. At equivalent clock rates, a well designed ADM system is not limited by the deficiencies normally associated with PCM systems. PCM systems in widespread use or discussion include 12- to 16-bit (less than 12 bits is generally not acceptable for high quality audio), linear or floating-point designs sampling at 50

kHz or less. This requires a basic clock rate of up to 800 kHz. Let's compare these with ADM systems that use the same clock rates.

With sampling frequencies less than three times greater than the highest signal frequency of interest, PCM systems require precision multipole lowpass input filters to prevent aliasing. With ADM, aliasing is not a concern since the sampling frequency is the same as the clock frequency, making its sampling rate 30 to 40 times greater than the highest signal frequency of interest. A single-pole input filter usually is all that is needed to prevent ultra-sonics from interfering with the ADM system.

At the output of the PCM decoder another multipole lowpass filter is employed to elimi-

nate a strong sampling frequency component, and to restore a plausible replica of the input waveform. Again, the ADM decoder needs only a simple filter to reconstruct the original waveform. In fact, without filtering, the waveform is already a decent replica. Why is filtering important?

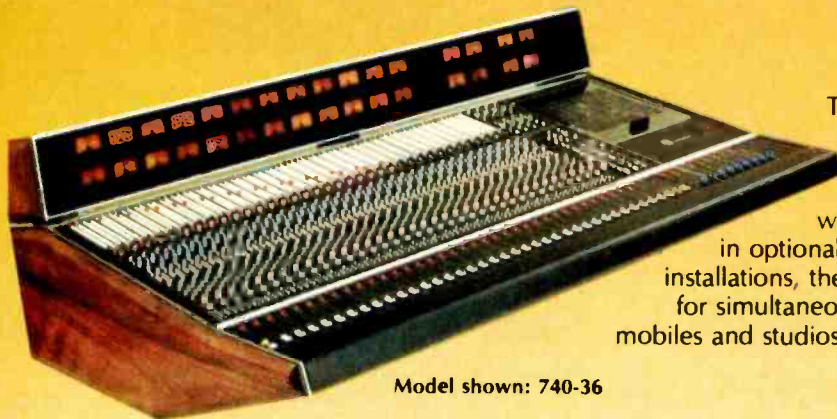
Using higher-order multipole filters in a system creates what I call the "brick wall effect": there is absolutely no response whatsoever after the cutoff frequency. For example, a PCM system with a cutoff frequency of 16 kHz will have no response, at all, at 17 kHz (rolloffs of greater than 84 dB per octave are commonplace in PCM systems). Compare this to an ADM system with the same cutoff frequency, and you will soon discover that

... continued from page 15

... continued on page 22

Production quality.

700 Series Multichannel Audio Mixing Console



Model shown: 740-36

The Audiotronics 700 Series is one of the few multichannel audio mixers specifically designed for production use. Available in 5 mainframe sizes, with or without integral patchbay, and in optional shallow depth variations for custom installations, the 700 Series has become the console for simultaneous production and recording in both mobiles and studios and for audio for video production.

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- Audio Follow Video Capability
- Multichannel Metering

Available in 8, 16, or 24 outputs. Level and Mute Automation optionally available.



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For the last two years, we've been working to build the type of instrument that would inspire satisfied owners to tell potential customers just what they're missing. Yes, we're very pleased with the response of our owners. In fact, at New England Digital, we like to think of them more as family than just customers. Although we've been saying that an investment in a Synclavier II is an investment that increases in value year after year, it's still nice to hear our customers express the same feelings. So, as we enter 1983, we would like to extend our appreciation to the nearly 200 Synclavier owners worldwide. The financial support and musical ideas of these visionaries have been essential to the success that the Synclavier II enjoys today. Ask any of them: you'll find we're a high technology company that places a high emphasis on people.

So, potential customers, be assured that New England Digital will not rest on its laurels. This year we plan to revolutionize the already revolutionary Synclavier II with exciting enhancements for Music Printing, and incredible new options: Digital Guitar, Stereo, and more.

So quit hesitating . . . talk to a Synclavier II owner or, better yet, visit New England Digital or one of our local distributors for a personal demonstration.



Bradley J. Naples
Director of Marketing and Sales

Synclavier II Instruction Manual

A complete and descriptive Instruction Manual is available for \$85 (USA & Canada) and \$100 US (elsewhere).

Synclavier II digital music systems start at \$14,150.

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New England Digital Corporation

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The Power of Communication

From a Complete Mixing System.



MARK IV™ MIXING CONSOLE



MARK IV™ MONITOR

Features and specifications subject to change without notice.

It is the purpose of any musical performance, live or recorded, to successfully communicate with the listener. To attain that goal is often a challenge — even for the most experienced musicians, sound personnel, and stage crew. At Peavey we realize the criteria to be met before this goal can be obtained.

MARK IV™ MONITOR MIXER

First, the musician must be satisfied with the blend and balance of the on-stage monitor mix. In most concert type situations, the musicians may demand anywhere from two to six separate monitor mixes. Our new Mark IV™ Monitor Mixer can supply this need with up to eight individual monitor mixes.

The Mark IV™ Monitor Mixer is available in 16 x 8 or 24 x 8 configurations and features transformer balanced inputs and outputs, 8 unbalanced outputs, PFL/Solo headphone system, 10-segment LED ladder displays for each of the 8 outputs, auxiliary inputs and low-cut controls for each mix and a unique PFL/Solo patch. The PFL/Solo patch is a highly desirable feature that enables the monitor engineer to patch any of the mixes back into the switched inputs so that externally equalized or processed signals can be monitored. This is a feature which is not usually found on custom-made monitor mixing systems costing \$15,000 or more.

Each channel of the Mark IV™ Monitor Mixer features LED status indication of -10 dBV and +10 dBV, an input gain control, 4-band equalization, built-in mic splitter, phase reversal switch, PFL and mute switches, and 8 color-coded rotary level controls which correspond to color-coded slider level controls in the output section.

To make the most out of the Mark IV™ Monitor Mixer's capabilities, we have equipped the mixer with two separate built-in communication systems. By utilizing our optional headset or "gooseneck microphone," the monitor mix engineer can communicate with the musicians through any of the 8 separate monitor mixers. This

talkback system will help alleviate the problems musicians sometimes have in establishing the proper on-stage mix, especially if a previous sound check was not possible.



A second communication link can also be established by the monitor mix engineer between the stage crew and lighting personnel by utilizing the optional Talk/Comm "slave" units. The Mark IV™ Monitor Mixer's front panel utilizes an LED indicator to alert the engineer as a call function and also shows when intercom is active.

MARK IV™ MIXING CONSOLE

Next, the house (main) system must be able to deliver crystal clear, noise-free sound reproduction to the associated equalizers, power amps and horn/loudspeaker enclosures. For the main PA, our new Mark IV™ Professional Mixing Consoles offer the sound engineer the necessary performance, flexibility and functions to do almost any sound job.

The Mark IV™ Professional Mixing Consoles are available in 16 or 24 channel versions (16/24 x 4 x 1) and feature transformer balanced inputs and outputs, PFL headphone system, 10-segment LED ladder display for all outputs, channel and sub output LED indication (-10 dBV and +10 dBV), internal reverb and effects/reverb return to the monitors. The console also utilizes a 24 volt phantom

power supply, variable low-cut controls on each sub (20 Hz to 500 Hz), and in-line patching facilities between the sub outputs and the sum.

Each channel of the Mark IV™ mixing console features an input gain control, two pre-monitor sends, 4-band equalization, effects/reverb send control, pan control, "push/push" channel assignment switches, pre and post EQ, send/reverb patching and PFL (pre-fade listen) switch.

The Mark IV™ Professional Mixing Console has two complimentary communication systems for use with our Mark IV™ Monitor Mixers, headsets, gooseneck microphone and Talk/Comm "slave" units. The Mark IV™ Series intercom system allows communication between the "house" and monitor mix engineers as well as stage, lighting and other associated concert personnel.

Both the Mark IV™ Monitor Mixer and the Mark IV™ Professional Mixing Console feature gooseneck lamp connectors (BNC) with dimmer controls for use with our optional gooseneck lamps. This option allows superb visibility of the mixers in poor lighting situations.

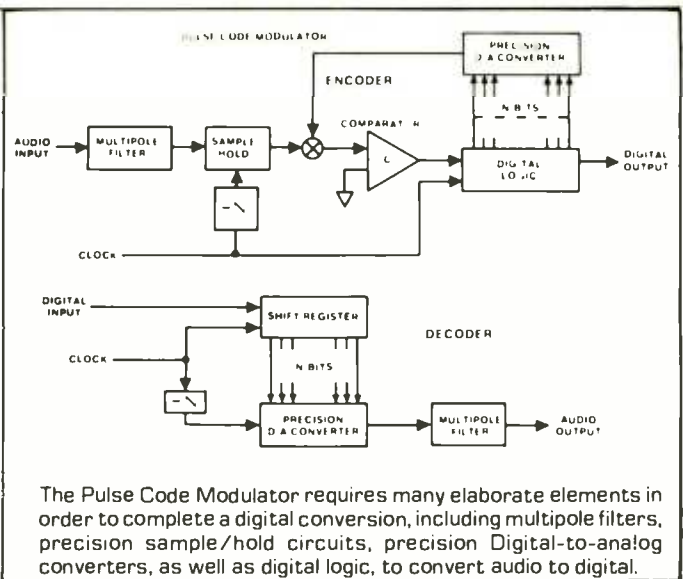
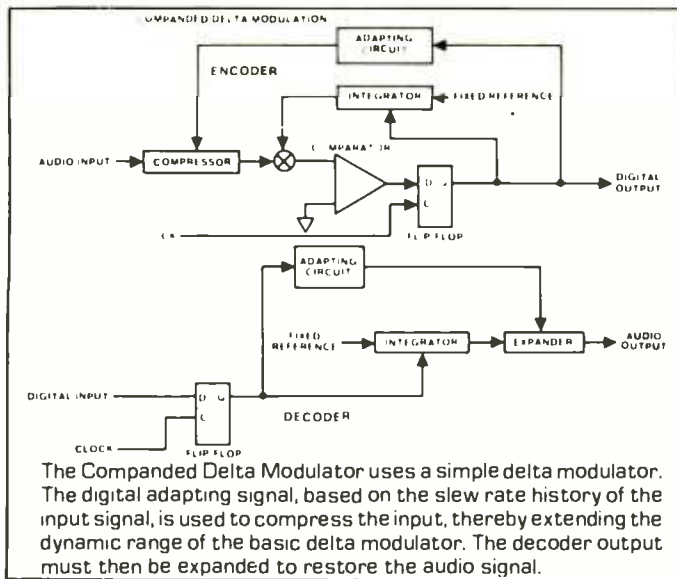
The Mark IV™ Series Monitor Mixers and Professional Mixing Consoles are the successful result of our extensive research and development efforts as well as constant "monitoring" of the needs of professional sound reinforcement companies and soundmen. This outstanding series of mixers represents, we believe, truly exceptional and professional products that will outperform competitive products retailing for many times the price.

For complete information on the Mark IV™ Series write to: Peavey Electronics Corp., P.O. Box 2898, Meridian, MS 39301.



PEAVEY ELECTRONICS CORP.
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continued from page 18

although both systems are -3 dB at 16 kHz, the ADM still has a nice response beyond 20 kHz. In fact, at 20 kHz the ADM's response is less than -6 dB, and only gradually rolling off. Is this "brick wall effect" important? You bet it is! Even if you cannot hear beyond the 16 kHz cutoff frequency in the example above, you still will be subjected to the tremendous phase shift and associated group delay reflected in-band as a result of multipole filtering. This creates listening fatigue, and is one of the biggest reason why ADM systems sound more natural and cleaner than their PCM counterparts.

Fiction: Companded Delta Modulation is Superior to ADM
 Companded Delta Modulation (CDM) is certainly more expensive than ADM, but it is definitely not superior. In fact, CDM is merely another form of ADM; both use an adapting signal generated in the digital circuitry which represents the most recent history of the input signal's slew-rate. In general, ADM uses the adapting signal to optimize the "reference signal to input signal" ratio by adapting the reference signal within the delta modulator; hence, the name Adaptive Delta Modulation. CDM uses the same adapting signal to optim-

ize the "reference signal to input signal" ratio, by varying the input signal via compression and expansion; hence, the name Companded Delta Modulation. It is only the ratio of the reference to input signal that is important; the manner in which it is accomplished is a matter of economics, and repeatability. Unlike ADM, CDM requires the use of a rather elaborate voltage-controlled amplifier (VCA) to perform the actual companding. As previously stated, ADM requires no super precision components. It is claimed by the advocates of CDM that it is easier for the comparator in their system to make critical decisions, since the step size generated by the reference integrator is constant throughout the range of conversion. While the CDM reference step size is indeed constant, it is usually equivalent to the smallest step size that an ADM system must tolerate; unless, of course, a tradeoff has been made in the lower frequency performance of the CDM system. A big point is made by the proponents of CDM that having a constant reference step size allows them to use a dither signal to mask their "birdies" and "whistles" — shades of PCM. Who needs a dither signal? Birdies and whistles can be eliminated completely in both ADM and CDM systems by the use of a patented positive feedback circuit, which does not allow any audible distortion component to prevail in the normal quantization process. For future reference, this is called the "Ear Circuit," and it completely eliminates the need for any kind of dither signal. Since CDM is simply another form of ADM, let me say that using the same building blocks, ie comparators, ear circuit, integrators, flip-flops etc, but arranging them to form either system, the results will be almost exactly the same. What distinguishes one system from another will be the individual design of the building blocks, and not the system itself. Hence, using a multipole integrator in a CDM system may yield a couple of dB improvement in performance over an ADM system that uses a single-pole integrator. But, that is only due to the differences in integrator design, and not the basic differences in system concept. Incidentally, like multipole filters, multipole integrators come with



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For additional information circle #13

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their own set of problems —enough said!

Note: While it is certainly clear that I am an advocate of ADM, I consider CDM to be just another form of ADM and, as such, I recognize that a properly designed CDM system will perform as well. Therefore, from here on out, any reference made to ADM applies equally as well to CDM, unless expressly stated otherwise.

Fiction: ADM is the Best Method to Convert any Analog Signal

Adaptive Delta Modulation is best suited for audio applications, since absolute amplitude accuracy is not critical. Other types of analog signals require strict amplitude accuracy — for example, digital voltmeters. There is no amplitude information available in the ADM digital signal; it works totally on rate of change information. There exists a cousin to delta modulation, called delta sigma conversion, that converts analog signals, such as DC voltages, to a pulse rate . . . synchronous to the basic clock; but that is another story. PCM analog-to-digital converters are usually designed for non-audio applications, and therefore are more suitable for these applications.

Fiction: There are no Tradeoffs Using ADM

Not true! The reason ADM is so inexpensive is that the analog circuitry required to make a good ADM system does not require the use of precision components, nor does it require elaborate filtering. PCM, on the other hand, requires exotic analog circuitry, such as precision sample/hold circuits, precision

ladder networks, and precision filtering. Well! Where is the tradeoff? We all know that you cannot get something for nothing. The law of conservation of goodness applies here also.

The digital PCM signal is a binary word consisting of a fixed number of bits. These words represent amplitudes, and therefore can be used in computations such as adding, subtracting, multiplying and dividing. Just think, a digital mixer . . . It's still not that easy!

The digital ADM signal is a non-binary series of bits that represent the derivative (rate of change) of the signal. Actually, the digital signal consists of a new word of infinite length — every bit. In order to compute these "words," the digital signal must be digitally integrated, and then operated on by other digitally integrated signals. After the computation, the result must be digitally differentiated to restore the delta format. This is bad enough, but before any of this can be done the digital logic must be taught the adaption algorithm. Wow! Digital IC costs are getting lower, and some day it may be feasible to compute ADM signals, but for now . . . forget it!

As long as the application concerns only storage, such as tape recorders and time delay processors, we have actually beaten the law of conservation of goodness. Please, not a word!

There are some minor tradeoffs that are made in the audio conversion process, but they are kept under control and are, in fact, invisible to the human ear.

Fact: PCM Measures Better Than ADM

This is probably the toughest nut to swal-

low. PCM systems do measure better — sometimes notably so — even when they do not sound as good as ADM. What are we measuring? Are these parameters important to the ear? Who knows?

Frequency response measurements are straight forward, and usually represent what the ear hears, provided that the tolerances are relatively tight. But what about the "brick wall" effect? Who specifies a measurement beyond the cutoff frequency?

Dynamic range is not necessarily a measurement of signal-to-noise, especially in ADM systems. While an ADM system's instantaneous S/N may be only 60 dB or so, unlike PCM it maintains this ratio over a wider dynamic range. In fact, ADM systems maintain the full character of the audio even at very low levels. Even when the signal is lower than the noise, the audio is maintained in all its glory. This is absolutely not so with PCM — when you get down to that last quantum level in PCM you hear nothing but gross distortion. Don't believe me . . . try it for yourself!

Apply a -85 dB audio signal to both a PCM and an ADM system. By amplifying the output 85 dB, to restore the level, you will hear what I mean. But, alas! We have no standard measurement to show this on a data sheet.

Distortion measurements are definitely better for PCM than for ADM systems. Fortunately, the increased distortion measured in ADM is not of the audible variety. But, once again, PCM wins on the spec sheet.

Since the ear is the best instrument to measure what the ear hears, the only solution is to listen and compare. This may offend

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THE TOA RX-7 SERIES

some of you more scientific types; however, if it sounds good and keeps sounding good... it is good!

Fiction: ADM is Totally Immune to Tape Dropouts

It's true that since ADM is a one-bit system, each bit is a least significant bit and, as such, does not have the problem associated with tape dropouts in PCM tape recorders. However, since both ADM and CDM are adaptive, some havoc will be raised by long lasting losses of digital information — but certainly not to the extent found in PCM. A much simpler error correcting method can be employed. At least two companies, one

using AMD and the other using CDM, have had excellent success with very simple error correction schemes. I'm sure more will follow.

This new awareness of delta modulation will probably be exploited to its fullest by many manufacturers. Much will be said and, again, many claims will be made. The only sure-fire method I know to separate fact from fiction is to "listen and compare." I have tried to be as candid and informative as I could without being too commercial. I hope I have succeeded. ■■■

software to support it. The Sony-Philips Compact Disk has nearly two dozen companies offering software for the digital system, including CBS, CBS/Sony, Decca, Denon, Deutsche Gramophone, London, Matsushita, Nautilus, Nimbus, Nippon-Columbia, Philips, Phonogram, Pioneer, Polygram, Polydor, RCA Europe, Realtime, Sanyo, Sonopress, Telarc, Toolex Alpha, and Toshiba-EMI. Software will be released during 1983 in Japan, Europe, and the United States. Players initially will come from Akai, Aiwa, Denon, Hitachi, JVC, Kenwood, Magnavox, Mitsubishi, Nakamichi, Panasonic, Philips, Pioneer, Sanyo, Sony, and Technics, among others. The available musical repertoire will range from classical talents, such as Ashkenazy, Bernstein, Pavorotti, Solti, Sutherland and Williams, to the Moody Blues, Bee Gees, Kool and the Gang, and the Statler Brothers. While it is true that there are fewer US-owned record companies involved with the Compact Disk system, the world record industry is changing and the introduction of the digital disk will certainly create new marketing alignments. The fact that system founder Philips is interested in a royalty position on the new disks has slowed the acceptance of US-based companies, but it seems likely that the royalty issue will be ironed out. Philips, it is rumored, are seeking a three-cent royalty on each Compact Disk sold.

Fact: Sony and a group consisting of

AUDIO/VIDEO PERSPECTIVES —

IS AUDIO DEAD . . . AGAIN?

by Martin Polon

The doom callers and negative soothsayers of the electronics industry again are predicting for the demise of audio, at all levels. Most of the self-appointed pundits are calling for another bad year in record sales, lowered expectations for audio components, and a concomitant reaction at the recording and professional audio marketplace. Many of these experts, citing the recent Winter Consumer Electronics Show as mute witness, claim that computers have captured the public's fancy, and that audio

will be destined to a poor third in sales behind video equipment. The only problem with all of this is that, to borrow from Mark Twain, "The report of audio's death seems a bit exaggerated."

Fact: Future sales projections of electronic-based devices for 1983 all indicate that the total sales of audio in every format will be greater than personal computing, with audio shown to exceed the \$6 billion level.

Fact: Digital disk is coming to the marketplace, and with the necessary

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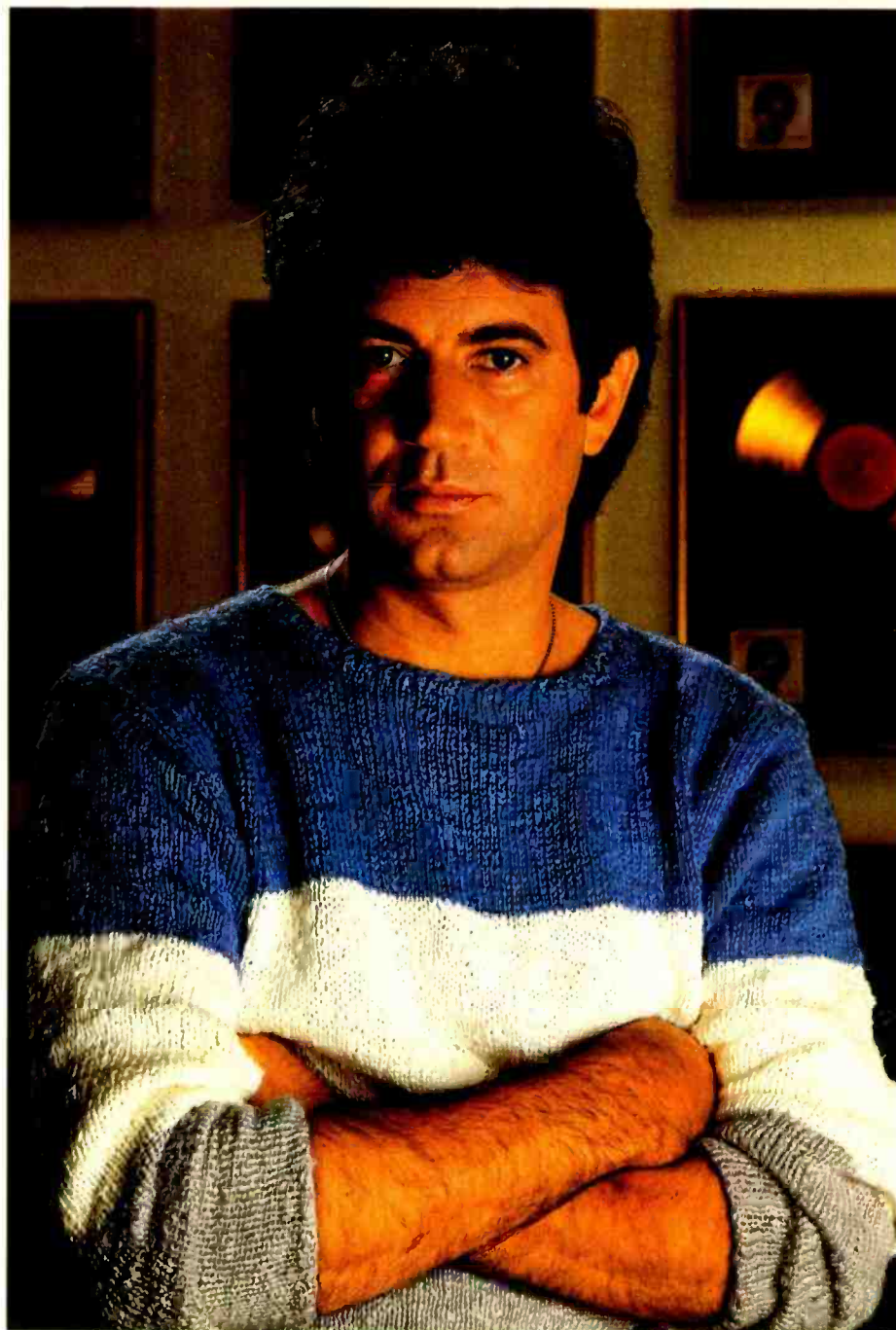
CONSOLES 32X8, 24X8, 16X4.

February 1983 □ R-e/p 25

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10 other companies have released an FM modulation system for Beta videocassettes, which reportedly allows accompanying audio recording and reproduction with a 20 Hz to 20 kHz frequency response, greater than 80 dB dynamic range, and wow and flutter less than 0.005%. Harmonic distortion is said to be greatly reduced, and channel separation better than 60 dB. This development, it is predicted, will allow pre-recorded video cassettes to provide a stereo soundtrack quality superior to all previous formats. The marketing and manufacturing group for the new system includes Aiwa, Marantz, Nakamichi, NEC, Pioneer, Sanyo, Sears, Technika, Toshiba and Zenith.

Software for the new Beta format, which superimposes audio information on the video signal with the chrominance and luminance information, will come from many sources. Initially, several companies, including Chrysalis, MGM, Pacific Arts Video, United Artists, and Walt Disney Home Video, will be releasing some 65 titles recorded for the new system. The potential of utilizing the entire catalog of theatrical features with Dolby Stereo soundtracks provides another 300+ productions suitable for Beta-HiFi release.

This forward movement in audio for video is virtually guaranteed to be matched by a similar FM system for the competitive VHS videocassette system. Units equipped for a similar standard of high-quality stereo are expected this year from JVC, Panasonic, RCA, and others licensed for the VHS system.

Fact: RCA's SelectaVision videodisk system is now stereo equipped, and numerous titles currently are being released with stereo audio. The Philips/Pioneer Laserdisk now is utilizing the CBS CX noise reduction system, to provide high-quality reproduction of accompanying audio.

Fact: The Electronic Industries Association (EIA) subcommittee on multichannel sound is reported to be very close to reaching a decision on the future of stereo television. A decision would have been delivered at the close of 1982, except for the need to resolve a technicality. Stereo TV sound is being broadcast regularly as a part of several cable movie services, while the videomusic-based MTV-The Music Channel from Warner-AMEX utilizes stereo transmission at all times.

Fact: The average American is getting older, with a median age presently above 30 and rising. This affluent and mature audience has demonstrated a willingness to buy new and better audio equipment to improve the reproduction of music in the home.

All of these facts adds up to the following: by 1986, projections show that the introduction of car stereo utilizing the digital disk, digitized "Walkman-type" components, and high-fidelity home systems based around the digital disk could potentially double record sales. For the professional audio industry, the

implications of a revolution in home listening habits are of growth in the studio. The crossover point for digital disk is estimated to be 1985, when the price of a player will be under \$500. 1985 also is the year when stereo television could achieve 20% total penetration of the US marketplace, assuming a 1983 start. The growth of home VCR use, with full-frequency stereo, could double by 1985, especially if the current legal challenges to taping in Congress and the Supreme court are concluded to allow free use in the home.

All of these formats will require new product, and the library of current recording is inadequate to fulfill software demands for the new systems.

While it is true that many albums have been recorded digitally for future release in that format, the large libraries of audio software needed in the immediate future will require state-of-the-art studio space for recording.

Audio, it would seem, is not moribund, but rather emerging like a sleeping giant from the cocoon of change. The systems and softwares of the Eighties will provide audio recording and reproduction at quality levels only dreamed of five years ago. The net effect for improvement in the home will create benefits at the semi-professional and professional levels, as new technologies become the standards of the Eighties and Nineties. ■■■

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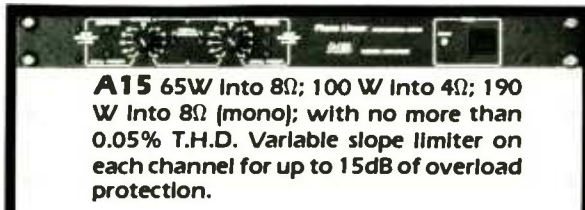
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news

... continued from page 12 —

made available to professional clients in Nashville, and throughout the United States.

The first project booked on the PCM-3324 was a videotape soundtrack recording at New York's Atlantic Records Studios, followed by recording of an album by Neil Young at Nashville's House of David studios, and a Frank Zappa project in Los Angeles, Moran said.

The PCM-3324 records full 24-channel digital audio, in addition to separate SMPTE timecode and internal control tracks. The machine uses half-inch tape, and includes two analog audio tracks designed as part of a system to allow simple razor blade editing.

"We selected the PCM-3324 because it is the first standardized digital machine," Moran commented. "Tapes done on the machine will be compatible with recordings made on digital machines from MCI and Studer. We're convinced that as more manufacturers develop machines, they will tend toward this format."

FLANNER'S PRO AUDIO MOVES

Flanner's Pro Audio, the Wisconsin based pro-audio supplier, has moved to a new facility that offers over double the amount of office and showroom space to in excess of 2,400 square feet. The new facility includes an increased service and sales department, consultation services, a fully operational demo studio, and an additional computer customer service center.

The company's new address and telephone is: Flanner's Pro Audio, 2323 C Bluemound Road, Waukesha, WI 53186. (800) 558-0880; (414) 785-9166.

AMPEX ANNOUNCES NEW FINANCIAL AGREEMENTS

Ampex Corporation has reached agreements with Wheelabrator Financial Corporation and Commercial Funding, Inc. to provide financing alternatives for the lease or purchase of audio and video recorders to its US customers. The new term funding program, which became effective January 31, provides customers with the opportunity to lease or purchase Ampex audio or video recorders through one of four financing alternatives: tax-oriented lease; lease purchase; conditional sale; or operating lease.

"The economy has necessitated the extension of financing alternatives for the purchase of capital equipment," said Michael Scott, Ampex sales finance manager. "We believe these new agreements will enable our customers to lease or purchase Ampex equipment more cost effectively."

— continued on page 117 . . .

Sound Workshop on the right to bear ARMS.

When Sound Workshop introduced its computer automation system several years ago, we named it ARMS — a tongue in cheek acronym for the Auto-Recall Mixdown System. At that time, recording industry use of console computer automation was focussed on the multitrack mixdown process and a system designed to aid that process would thereby provide additional "arms" for the engineer.

Technology has continued to evolve since that time, and so has the idea of using a computer to do more than just assist in the mixing process. One can spend more than a quarter of a million dollars for a computerized recording console nowadays. And the computer in that board will eliminate the use of pencil and paper forever by allowing the "recall" of virtually all of the console set-up information. A definite advantage in the creative process, but the price tag can be forbidding (even when you consider the money saved on pencil and paper).

Sound Workshop is not presently building consoles in the highest price brackets. We have concentrated our expertise on designing and building cost-effective professional console systems that in many ways outperform their more expensive counterparts. The Series 30 shown here provides a perfect example of what we do. And we have maintained this same approach regarding console automation.

Although ARMS was specifically designed to aid the recording engineer during complex mixdown situations, it actually functions throughout the recording process by providing computer control/assistance to a number of mechanical operations previously done manually, with the help of other engineers, or not at all. ARMS Automation includes the following functions:

- Automated control of channel levels (Level Write)
- Independent automated control of channel on/off status (Mute Write)
- Full In-Place Solo System
- Total integration of all automated functions into all group structures
- Super-Group

The most vital aspect of ARMS Automation is its ability to control the on/off status of each input channel totally independent from its control of channel level information. Even if ARMS was used just to turn channels on and off without writing level information (i.e. having the system control the actual "mix," normally the stated purpose of automation), a number of mechanical operations common to nearly all mixdown sessions would be eliminated. These include: noise gating; erasing unwanted sections on the multitrack master; selecting proper tracks from duplicate performances; switching

between "time shared" tracks; changing EQ, Echo, Panning etc. during specific "sections."

Another major asset of ARMS Automation is its computer-controlled sub-group system named **Super-Group**. Super-Group permits all grouping functions to be controlled by the computer, eliminating previously awkward systems of group selection, modification and visual confirmation. Conventional systems require the user to scan each input module's thumbwheel switch (or digital display) to determine which inputs belong to a given group, an often cumbersome process on today's larger consoles. With Super-Group, the user merely pushes the button on any channel and all members of that group light up — **instant visual group confirmation!** Other Super-Group features include:

- **Solo Dim** Allows all channels except the one (or ones) soloed to be attenuated by any preset amount.
- **Negative Grouping** Allows instant selection of a group consisting of all channels **except** those selected.
- **Grand Master** Any fader may be established as the console Grand Master.
- **Local Control** Any Group master can be changed over to local channel control without affecting the group level.

ARMS Automation is available in the Sound Workshop Series 30 and Series 40 recording consoles. The exceptional performance and practical value of these consoles can be confirmed by sitting behind one of them or by consulting with a studio who owns one. Twenty-four track automated consoles from Sound Workshop start at less than \$32,000.*

Sound Workshop's ARMS Automation is genuinely innovative and amazingly cost-effective. Much more than just a mixdown aid, it provides a variety of functions not found in other systems regardless of cost. And Sound Workshop will soon be introducing DISKMIX™ — a disc-based storage system designed to augment ARMS with the capability to store and merge a number of mixes while providing off-line editing, computer control and storage of session documentation.

Just a part of your right to bear ARMS.

*Prices subject to change without notice.

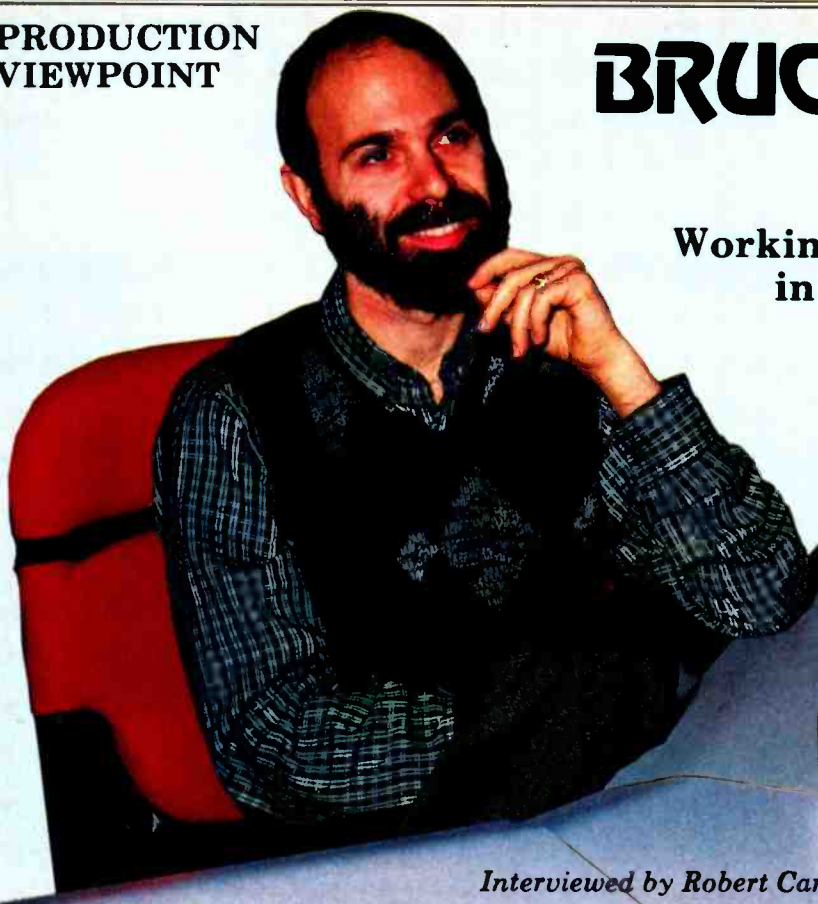


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BRUCE BOTNICK

Working with Digital Audio
in Film and Video



Interviewed by Robert Carr

For the baby-boom generation, the Sixties was a point of departure from the established patterns of thought that had gone before. Likewise, the music of that era provided the rallying force behind those changing social values. One man responsible for a large number of those trend-setting recordings is Bruce Botnick. While not considering himself a radical, Botnick consistently has remained at the forefront of the music field. After either engineering or producing such artists as The Doors (*The Doors*, *Strange Days*, *Light My Fire*, and all the rest); The Beach Boys (*Pet Sounds*, *Good Vibrations*); Rolling Stones (*Let It Bleed*), Dave Mason (*Alone Together*); and the music for all the *Beach Party Movies*, Bruce really got serious. He received a Grammy Award in 1972 for his engineering on *Lenny*, the first Broadway play recorded live on stage; as executive producer at CBS he produced the first digital soundtrack recording for the motion picture, *Star Trek — The Motion Picture*; and, most recently, as producer/engineer he completed the first all-digital recording and post-production of a live rock video shoot, *Kenny Loggins, Alive*. Recent film credits include soundtracks for *Caddyshack*, and Steven Spielberg's *Poltergeist*, and *ET*. Such a versatile background provided a natural starting place for this interview.

R-e/p (Robert Carr): Looking at all the different albums you've worked on, there always seems to be a different title next to your name: Executive Producer, Producer, Engineer, Mixer, or something else. Is there a particular role with which you feel most comfortable?

Bruce Botnick: The more jobs I get to do, the more hats I get to wear. One job or project gives to the other. It's like when I used to record a commercial in the morning, a children's album in the afternoon, a rock-and-roll date at night, and the next day I'd do jazz. When you're an engineer, and you work with a lot of different types of producers, you see their various styles; certain approaches appeal to you, and certain ones don't. When you get in that producer's chair, you try to apply the things you've learned that you feel will work. At that point, you find out that some of

them don't work for you, even though you thought they would, so you exercise some lateral thinking.

Let's say you work on a jazz date in the afternoon, and in the evening you're doing a rock and roll date. They definitely feed one another. An emotion that you get from a jazz session may feed an inspiration when you hear something during the rock and roll date, or vice versa. Some classical music may inspire you to do something else. I don't approach a session with the attitude that, because this is a rock and roll date, certain parameters apply. I approach each date as a piece of music, and let it take on a unique life of its own.

I don't go in with any preconceptions. If I meet an artist and become enamored with their material, I try to immerse myself, and conceptually I come up with how I think I can realize what they have

to say. Every project is unique, it has its own challenges. No two have been alike, out of all the years I've been in the business. That's what makes it really refreshing and worth continuing.

R-e/p (Robert Carr): I assume you're still fulfilling the role of the traditional producer — taking part in the pre-production stages, and all the rest?

Bruce Botnick: . . . doing budgets, sitting down with my Apple and Visicalc [program], putting in numbers, and going "What If?" . . . Then, as I get towards the end of the project and I find out "What Is," I start having coronaries.

R-e/p (Robert Carr): when you discover that a group is going to be recording digitally, do you change the pre-production format in any way?

Bruce Botnick: No, I don't change the

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BRUCE BOTNICK

pre-production. The only change that may occur is that I budget for the digital process. If I have so much money to spend — say \$50,000 for an album — I say to myself, “Okay, I want this particular act to do as much live as possible, in order to cut down the cost, and be able to take advantage of this new technology.”

R-e/p: That obviously would entail rehearsing the band for a longer period of time before going in to record?

BB: Definitely. But you can only do that with self-contained groups.

R-e/p: Have you found that you might have to get the group's sound more “polished,” because digital is so much cleaner?

BB: No, I don't change anything for the recording medium. Digital is just a storage medium, like any other recording machine; one just happens to be a little cleaner than the other. I don't ever try to “sanitize” a band. The reason you get attracted to a band is for that rawness and uniqueness. I want to keep that.

R-e/p: What pre-production was involved for Kenny Loggins' High Adventure album? The song “Heart to Heart,” especially.

BB: Kenny wrote the song with Michael McDonald and David Foster. The original pre-production was primarily Kenny making demos of the song, playing them for me, and then talking about them. He wanted to know whether I really got excited about them, and why I got excited; if I felt the verse was weak, or the chorus was weak. We sat around and talked about the various musicians we thought would be right. At that time he hadn't written the words. But, as we went along, he talked about what he thought they should be, and wrote them out. The song just expanded as he was doing it.

R-e/p: So basically you acted as a sounding board?

BB: Always. I didn't help write the lyrics though. I have done that in the past, but I prefer that it comes from the artist, and that I be a good sounding board.

R-e/p: You try and stay away from the creative aspect of a production?

BB: No, not at all. I don't try to stay away at all. I just feel that when people look at a record, it's not my name that they're buying; people are buying the artist. And if the artist has the ability to write the material, they should certainly do it. Then I'm able to contribute what an artist really needs, which is to be that great sounding board, and be able to see the things that they can't see. But if lyrics are missing, and the artist gets into a log jam where they can't figure them out, sometimes I'm able to help. Or

maybe there's a melody change that's necessary. But I don't make it a habit that I sit there and figure that I'm going in on somebody's record; I'm not going to help write their tunes for them.

R-e/p: You let the artist expand as much as he can, but give him or her general guidelines?

BB: The goal is to let the artist realize his whole potential, so that he can grow even further. It's not my job to sit there and stifle them, and stop them from being creative. But it is my job to encourage them, and say “No” if they go astray.

R-e/p: Is there a general approach that you find works for you when dealing with an artist?

BB: Honesty; it doesn't pay to be polite sometimes. Sometimes you have to be the bad guy. As long as you're honest



“Everything I do when I make a record is like playing an instrument . . . it is a total entity. And there is a cohesive, creative design to it.”

and responsible, it works out okay in the end.

R-e/p: Was the recording of the “Heart to Heart” single from High Adventure done pretty much live?

BB: The rhythm tracks were done first: bass, drums, percussion, two keyboards, no guitar. The rest of the instruments were overdubs done one at a time, except for the orchestra, which was done at a later date at Twentieth Century Fox music scoring stage.

We replaced a couple of instruments here and there to tighten it up. But we basically went for the performance. In the case of “Don't Fight It,” we went to Fantasy Studios in Berkeley, where Steve Perry and Kenny sang [overdubs to the finished tracks].

R-e/p: Do you think you can achieve a better “feel” when a song is recorded all at once, in live performance, as opposed to overdubbing everything against some basic tracks?

BB: Definitely. There's a unity there; a communication; a synergy with the audience, the listener.

R-e/p: Jerry Goldsmith handled all the scoring and music conducting for the soundtracks of Poltergeist and Star Trek, while John Williams did ET. What were your planning meetings like with them?

BB: We discuss what the music is going to say, and how they imagine it sounding. When we actually go in to record the soundtrack music, I know conceptually what they're trying to achieve, and I strive for that.

R-e/p: Do you see your role as one of staying behind the board, and offering feedback as the tracks are being recorded?

BB: I work as a producer, just as I would on a record date. I don't approach a commercial record date or a scoring date any differently. That's the whole point. I don't know how other people work, but I like to look at a session from the aspect of “Music is Music.” I approach the recording looking toward the level of quality that I want to achieve, and the results that I want from the artist. When I'm at the scoring stage, if Jerry Goldsmith is composing and conducting then he's the artist. If John Williams is composing and conducting, he is the artist. My goal in any situation is to draw the most out of the artist. I might say, “At bar #65 through #72 I think the brass is too loud. I can't hear enough of the cello section,” Or, “I think we could get a better performance.” Or, “Let's take it from bar #65 to #72, because the French horns flubbed, and we can just cut it in.” Those kinds of things.

R-e/p: I assume you'd have more flexibility with a self-contained group, as opposed to working with an orchestra, which is obviously very expensive in terms of rehearsal time?

BB: They'll rehearse for maybe an hour, and then cut it. It all depends on how difficult or long the cue is.

R-e/p: Doesn't that limit your role as the producer, in that everything goes down so quickly?

BB: Not at all. The composer has written the music to the film and, true, the parts are pretty well cast in cement. But it's up to me to realize the recording with the best possible sound; the best possible mix; and the best performance out of the orchestra, and the conductor. I encourage him and everybody there.

R-e/p: Do you help the engineer choose mikes, or set up the orchestra?

BB: Always. That's part of my creativity. It's not necessarily the case when I'm in the studio doing a record and working with an engineer like Andy Johns, Rik Pekkonen, or somebody like that. I've hired them for their particular expertise, and unique sound. In the case of a motion picture, however, I have a

BRUCE BOTNICK

conceptualization of how I and the composer want the recording to be. Then I choose my mikes accordingly, and how the orchestra should be set up to achieve that end. You can set up orchestras in different ways to achieve different balances and effects. That's also part of the creative process.

R-e/p: The entire production process actually becomes you "instrument"?

BB: Exactly. Everything I do when I make a record is like playing an instrument. From pre-production, song selection, to picking mikes, to putting my hands on the console, to choosing a tape machine, a specific kind of tape, an equalizer, any kind of effects, right down to the final mix that goes to the digital two-track; it is a *total* entity. And there is a cohesive, creative design to it.

R-e/p: How did you get into digital recording?

BB: While in my office at Columbia Records reading a trade magazine, I saw an ad for the Sony PCM-1600 digital processor. I didn't have the slightest idea what digital was at that time — all I knew was that it looked interesting. When I went to the AES Convention here in Los Angeles, Sony was displaying the 1600, and the first digital editor, a prototype of the DAE-1000. I only saw a five-minute demonstration of the editor, and it turned my head around.

About a week later, I was asked to produce the movie soundtrack recording for *Star Trek — the Motion Picture*. The head of the music department at Paramount was a real audiophile. During our first meeting together he said, "It sure



would be great if this project was digital." I knew that Columbia had a PCM-1600 in New York. So I made a phone call, and CBS bought me a system. We did the soundtrack to *Star Trek* as a live recording, and that's how it all began.

R-e/p: What about the various comparisons being made between analog and digital?

BB: The proponents of analog recording will tell you that when they're listening to digital recording there's nothing there above 20 kHz — that there are less overtones. Well, that's very true. Most

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music today has harmonics that go way above 20 kHz. But because of the sampling rate and anti-aliasing filter [required to keep the pass band below half the digital sampling frequency], those harmonics are chopped off. You miss a little bit of that "air" up there on the super-top, but you gain so much in so many other areas. It balances out.

I've made exhaustive tests by A/B-ing analog against digital recordings that have been made at the same time. If you play them both back immediately, the digital sounds "punchier," but the analog is really close. About five or 10 minutes later, when you play them both back again, the analog sounds like it has even less high-end. And a day later, even less, because the magnetic particles return to their inert state. Audibly, the change is *obvious*, which is why people do so much equalization on their mixdown; they're trying to get back what they've lost.

The sooner you get the tracks down to the final mix, the more you've captured the original state; the more passes over a head, the more there is magnetism created, and the more high-end goes away. With digital, the crispness and



freshness is *still* there — what you get at the time of recording is what you keep. You don't use as much equalization with digital so, from that standpoint, digital is better.

Then again I'm a big fan of tubes. I have a lot of recordings that are pure tube from the console to the tape machine: they sound better than a lot of solid-state stuff I hear today. There are *no* absolutes.

R-e/p: At a recent SPARS Digital Convention in Los Angeles, the panelists [manufacturers and studio owners] were saying that the digital audio disk is going to save the recording industry from its current slump.

BB: No, it's *not* going to save the recording industry. What it's going to do is let people have a better sound in their home. The *only* thing that is going to save the industry is *good music*. If anybody goes into digital saying this particular piece of equipment is going to save the industry, they better have their head examined.

R-e/p: Do you think that consumers are going to buy digital disk players? Is it

going to catch on in a very big way?

BB: Yes, I do. It's going to catch on *very* big. But I think it's going to take a good five to 10 years to filter down to middle-America. It will be expensive [for record labels] to convert a record collection to digital, and not all the record collection will be available. Right now [at Digital Magnetics, Botnick's LA-based company] we're doing a digital documentation of the entire Doors' catalog, basically to preserve it, because those tapes are very old — 1966 — and some of them have warped, and already are unusable. It's a matter of safety. Also, if we decide



to put the whole catalog out on digital disk, it's ready.

R-e/p: In what way do you think the audio industry can help consumer digital disks take off?

BB: Just have good software out there; the more software, the better. And, of course, digital disk machines have to be out there at a price the people can afford. I hear that they're going to cost anywhere from \$300 to \$500, which is the price of a good turntable, but you get a lot more convenience and higher quality. When the player becomes portable — so it's available in the automobile — and you can carry it to the beach, it'll become an everyday affair.

R-e/p: Are there any features that you would like to see added to digital machines that currently are not available?

BB: What I'd like to see is a digital machine that can sample at 100 kHz, so I would have all that wonderful frequency response that the analog tape has initially. Essentially, I think it's a matter of economics. Research and development is an incredible investment. I would imagine that Sony, Philips, all those companies, have maybe \$15, \$20 million, minimum, invested in the development. Maybe to make a 100 kHz digital disk for the home would be prohibitive for the market. So they had to make some compromises.

R-e/p: Have you had a chance to work with Sony's new portable PCM unit, the F1?

BB: I have one at home, and Digital Magnetics has one here. We make F1 copies for our clients, rather than give them a regular audio cassette.

— continued overleaf...

A QUESTION OF STANDARDS.

48KHZ. VS. 44.1KHZ.

The recent explosion of digital audio systems has also raised questions about digital technology. What follows are some answers from Mitsubishi Electric to questions we find most often asked about one aspect—sampling rates.

Question: What is meant by the term, "sampling rate"?

Answer: In digital audio recording and playback systems, the sampling rate is the speed at which the conversion from analog to digital takes place. In theory the faster this "sampling" occurs, the wider the frequency response of the system will be. This is because more samples per second are used to digitally describe the sound.

Question: Why have Mitsubishi Electric and most other manufacturers of professional digital audio systems used the rate of 48kHz. as their "common sampling rate"?

Answer: It was important to establish a "common sampling rate" to allow the simple transfer of digital audio recordings to other media, such as digital playback systems and broadcasting lines. Again, in theory the higher the sampling rate the wider the frequency response of the system will be. Since the rate of 48kHz. is roughly 9% faster than the 44.1kHz. rate used on some other recording systems, the Mitsubishi recorders can reproduce frequencies above the normal upper limit of 20kHz. Secondly, since this upper cutoff frequency is higher than 20kHz., it allows for the design of simpler low-pass filters, thus minimizing any phase-shift characteristics throughout the audible spectrum. Finally, since digital audio broadcasting lines already established in

Japan and Europe utilize a sampling rate of 32kHz., the transcoding of professional digital mastertapes is relatively simple.

Question: Then why use the lower 44.1kHz. rate at all?

Answer: This sampling rate is the one used on all Compact Disc playback systems and represents an excellent choice for the playback of those frequencies in the 20Hz. to 20kHz. range. The lower rate does not allow for some of the features that professional recording systems require, however.

Question: Then can digital mastertapes produced on the 48kHz. professional systems be made into Compact Disc software?

Answer: Certainly. The procedure is relatively simple and is performed at the CD pressing plant.

Question: Are there any other advantages to using the 48kHz. rate on professional digital audio systems?

Answer: Yes. One feature important to the creative process of making and recording music is that of variable-speed operation (VSO). To alter the pitch of digital master-tapes it is necessary to likewise alter the sampling rate slightly. To perform this VSO and still maintain the high-quality specifications of digital audio, the system must use the rate of 48kHz.

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THE BEST ANSWER FOR PROFESSIONALS.

R-e/p: Does it have an application in the recording studio? It seems to be aimed more at the "upper-end hi-fi" and audiophile market.

BB: Well, the PCM-F1's error correction scheme isn't as good as the professional models, and you can't edit the tapes at this point.

R-e/p: Have you done any sessions with the Sony PCM-3324 digital multitrack?

BB: Yes. One of the cuts from the new Kenny Loggins album, *Welcome to Heartlight*, was recorded on it. To me, it's a state-of-the-art recorder as far as the way the deck handles, and the ability to punch-in and -out. There's no erase head involved, so there's no ramp up and ramp down times, or any of that overlap to worry about. It's just *very* quick.

R-e/p: Did you get the opportunity to do any razor-blade editing?

BB: Yes. In fact, when one of the first production PCM-3324 machines came in the other day, we did a recorded music test on it, and I made some edits with a razor blade. Somehow, the piece of tape I pulled out ended up on the floor, and got stepped on. Somebody suggested that we put it back into the original tape. Well, before I did, I made a ball out of it, really scrunched it up, and stretched part of it just to see what would happen. When we put it back in it played *beautifully!* Where the tape was really out of commission there was a slight dropout.

I haven't yet had the opportunity to edit on the Mitsubishi [X-80]. I've edited on the 3M, but that's a totally electronic system and, to my knowledge, you can't cut the tape.

R-e/p: What splice angle did you use — 45, 90 degree?

BB: A 45-degree cut. I took a normal half-inch splicing block, and tried to approach the machine as though it were analog. For most engineers today a digital transport has to respond like an analog machine.

It's good being able to cut with a blade. Electronic editing is more secure, but it takes a great deal of time. Everything is a digital copy, although you're not physically going down any generations. But when you have musicians sitting in the studio, and you say, "Let's lift four bars here and two bars there . . . put something in place of that," you've got to do that quickly. You can't sit around and wait for electronic editing. Razor editing is really a great advantage.

R-e/p: At this point in time, do you have any preference for a video-based system, as opposed to a fixed-head multitrack?

BB: I like the fixed-head concept for the multitrack. For two-track there would be some definite advantages to having that too. But, right now, I like the video-based system because we do a great deal of work against video. That way we're

all working in the same realm with timecode, and sync. It just makes a lot more sense.

Electronic editing gives me the ability to do crossfades, and to do level adjustments. I can also edit to within 363 microseconds, which is thinner than the width of a razor blade. That's really tremendous. Where video can be edited on the frame [1/30th of a second], we can edit anywhere within the frame.

R-e/p: Do you approach the digital editing process with the attitude of an engineer, or of a producer? Or do the two marry together?

BB: In the case of the *Alive* album, Jim Pace was the editing engineer; he did all the physical work. I did all the conceptualization and direction. I recorded the original music with the Record Plant mobile truck, and Rik Pekkonen mixed it. I have a responsibility in the end that it'll marry well. I have to be watching all the aspects at all times, and make sure that whatever procedure we're doing technically is going to work in the end.

R-e/p: Electronic digital editing is a relatively easy process to learn. Do you find that it's perhaps too easy, and that people can get carried away?

BB: Yes. The editing times get longer, because you have so many avenues available to you. You don't have to physically cut the tape, so you can experiment like crazy. For instance, I just did an album where we had to edit two singles. We could make a couple of different versions, and make versions of those versions without ever injuring the tape. You can go on and on!

R-e/p: Speaking of digital editing, you recently completed an audio/video presentation shown at the AES Exhibition, which included extracts from the original digital soundtrack recordings for Poltergeist, ET, Star Trek, and the Kenny Loggins, Alive video. How did that go down?

BB: Some of it was very difficult, especially in the case of *Poltergeist*, where we were matching the original digital audio recording to the picture. Steven Spielberg had tightened up the picture a lot, and there were edits made that we didn't know about. The paper work was unavailable, although I had the musical scores. We'd be going along in sync for maybe four bars, and then out of nowhere we'd be someplace else. Steven would move a frame here, a frame there, to make the pacing better. It took close to three days just to figure out what had been done. We were sitting there with the score, listening over and over and over again, going "Let's try this . . . let's try that."

The music tracks we were working with were copies of the original digital masters. In order to use the original dialog and effects from the respective films, we transferred the optical soundtrack on to PCM digital, with timecode. Then it was a matter of studying the picture

and working out where the dialog and effects came in, and remixing the tracks to match the film. That way, I only lifted the non-music, optically-recorded tracks when they were needed in the mix, and could keep the noise down to minimum levels.

There's a scene in the *Poltergeist* sequence from the presentation, where the father throws a rope into the closet, this flare of light shoots out, and you hear something like a rocket sound. The audio/video demonstration was in quad, so we had the sound going from front to back, like a lightning bolt shooting over your head. The music was going all around in stereo. We also had a synthesized, combined stereo on a delay coming out of the rear for a surround, like in a motion-picture theater [to provide a four-channel quad mix, a pair of video transports were synchronized to the master video tape].

R-e/p: Did you do much signal processing for the digital presentation?

BB: All we did for the AES demo [laid on by Sony/MCI] was take the audio off the existing film, marry the digital music, and then process the optical sound so that we could make the final product as clean as the digital. By processing I mean moving the faders up and down to cut out noise from the optical tracks when there was no dialog. It took us about four days.

R-e/p: Having been involved with so many aspects of recording, is there one realization you've experienced since the early Doors' sessions which stands out in your mind, and relates to working in the studio?

BB: You should be in the studio to have a good time, and make music — not to live there. In other words, there is life around us to enjoy. If you're going to bring freshness to the music, you have to be fresh. That applies to everybody: musicians, engineers, producers. We, as human beings, need relief; we've got to get out and enjoy. Go to the beach for five days and vegetate; let your mind drift. Then when you come back into the studio, you feel great! You're more receptive to other people and their feelings. Equipment has feelings. Some people may think that sounds crazy.

R-e/p: I have to ask you what you mean when you say "equipment has feelings"!

BB: Certain microphones hear differently than others. A tape machine sounds different from others. It's the same situation with consoles — they each have a life of their own. Some consoles, mikes and tape machines just have a bigger, "brighter-sounding" life to them than others. The more open and simple the sound, the more of a chance you have to hear everything that's being offered.

R-e/p: But doesn't a piece of equipment's "personality" change with the interaction of the person using it?

— continued overleaf . . .

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BRUCE BOTNICK

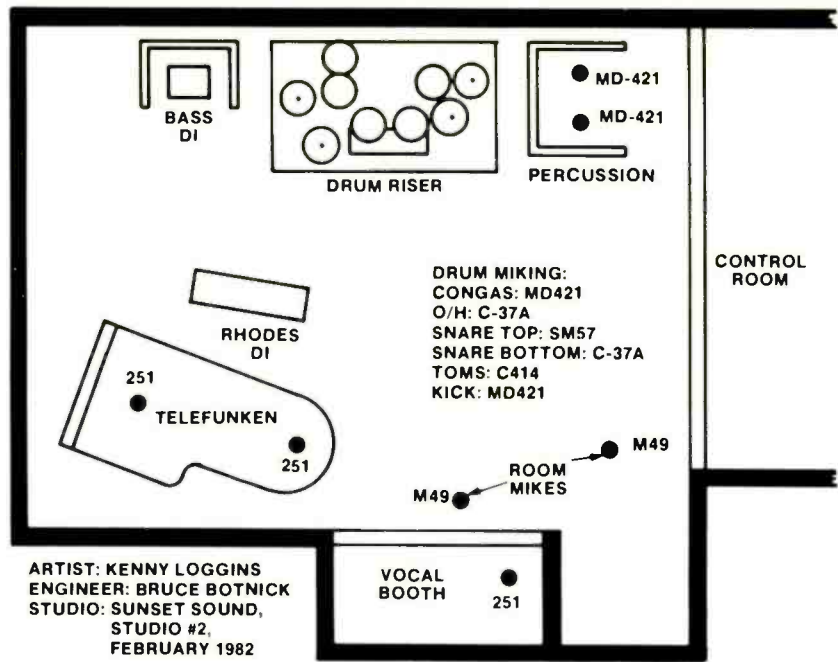
BB: That's right. You can take five of the greatest mixers in the world, put them in the same room, with the same console, same microphones, everything, and they'll make five *completely* different sounds.

R-e/p: Given your wide experience of working in so many different studios around the country, have you found any one to be your particular favorite?

BB: No. Every studio that I've gone into has given me something either emotionally, or tangibly — each studio has its own "personality." That's why I generally don't record in one studio all the time. Instead I use a lot of different places, because I feel that each song is best recorded in its own special environment.

I did an album with a group called The Beat. We went over to Twentieth Century Fox motion-picture scoring stage, which is an enormous room; it holds 300 musicians. I put those four guys in the middle of that giant place, and recorded with a lot of room mikes and no baffles, just to get that kind of live environment. So, to answer your question . . . it depends.

R-e/p: So you're literally "casting" the room, as well as casting the musicians with the song?



BB: Right. You have to. For example: there's a room — Studio A at Capitol . . . ever since the first time I walked in there, it's remained basically the same way as it was when it opened in 1950, except for the console. The control room is the same. You literally can feel Frank Sinatra, Nat King Cole, Stan Kenton,

Peggy Lee, Fats Waller; they all recorded there. That's a very special "intangible." I mixed two of Kenny's songs in Studio A, just because I wanted the sound of the echo chamber, which is *incredible*.

But I'm not only going for the sonic subtleties; I'm also going for what I feel

DIGITAL AUDIO POST-PRODUCTION FOR KENNY LOGGINS, ALIVE VIDEO PROJECT

Artist — Kenny Loggins and Band
Event — Video and audio recording of two live concerts
Audio Producer/Remote Engineer — Bruce Botnick
House Engineer — Jim Pace
Mobile Audio Facility — Record Plant, Los Angeles
Video Producer — Ken Ehrlich
Video Director — Don Mischer
Video Mobile Facility — Orange Coast Video
Location — Santa Barbara, California

Using the digital recording medium in combination with innovative post-production techniques, Bruce Botnick, with Kenny Loggins and band, and a crew of top audio and video professionals, put together an innovative rock-music video, *Kenny Loggins, Alive*. By utilizing digital techniques, the team was able to produce a finished, edited videotape with only a second-generation audio track, instead of the accepted standard video product whose audio is down about six or seven generations by the time it reaches the consumer, detailed below. Even more impressive is the fact that the consumer videodisks for *Alive* were made *directly* from the first-generation digital dub, as will be explained later.

The audio/video shoot focused around two, live outdoor concerts presented by Kenny Loggins and band in Santa Barbara, California. Jim Pace, Loggin's PA mixer for many years, handled the house-sound mixing for the *Alive* concerts. (Soon after the shoot, Pace joined the staff of Digital Magnetics, a digital audio post-production house based in Los Angeles.) Bruce Botnick was the audio producer, and engineered the remote recording in one of the Record Plant mobiles.

Did Botnick have his own mikes set up on stage, or was the mobile taking a feed from the house system, we asked?

"I've done a few video shoots," he offers, "and for each of them the house-sound mixers and I talk ahead of time about the choices of mikes, and agree on what we want. Most of the choices are usually the same. Generally, we're talking about one or two differ-

ent microphones at most out of up to 40 mikes. The feed is always a split from the house. For *Alive*, I positioned all the house mikes [provided by the mobile] for picking up the audience. But, in most cases, the mikes that Jim was using were what I wanted to use."

Directing the videotaping of the outdoor shows was Don Mischer, who ran six cameras on to separate isos (backup videotapes from individual cameras), and was calling all the shots live at the afternoon and evening concerts being recorded. Throughout the finished video mastertape, editor Harvey Burger intercut segments from both shows. One song, "Love Has Come of Age," switches back and forth from night to day to night practically on every beat.

Did differences between the recordings from the afternoon and evening shows create any complications?

"That was no problem," Botnick says. "Luckily, both versions of 'Love Has Come of Age,' for example, were *exactly* the same tempo to within a tenth of a second. The drummer, Tris Imboden, is *really* rock steady; that's one of his great attributes, besides being a great drummer.

"What was done in terms of the [video] editing was as much a function of the musicianship, as of the recording technology. I've always felt that 99.9% of the success of a session's success lies with the musicians. If the music is not happening there, it's not going to happen in the control room. The musicians that I'm producing must believe in what they're doing; that they're exuding that reality, and really performing. When that happens, everything comes together. We were very fortunate on this piece [Love Has Come of Age] that we got two very hot shows."

Was it difficult to match the sound quality of day segments with those recorded at night?

"Sound carries differently during the day than it does at night, especially on a hot day and a cool night. We had to add more digital reverb to the daytime tracks, because they were a bit drier; the sound didn't go as far. I believe we mixed the night segment first, and threw the day segment up against it. We just kept shaping what



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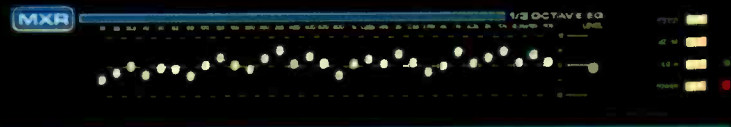
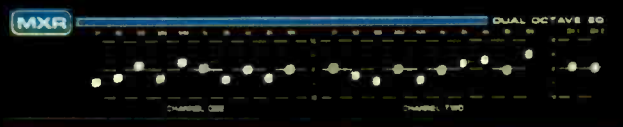
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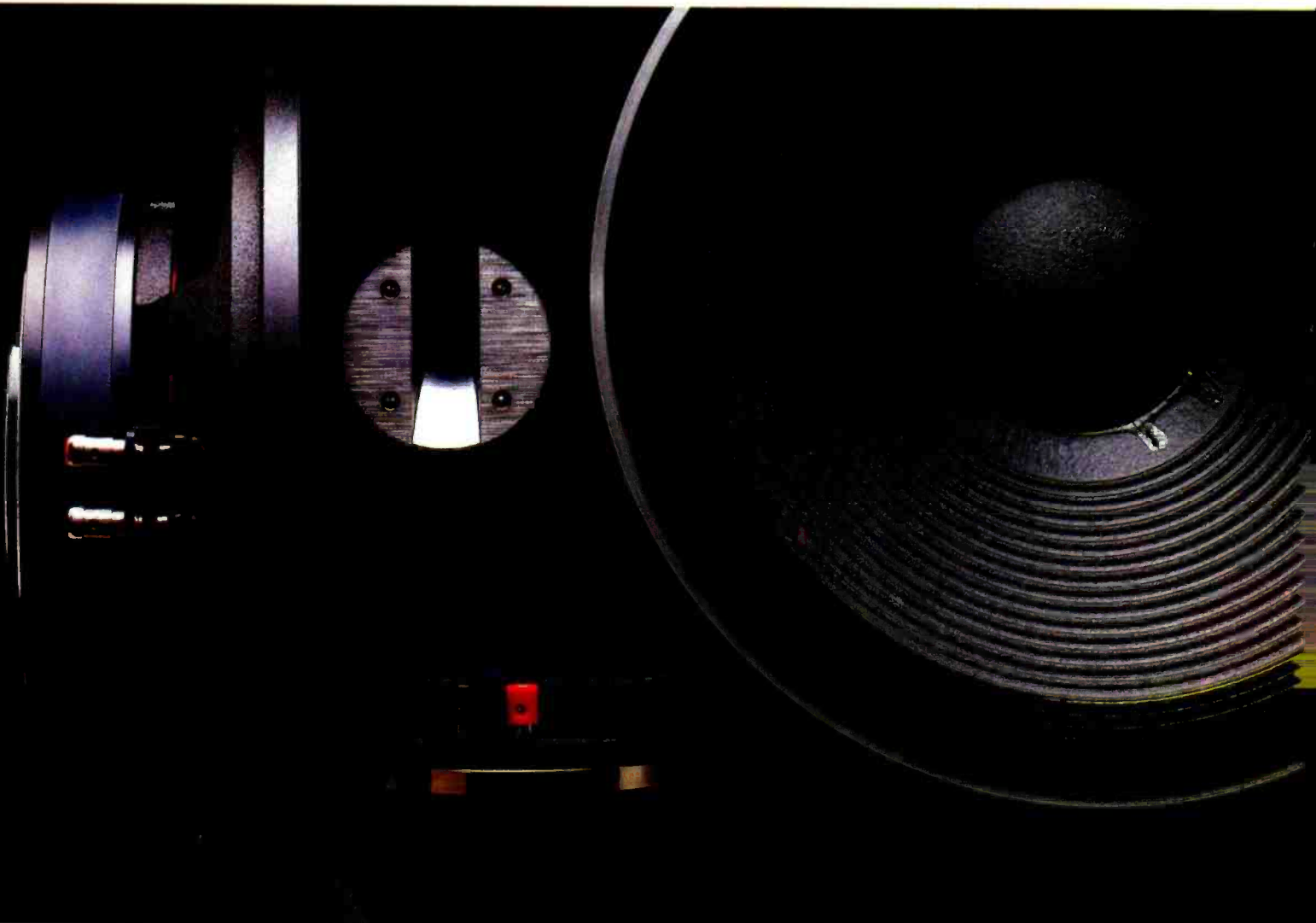
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BRUCE BOTNICK

the room gives me emotionally.

I remember doing a recording at the [Los Angeles] Record Plant for the first time with The Silvers, and I think I had Harvey Mason playing drums in the drum booth. I had never recorded under those circumstances before, which was a very, anechoic-type room — dry, with no room tone or ambience. We were in the middle of a song, and all of a sudden I realized, "My God, this sounds just like Stevie Wonder." He had done all his recordings in that room. The song we were doing just reminded me of "Living in the City." So that gave me a key to the room, and I just went in that direction. The more I heard that went in that direction, the more the song came out that way.



Sometimes I hear a phonograph record that I really like, and I'll be able to say, "It was recorded in this place, with this person." And somewhere down the line I'll work with an act, and

will hear that their song would be perfect in that room, like in the case with Eddie Money and Andy Johns. Andy had been working with Led Zeppelin, and that was the kind of attitude I wanted. I spoke to him about the direction, and played him Eddie's songs. We recorded at the Record Plant, because Andy knew he'd get that kind of sound. They had the limiters that he wanted, and I got the kind of sounds that I wanted. It was all a matter of hearing what I wanted in my head, and getting the right parts together to make it happen in the end.

R-e/p: It would appear as though the diversity of your background has paid off.

BB: I like motion pictures, records and television. As long as it has some music to it, I'm happy. And I'm fortunate that I'm able to do this for fun and profit. ■■

DIGITAL AUDIO POST-PRODUCTION

... continued —

we had until it sounded consistent. Basically, we wound up with an entire piece of tape from the daytime performance, and an entire piece of tape from that night. For all intents and purposes, they sounded identical."

Soundtrack Editing

After the video had been edited, Botnick conformed the audio to match using SMPTE timecode as reference. The video editing points were chosen to coincide with key movements of the performers on stage, but were restricted to being cut to the nearest frame. Botnick was able to edit the digital audio in the middle of a frame if necessary, which enabled cuts to be made exactly on

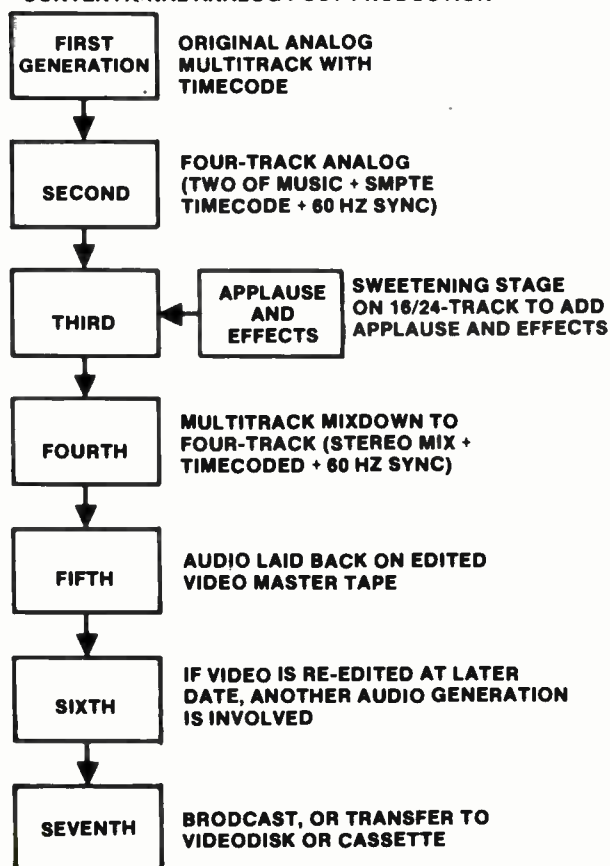
downbeats, or other conveniently inconspicuous points.

No new timecode tracks were generated, however, the original audio tracks and timecode were duplicated on all the worktapes in order to maintain the exact timecode locations contained on the original master tapes, which ensured that all the finished tapes would lock with one another. For reference during the post-production process, timecode locations were displayed continuously in a window superimposed on the video monitor screen.

Because most of the videotape was edited first, edit points occurred without regard to audio continuity between songs. Several times on the finished, master videotape, songs would simply end and the accompanying applause simply cut off, followed by the introduction to the next song coming out of nowhere. Under normal circumstances, an engineer would be forced to sweeten the tracks with applause in the analog realm. Luckily, Sony was able to provide a prototype digital mixer that allowed the entire post-production process to remain in the digital domain.

On a separate reel, Botnick prepared several slugs of tape, each extending from the end of one song to the beginning of the next, with applause from the shoot mixed into it. All of the slugs were recorded digitally with the same timecode as the original master. Guided by the timecode, the improved slug then was dropped back into the original master to replace the inconsistent audio portion. In essence, the process comprised of a set of video edits executed to the nearest frame, but corresponding to the last note of the song going out (before the applause began), and somewhere into the next song where the applause had ended.

CONVENTIONAL ANALOG POST-PRODUCTION



Conforming Video to Edited Audio

On the song "Celebrate Me Home," the audio was mixed and edited, and then the video cut to match. Was the approach so successful that it might become a standard procedure for such projects?

"It was a matter of necessity," Botnick considers, "We had to edit the song down; it was 14 minutes long, and needed six minutes. Those weren't decisions the director could make unless he really knew everything that was inside of Kenny's head. It was easier for Kenny to watch and listen, and say, 'I want to cut here and here.' He made notes from the timecode in the window, and then we cut the audio according to his notes. I just gave the visual people the numbers, and they matched the video to it. I dubbed the digital audio up to one-inch videotape, and they conformed the picture to it all by timecode."

Did you discover any particular production advantages by doing it that way?

"Well, it's just saying that there are no barriers. If you think it can be done, it can be done. That's all." — continued overleaf . . .

Finished Product

When the editing process was completed, Botnick took the Sony PCM-1610 digital processor to the Post Group, plugged it into one of their Sony BVU-800 U-Matic transports via a CMX editor, and locked up the original 1-inch edited video master of the show to the digital audio tape machine. The mono analog guidetracks were replaced with the digital audio signal, now converted to analog. This last stage married the synchronized audio and video back on to one piece of tape, so that copies could be made for cable presentation, and other outlets.

In addition, the special audio and video preparations were handled slightly differently for Laserdisk and RCA Selecta-Vision videodisks.

"In those cases," Botnick recalls, "we made a dub of the one-inch video with timecode, and a separate digital audio dub of the show. We sent both of the tapes to Japan, where they synchronized them on their editor and dubbed it directly to those two consumer products. The Laserdisk actually has the digital-quality soundtrack *without* any generation loss. We went from 24-track to Laserdisk without going down any further analog generations." ■■■

MULTIPLE DIGITAL AUDIO POST-PRODUCTION STAGES

Remote:

1) Location recording was done in a Record Plant mobile, tracking to a 24-track analog tape machine with Dolby at 30 IPS. SMPTE timecode and a 60 Hz sync reference were taken from Orange Coast Video's remote truck, and recorded on the tape for reference and later audio/video hookups.

Post-Production Facility:

2) The original 24-track analog tape recorded in the mobile was played back on a 24-track Studer machine.

3) A Sony 3/4-inch U-Matic video machine was used to play back the "A" reel videotape (a copy of one of four videotapes shot at the *Alive* concert, the "A" reel being the main video reel), and served as a reference while mixing the audio tracks. Occasionally, a second videotape recorded from another camera angle was substituted for the "A" reel, to facilitate the audio mixing process.

4) The 24-track analog master was mixed down to two-track digital on a second U-Matic video machine through a Sony PCM-1610 processor, while watching the visual mix.

5) An Audio Kinetics Q-Lock 2.10 SMPTE synchronizer locked the digital audio and video, and drove the 24-track Studer via its built-in synchronizer/remote control unit.

6) Bruce Botnick then assembled long audio slugs that consisted of a song ending; the following applause; an introduction to the next song; that entire song; its ending; the following applause for that song; and then the introduction for a third song. These slugs could be spliced together during a song's intro or ending, rather than during the applause between songs, which would result in an aurally obvious edit point.

7) Once the video editing was completed, Compact Video (a video post-production house in Burbank, California) provided Botnick with two identical 3/4-inch edited videotapes of the *Alive* show. Both had the following track configurations:

- Video track — final edited video;
- Audio #1 — edited mono mix of original audio;
- Audio #2 — SMPTE timecode of final edited video;
- Timecode address track — the same timecode as Audio #2.

Video copy #1 was used as a visual reference for splicing/editing the digital audio.

8) The video track on copy #2 was replaced by digital audio slugs that were edited together to conform to the visual information on video copy #1. A Sony DAE-1100 Digital Audio Editor handled audio inserts in the video mode.

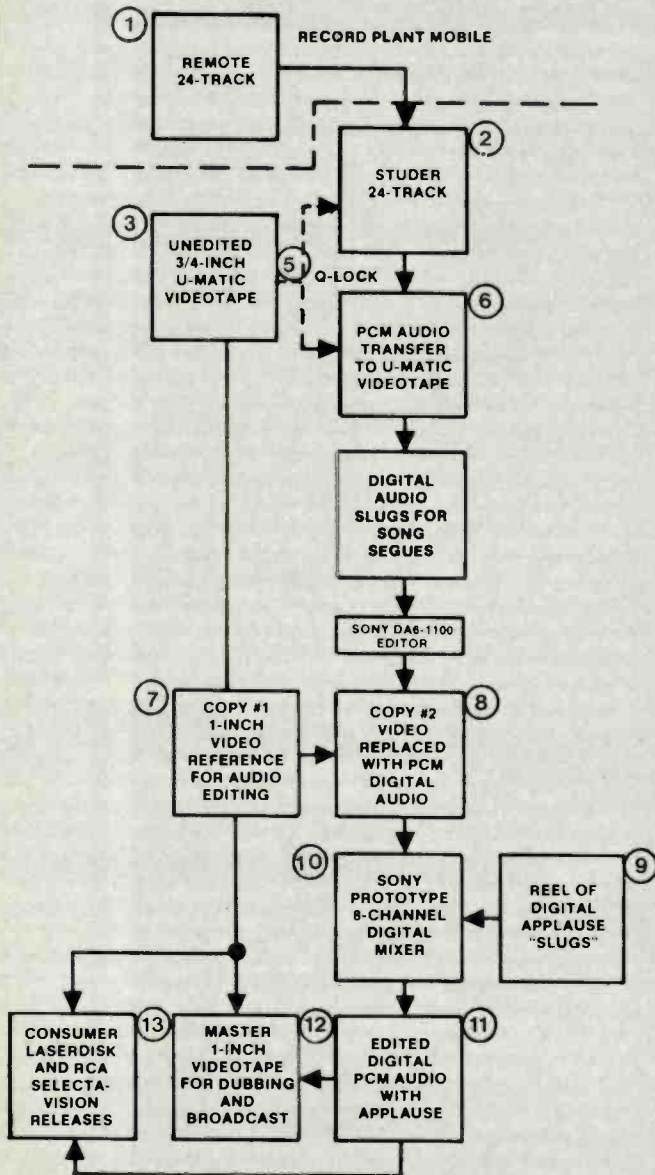
By erasing just the video signal on videotape copy #2, and keeping the original mono audio mix on track #1, synchronizing the digital audio to the finished video did not depend solely on timecode numbers. Using a Sony DAE-1100 digital audio editing system, the mono audio and the finished digital audio could be played simultaneously, and restarted or advanced in relation to each other (an advantage that the video editing process offers that audio editing doesn't at present). With this approach the two audio tracks can be synchronized exactly, and it ensures perfect sync of the edited digital audio to the edited video master.

9) In most cases, the video editing stage produced audio tracks between the songs that were inconsistent; for example, applause was erratic or non-existent. Applause slugs were made from the original concert footage, ranging in duration from a few seconds to two minutes, and recorded in sync with the timecode. The appropriate slugs were mixed with the final digital audio tracks of the concert via a prototype Sony eight-channel digital mixer [10].

11) The finished digital audio tracks with applause.

12) The one-inch video master and the digital audio were combined to produce a finished tape for broadcast or tape dubbing.

13) The one-inch video with accompanying digital audio were dispatched to Japan, where they were synchronized to produce Laserdisk product with first-generation quality soundtracks. ■■■



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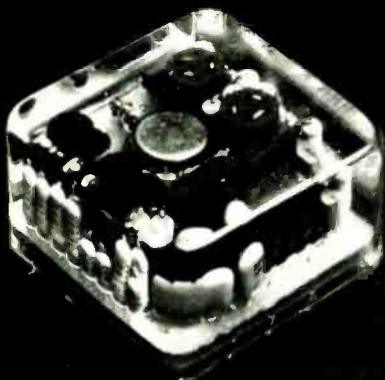
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Electronics • Troubleshooting • Maintenance

A

PRACTICAL APPROACH TO CIRCUIT DESIGN

by **ETHAN WINER**
By-Word Corporation
E. Norwalk, Connecticut

I have always felt that any article dealing with matters of a technical nature should be enhanced with practical examples and applications; this issue's installment in my regular series will be no exception. While past articles have tended to dwell on the basics of audio circuit design and fundamental building blocks, this time around I'll be exploring some of the finer points of transistor and op-amp circuits, and also illustrate some of the techniques required to implement a reliable working circuit. But first, let's back up just a bit and review the fundamental principles of a single-transistor amplifier stage.

Circuit Basics

As shown in Figure 1, there is always a difference of approximately 600 millivolts between the base and emitter of a normally operating transistor. This voltage will deviate, however, due to several important factors; important, that is, if you want to build stable and predictable circuits. I suppose the most fundamental aspect would be the type of material the transistor is made from — silicon or germanium. Most transistors these days are of the silicon variety, though germaniums are used occasionally for their 200-millivolt base/emitter drop. But what I'm really talking about is the way this drop can vary, and the main contributor to that is the amount of current flowing through the base-emitter junction. As we saw several issues back in an article describing the design of a peak-reading meter, the junction voltage will increase in a logarithmic fashion as the current is raised linearly; and, interestingly, this holds true through a very wide range of values. Such behavior can be quite useful in synthesizer circuits, where equal voltage steps


from a keyboard must be converted into ever increasing octaves — an exponential function. Unfortunately, this same phenomenon can be a serious problem, particularly when dealing with precision voltages or currents.

Temperature, of course, is the other factor that influences this junction voltage, and it too can be both a blessing and a curse. When used as a temperature sensor, for example, the voltage will vary in a precisely linear fashion — again over a very wide range, which is useful. But in a normal amplifier circuit, especially when accuracy is important over a broad range of ambient temperatures, some kind of compensation will be necessary. One clever way to accomplish this goal would be to add an extra junction into the circuit, especially in a negative feedback loop if possible. In this way, as one junction varies the other will precisely oppose it (well, almost precisely).

If you take a peek into some of the products made by dbx, for example, you will notice a type of heatsink that is used to thermally couple two transistor packages. Perhaps even easier would be to use a dual transistor, where both junctions are on the same piece of silicon, although I suspect that would be more expensive. Temperature tracking among transistors on one common chip is no small contributor to the high quality of modern IC op-amps.

Speaking of op-amps, one new twist is added to the story, called *offset voltage*. Even though both the plus and minus inputs are made to be as identical as possible, tiny imbalances in the circuit components can cause the two bases to be at a slightly different potential. In many circuits this would not be a big deal, but when working with moderate to high

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CIRCUIT DESIGN

gains this offset gets amplified along with the signal. FET op-amps have a similar problem in trying to match input voltages, and in fact they are generally worse, although that's really a different consideration altogether. Another property of a transistor's input junction is its inherent capacitance, but at audio frequencies this seldom represents an important design factor.

In Figure 2 you will notice the earlier transistor circuit, but with the addition of an emitter resistor; and if you guessed that this will influence the gain of the circuit, you'd be absolutely right. Now, without getting into long equations using

parameters such as Boltzmann's constant and other such unpleasanties, there are a couple of handy rules of thumb that will get you into the ballpark when designing transistor circuits. The first is an approximate formula for determining the gain, based on the collector and emitter resistors. The other will help you to determine the input impedance of the stage, which is a function of the emitter resistor and the transistor's inherent gain — technically referred to as H_{FE} .

Figure 3 shows a complete working circuit, although I wouldn't exactly call it a model of sophistication. Notice the addition of the input biasing resistors (R_{BI}), which are required to get things going, as well as the emitter follower at the output, which will ensure that the circuit's gain doesn't vary depending on what it is con-

FIGURE 1

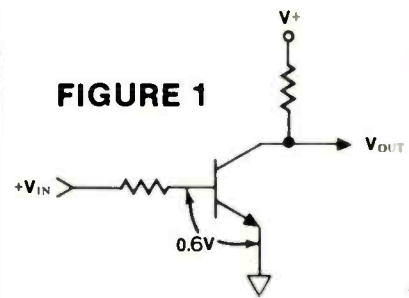
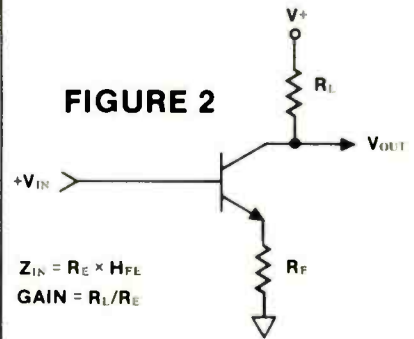


FIGURE 2



$$Z_{IN} = R_E \times H_{FE}$$

$$GAIN = R_L / R_E$$

nected to. The output impedance of this follower is also related to H_{FE} , as well as to the emitter resistor, R_E . Input and output capacitors are used to isolate the DC levels in the circuit from ground, though the bypass capacitor (C_B) is for another purpose entirely. Without this cap to lower the impedance of the power supply, unwanted feedback could result from signals at the output being coupled back into the input through the biasing resistors. I suppose with a circuit as simple as this one, it's something of an overkill, but in circuits comprising several stages bypassing is essential.

Op-Amp Designs

While all of these considerations affect the innards of an IC op-amp, the fact that you don't need to concern yourself with most of it has made op-amp circuits very popular. Which does not mean, however, that just anyone can successfully design a high-quality parametric equalizer, for example, since op-amp circuits have their own set of design constraints. But they certainly can make life easier! During the last few months, several readers have contacted me and asked about how hard it would be to build one of those "-10 to +4" pre-amps that have become popular for interfacing low-level (or "semi-pro") equipment with standard 600-ohm studio gear. The answer, obviously, is not very hard at all, and it seems to me that such a circuit might be a natural example of just the kind of thing we've been talking about.

Figure 4 shows a straight forward way to obtain the required 14 dB of gain, along with an additional stage for an optional balanced output. By using an op-amp in the non-inverting mode, the input impe-

COMPUTERS IN AUDIO Taking the Drudgery out of Routine Calculations

During the course of putting together the accompanying article I was faced with a common problem that in the past I had always solved by "brute force": how to come up with an optimum combination of resistances to achieve a particular gain. The absolute values are not nearly so important as the ratio between them, and there are always quite a few possibilities to choose from. So I set out to write a simple program for my Apple II computer that would try every possible combination, and display those within a specified range, as well as the deviation from ideal.

When I first bought my Apple computer nearly a year ago, I thought I was pretty exclusive — that is until I mentioned it to some other studio folks I know. It turned out that

LIST

```

10 HOME : FOR N = 1 TO 68: PRINT "RESISTORS"; SPC( 4);: NEXT
20 FOR N = 1 TO 2000: NEXT
30 K = 0: X = 1: DIM R(48)
40 R(1) = 1: R(2) = 1.1: R(3) = 1.2: R(4) = 1.3
50 R(5) = 1.5: R(6) = 1.6: R(7) = 1.8: R(8) = 2
60 R(9) = 2.2: R(10) = 2.4: R(11) = 2.7: R(12) = 3
70 R(13) = 3.3: R(14) = 3.6: R(15) = 3.9: R(16) = 4.3
80 R(17) = 4.7: R(18) = 5.1: R(19) = 5.6: R(20) = 6.2
90 R(21) = 6.8: R(22) = 7.5: R(23) = 8.2: R(24) = 9.1
100 FOR A = 25 TO 48: R(A) = 10 * R(A - 24): NEXT
110 HOME : VTAB 7: HTAB 3: INPUT "PLEASE ENTER THE DESIRED GAIN: "; GS
120 VTAB 15: HTAB 8: PRINT "IS THAT IN DECIBELS? ";: GET QS
130 IF QS = "N" THEN G = VAL (GS): GOTO 160
140 IF QS = "Y" THEN G = 10 ^ ( VAL (GS) / 20): GOTO 160
150 GOTO 120
160 HOME : VTAB 4: HTAB 5: PRINT "YOUR ACTUAL GAIN IS: "; G
170 VTAB 10: HTAB 5: PRINT "CHOOSE FROM THE FOLLOWING:"
180 VTAB 16: HTAB 5: PRINT "1) INVERTING AMPLIFIER"
190 VTAB 18: HTAB 5: PRINT "2) NON-INVERTING AMPLIFIER"
200 VTAB 20: HTAB 5: PRINT "3) PASSIVE LOSS NETWORK"
210 IF G > = 9.1 THEN X = 10
220 IF G > = 91 THEN X = 100
230 VTAB 10: HTAB 32: GET QS
240 IF QS = "1" THEN GOTO 280
250 IF QS = "2" OR QS = "3" THEN GOTO 270
260 GOTO 230
270 K = 1
280 HOME : VTAB 5: ONERR GOTO 280
290 INPUT "PLEASE ENTER LIMITS IN PERCENT: "; L
300 POKE 216,0: L = L / 100 + 1
310 VTAB 15: HTAB 4: PRINT "WOULD YOU LIKE A PRINTOUT? ";: GET QS
320 IF QS = "Y" THEN PR# 1: PRINT : GOTO 350
330 IF QS = "N" THEN GOTO 350
340 GOTO 310
350 HOME : PRINT "% ERROR"; SPC( 9); "R1"; SPC( 14); "R2": PRINT
360 FOR A = 1 TO 24
370 FOR B = 1 TO 48
380 RB = R(B) * X: AV = RB / R(A) + K: POKE 34,2
390 AV = RB / R(A) + K
400 IF AV > 1 / L * G AND AV < L * G THEN GOSUB 470
410 IF AV > = L * G THEN GOTO 430
420 NEXT B
430 NEXT A
440 PR# 0: PRINT : HTAB 6: INPUT "PRESS RETURN TO RUN AGAIN "; QS: POKE 34,0
450 IF QS = "" THEN RUN 30
460 END
470 PRINT INT ((AV - G) / G * 10E4) / 1000, R(A), RB: RETURN

```



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dance can be made to be very high; although in this case we have limited it to 100K with R_1 . As always, the circuit gain will be determined by R_1 and R_2 , except notice the addition of the $3.3 \mu\text{F}$ DC blocking capacitor between R_1 and ground. This limits the gain at very low frequencies (like DC) to unity, and prevents the input offset voltage from being amplified along with the audio. As mentioned earlier, the $0.1 \mu\text{F}$ bypass capacitors will keep multiple stages from "talking" to each other, and the 47 ohm output resistor prevents high-frequency oscillation when driving long cables.

Whenever a lot of capacitance is placed across an output, any negative feedback will be phase shifted at high frequencies on its way back to the input. This has the decidedly unpleasant effect of tending to turn negative feedback into positive — hence the possibility of oscillation. Use of the 5534 op-amp is just about essential if you need to drive 600-ohm lines at high levels, since most other devices just won't hack it into less than about 2 kohm loads.

For the balanced output version, simply add the unity-gain inverter shown at the bottom of Figure 4. Notice, however, the inclusion of a 10 pF compensation capacitor, again to prevent oscillation. While many op-amps contain internal compensation capacitors — which helps make things easier for the designer — the inev-

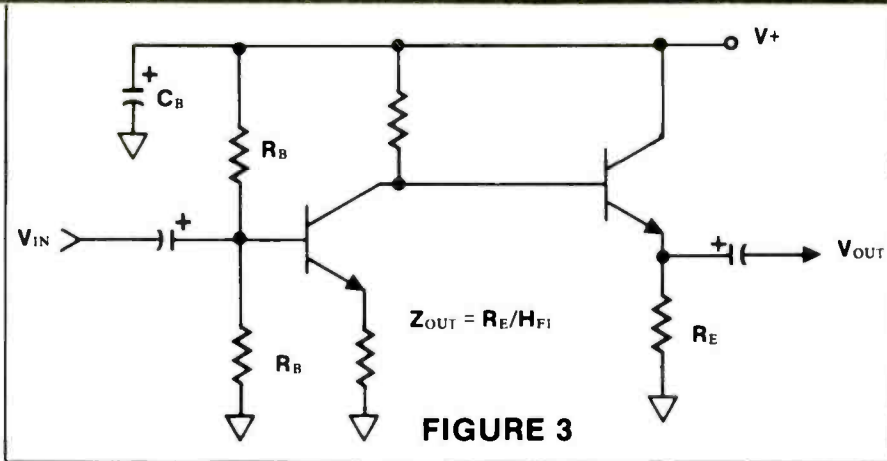


FIGURE 3

itable trade-off in performance involves a reduction in slew rate. It may be a fancy-sounding term, but slew rate is simply the maximum speed that the output of an op-amp can swing; and this obviously affects the high-frequency performance of the circuit. As we just saw, when the feedback path is shifted in phase the possibility exists of negative feedback becoming positive — at least for those frequencies that are affected. And the problem becomes more pronounced as the amount of feedback is increased, even though the overall circuit gain is being reduced. Therefore, these phase-shifting compensation capacitors often are not included in op-amps intended for high-frequency use, and are not needed so long as the gain is kept above a certain value, depending on the particular op-amp in question.

In the case of our 5534, the minimum gain you may use without adding compensation is 3 (about 10 dB). Terminals are provided, however, for adding a 22 pF cap that will maintain stability down to a gain of unity. In the balanced line driver shown, 10 pF is sufficient, because as far as the op-amp is concerned there's a loss of 6 dB in the feedback path, even though the actual gain is unity.

Also shown in Figure 4 is a simple passive loss network that can be used to reduce the $+4 \text{ dBm}$ levels down to -10 dBV , and this can use the same resistor values as the pre-amp [See accompanying sidebar — Ed].

Upgrading With New ICs

One of the great things about electronics (as opposed to, say, some hamburger restaurants) is the strict adherence to standards. Ever since the 709 was introduced as the first inexpensive, high-quality IC op-amp, all of its successors have used the same pin configuration for input, output, and supply. (Actually, the 709 went for about \$7.00 when it first appeared, and by current standards was a dog, but that just goes to show how far things have come in a relatively short period of time.)

As dual and quad op-amps were introduced, the chip manufacturers continued to abide by standards set by others, which makes IC upgrades very easy. Offhand, the only exception to the current standards that I can think of is the 4136 quad, though, sure enough, Texas Instruments has a pin-for-pin improvement with its TL075. Identical to the TL074 in all other respects, this little puppy will improve the high-frequency performance of any circuit that currently uses a 4136.

Other ICs in the TL0 Series can be used to replace the single 741 or 1458 dual. Where input noise is a critical factor, however, as in a mike pre-amp for example, the 5534 still wins hands down. And even for low-gain uses where you'll need the compensation capacitor, the 5534's slew rate remains quite respectable at 6 volts per microsecond — more than 10

COMPUTERS IN AUDIO

... continued —

lots of people already had a personal computer, and of course we all know how popular they are becoming these days. Therefore, because of this increasing acceptance of personal computers by studio types, as well as those involved in designing audio components, I have included below a BASIC program, in the hope that others will be able to benefit. It really is quite slick, if I say so myself, and although the program runs to less than 50 lines, it will quickly and accurately display (and print) all of the possibilities to whatever accuracy you would like.

While written in Microsoft BASIC for the Apple II, conversion to TRS-80 or other micro-computers should be relatively easy, with only occasional changes in syntax required. If enough people respond favorably, this could be an ongoing addition to these pages, and I can envision other simple programs that would help with the calculation of multipole filters, for example, in addition to other common, but cumbersome, design chores. Enjoy!

Editorial note: For those readers whose computer runs under a different species of BASIC, the following explanation of Applesoft BASIC commands might be in order:

GET is a single command that fetches a keystroke, and can be replaced by INPUT if necessary.

HOME is equivalent to Screen Clear, and home cursor.

POKE 34,n sets the top edge of the text "window" to row n+1.

POKE 216,0 resets the built-in Apple error-trapping routines.

PR#1 indicates the initialization of a printer plugged into Slot #1 of the Apple

II. (PR#0 restores normal output, and deactivates the printer.)

SPC(n) moves the print cursor n spaces to the right

VAL (X\$) returns a numerical value for the defined string variable.

VTAB and HTAB are vertical and horizontal displacements of the print cursor from the left-hand margin, and top of screen respectively (the standard Apple display is 24 rows by 40 columns). ■■■

times faster than a 741.

Now, to completely change the subject for a moment, you may have noticed that I've taken a different job, as indicated by the byline at the start of this article. Originally, I became associated with By-Word as a client for my studio, since the company would use the facility to record tapes for guided tours of tourist attractions and museums. Then one day they had trouble at an installation in a distant city, and needed to send someone out in a hurry. Ah, travel — now there's something that would appeal to anyone. I went and got the darn thing working for them, and had a pretty good time to boot! When they offered a full-time job, I took it.

Actually, their method of doing things is rather interesting I've discovered, since these tours use a wireless system that is superior to the cassette tape approach. The main problem with visitors using cassettes is that if they take a wrong turn they could be lost for the rest of the tour; and besides, they can't just go where they want, or see only what they are interested in. With the wireless method though, no matter what a visitor is looking at, they will always get the proper message.

Of course, a transmitter, antennas, and a bank of rechargeable radio receivers

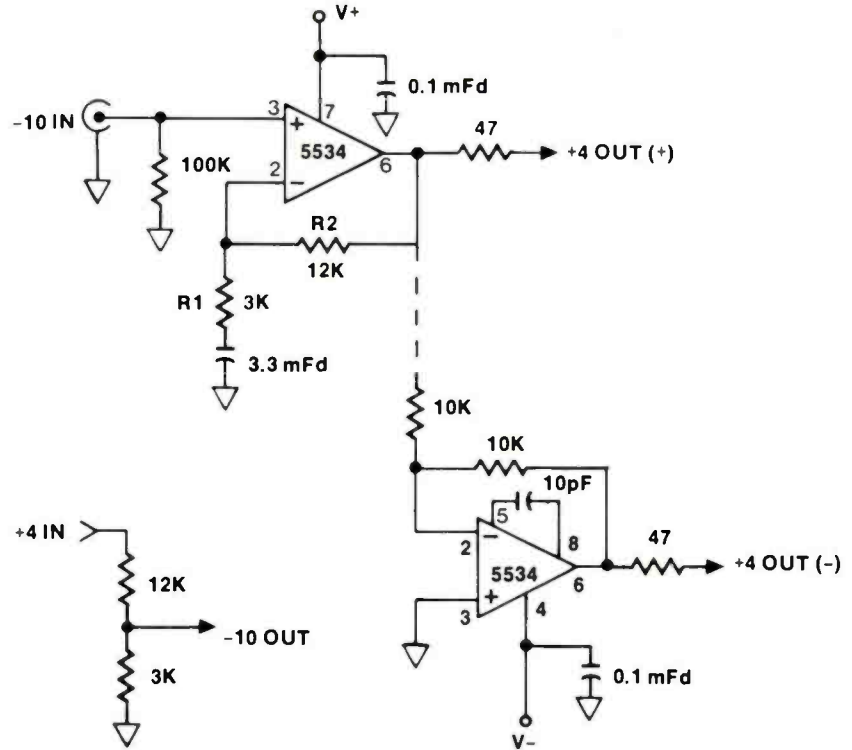


FIGURE 4

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present a considerably greater challenge from an engineering standpoint. The By-Word system uses a loop of wire as an antenna placed under the floor, over the ceiling, or wherever the heck they can hide it. And believe me, that can get to be quite a challenge, especially in a fancy museum constructed mostly out of brick. But the biggest trick of all is to eliminate crosstalk from nearby adjacent stations; and I'm sure you won't be surprised to learn that these techniques are kept strictly proprietary.

As an adjunct to several of the systems that By-Word has installed, lighted displays have been synced to the audio program, with a microprocessor controller allowing sophisticated sequencing. If a customer ever wants to change the display, all that needs to be done is to reprogram the EPROM memory chips.

One of the neatest things I've discovered here is the Mackenzie cartridge player. Made in California and available in one-, two-, or four-track configurations, this has got to be the most rugged and reliable unit yet. Like an eight-track

or NAB broadcast cart, this player also uses 1/4-inch lubricated tape in a continuous-loop arrangement. But what makes the Mackenzie so good is that the tape pack is *actively* driven, which greatly reduces the amount of wear on the tape due to friction. I've heard stories of these tapes lasting as long as five years — and we're talking about continuous use every day! Of course, I've run into a fair share of troubleshooting adventures since I took the job, most of them not unlike those in the studio. I mean, a row of identical circuit boards is a row of identical circuit boards, and repair under these conditions is generally a breeze.

Troubleshooting Examples

First of all, with that many working "spare" boards on hand, it's easy to isolate the problem to either the circuit board, or everything else. Then, with extender cards in place, (you *do* have extender cards, don't you) it's possible to compare voltages between like points on a working circuit. And if you can't see how this could be a help, you're probably in the wrong business. But seriously, at the heart of any AM transmitter is a VCA, much like the kind in an automated console; and with a carrier of only 50 kHz, it can be treated pretty much as audio. To

tell the truth though, most of the failures that I've had to fix were caused by lousy connections, which shouldn't come as a surprise if you've been following this column.

One thing that did surprise me, however, was what I found recently at a famous New York museum. I had been sent there originally to find out what was causing a severe amount of crosstalk, although since I hadn't been in on the original installation, I wasn't quite sure where to start. Actually, in a case like this the best place to start is at the beginning, which I did. Assuming that it wasn't the tape decks, I held a receiver in my hand, wet my finger, and started touching the antenna terminals at the rear of the transmitter, one by one. Each "Mod Board," as they call them, only puts out about 0.5 watts, so you have to use your body to help couple the signal into the receiver.

Every station was loud and clear without even a hint of crosstalk, and I began to fear the worst — having to trace out the trunk wiring. While the system is installed in only one wing, it's still an enormous building with cement ceilings and walls; and, don't forget, the wires must never show. The junction box turned out to be a real pain to find, and was hidden in a

... And For Those of You Looking for an Easy Solution to the Construction of Various Printed Circuit Projects ... A SIMPLE-TO-USE PCB BUILDING KIT — THE OMNI CARD

by Harvey Rubens, Chief Engineer, Apex Systems, Ltd.

If you're technically involved in audio, now and then you end up hand-building ones and twos of circuits using op-amps; for example, a quick summing amp or buffer, or a control circuit for some experiment, modification, or instant repair. And, bless their silicon hides, the IC folks have made it easy with their 8-pin wonder chips. You grab a piece of "perf" board, some assorted small components, an IC socket, some wire, solder and an iron, and *voilà!* — an electronic thing-doer (**thing-do-er, n.:** a thing that does something).

My own experience has been that building one such project is quick, and fun to do. If I need two, I'll xerox the first one in just a little more time. Making up three just became a hassle, and fabricating more requires *sincere* motivation.

At this point, when you consider the fragility of many hardware projects, and the labor hours involved (not to mention a few burned finger tips), cutting a custom card begins to make sense. And there's the Catch 22: Not all of us have the art

materials, practiced skills, or facilities to turn out such a card on short notice. *End of Project?* Maybe not.

I recently spent three weeks at Studio Marcadet, Paris, France, at work inside a nine- or ten-year old console, figuring out ways to remove transformers, and otherwise specify and implement changes intended to upgrade the boards's sonic performance. In devising a plan it became evident that I could easily use at least 150 or so of various single op-amp blocks. This was born the subject of this article: a printed circuit card that I have dubbed the OMNI card.

At just 1.5 square inches, OMNI is a compact PCB on which one can construct, as its name implies, almost any function circuit that can be built with a standard 8-pin DIP single op-amp, such as LF 351, TLO-71, NE 5534, or a good old 741. It is literally an almost infinite number of solutions looking for problems to solve.

Since it is a PC card, once you have defined a project, it is

FIGURE 1A

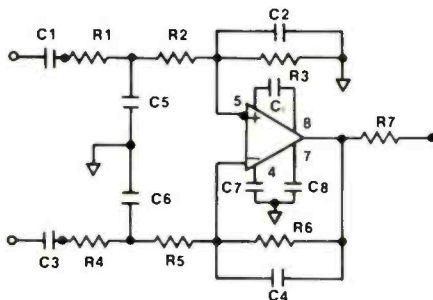


FIGURE 1B

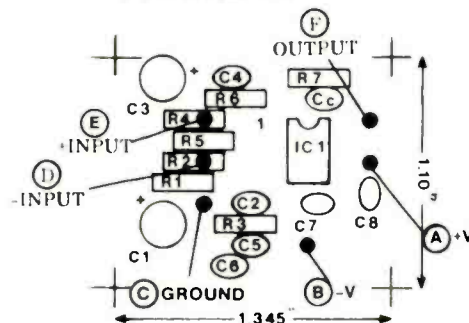
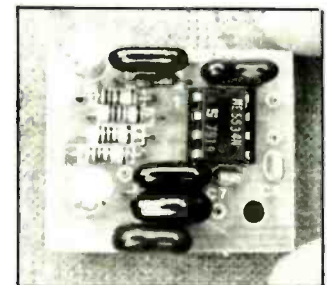


FIGURE 1C



dimly lit room with no outlets. Rule number one: Always Carry a Flashlight!

Once inside the box, I could see that all of the connections to the barrier strips were solidly in place, yet something seemed to be missing. All of the trunk cables had foil for a shield, but two of them were without any drain wire — the two that went out to the area with the problem. The only way to deal with it was to strip back more of the outside insulation, and use a bolt through the foil to make contact. On these cables the foil was very thick and anodized on both sides; more of an armor than a shield. But, to add insult to injury, there was a thick, wax type of goo covering all of the individual conductors. Worse, it was that awful kind of stuff that doesn't dissolve with soap and water. By the time I had finished, this crud was all over my hands, the flashlight, and my tools. None the less, when I took a receiver and went back to the affected area, the crosstalk had disappeared.

Another amusing incident occurred on an old battleship on display for tourists in Massachusetts. The system at this site is an older one that sends about 10 watts of audio directly into the loop, with the receiver being simply a coil and a pre-amp. Also, the tape decks used in these older systems employed eight tracks on 1/4-inch tape, which to me seems rather optimistic. None the less, with 48 tracks worth of tape and power amps in an unventilated room (ouch!), you can imagine how the equipment must have felt. In fact, the main reason I was there was because power output transistors were dropping like flies.

Not that this was how the thing had been designed; there was a rack-mounted air conditioner installed on the side of the unit. Only the bucket that was supposed to catch the condensation was empty — an obvious clue if I ever saw one. Being a bit out of my area of expertise, we called a local contractor, although — wouldn't you know — the fault turned out to be a motor starter capacitor. Oh yeah, these old systems are great. Like the way the maintenance guy kept getting shocks every time he put his headphones on the output terminals to check the amp cards; we bought him a new pair with foam rubber lining.

While I was there, I noticed one of the tape decks hanging up, so I removed the cartridge to investigate. A piece of Scotch tape was visible through the clear plastic housing, which to me was a prime sign of a home-made splicing job. Sure enough, there was about six inches of the stuff in this amateur splice, and worse it was protruding past the edge of the tape, sticking to adjacent layers. I explained to the guy about splicing tape and sent him off to a hi-fi store for one of those kits with a block and instructions. ■■■

STAGE...



OR STUDIO



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easily repeatable and will have the durability of a manufactured product. Since it is compact, the completed module can easily be "bolted on" to existing circuits in about the space of a standard nine-volt battery.

But enough about OMNI. Let's look at what it actually is. Figure 1a shows a textbook differential amplifier with RF rejection (R_1, R_4, C_5, C_6), input capacitors (C_1, C_3), high-frequency power decoupling (C_7, C_8), build-out resistor (R), and a compensation capacitor (C_c) sometimes required when using an NE 5534 op-amp. Figure 1b shows the placement of all of these components on the OMNI card, while Figure 1c is a photo of the completed construction. Parts values are not important yet, since you would tailor a circuit to fit your needs. Input, output, and power connections are via holes A through F, which can hold pins or wires. Pins will make the module free-standing, or

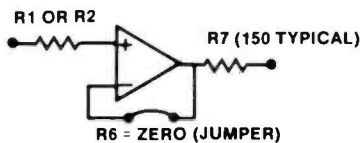


FIGURE 2A: UNITY GAIN BUFFER

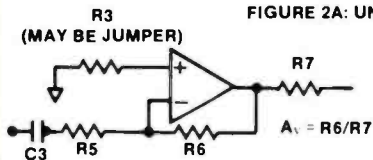


FIGURE 2B: INVERTING GAIN AMP

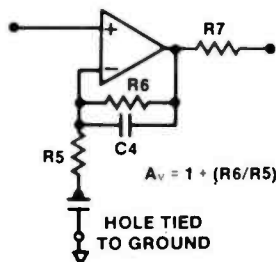


FIGURE 2C: NON-INVERTING GAIN AMP

you can mount the card on a stand-off secured through $\frac{1}{8}$ -inch hole G.

Other basic op-amp function circuits, such as a unity-gain buffer, inverting, and non-inverting amplifiers (Figures 2a, 2b, and 2c), are merely specialized cases of Figure 1a with some components values being equal to zero, or infinity. With this in mind, it becomes easy to build any of these classical blocks by replacing some components with jumpers, or by omitting them.

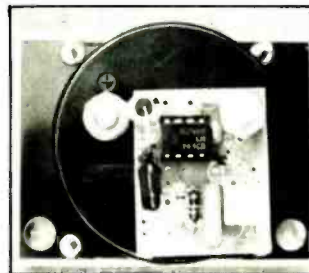
Circuits Plain and Fancy

As a matter of practical construction, the OMNI card is even easier to use than just described. As with a coloring book or a paint-by-numbers kit, once you learn what the finished project is going to be, you can "go outside the lines," or chose new colors. Looking at the metal connecting traces (the shaded areas of Figure 1b), we can see that some of the "jumpers"

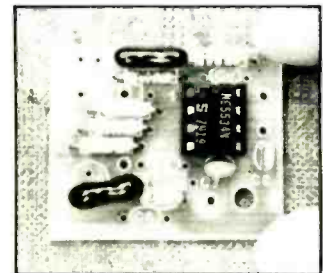
... continued from page 50 —

actually can be accomplished by bending the lead of a component over to an adjacent trace. For example, to delete the RF rejection portions of the input circuits of Figures 1 or 2, we need merely bend the leads of R_2 or R_5 to the appropriate adjacent traces, thus shorting out the unused component slots. To DC couple these inputs, just use the pads assigned to the input capacitors as input connections.

Now, here's the fun part. Figure 3 is the actual-size artwork needed to make your own OMNI cards. If you want to get fancy, Figure 4 is the actual size artwork for a silk-screen parts overlay. Any competent printed circuit house can fabricate them for you or, if you're so equipped, you can cut your own. The cost of cutting perhaps 50 pieces should be considerably less than the labor hours involved in hand-building a few such projects, and you will have more cards to try out your next brainstorm.



METER BUFFER



MIKE PRE-AMP

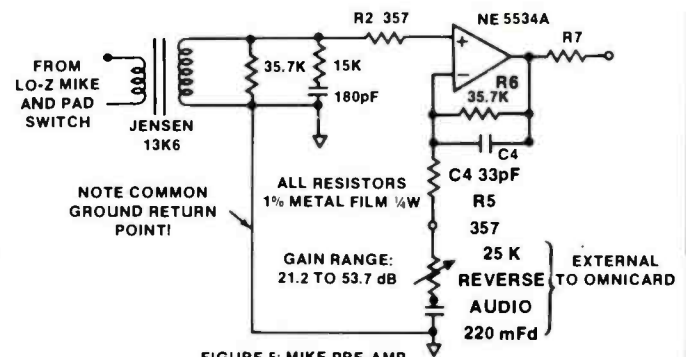


FIGURE 5: MIKE PRE-AMP

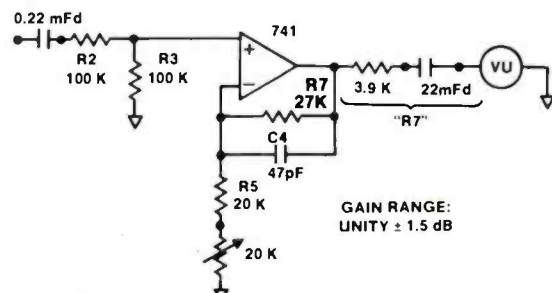
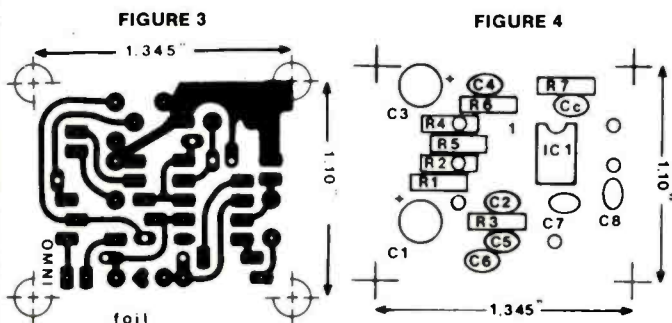


FIGURE 6: METER BUFFER

There is really little else to say about how to construct basic circuits on the OMNI card, so I'll close with Figure 5, a transformer-coupled mike pre-amp, and Figure 6, an active trimmable meter buffer. These are two useful examples of circuits you can build by creative re-allocation of the layout.

PS: Before press time I tried to set up some sort of mail order mechanism to make these cards available but, alas, I was unable to complete such arrangements. If I can do so in the future, I'll be glad to let you know. Until then, I hope that those of you who "roll your own" will save as many hours, and get as much pleasure, as I have with the OMNI card. ■■■





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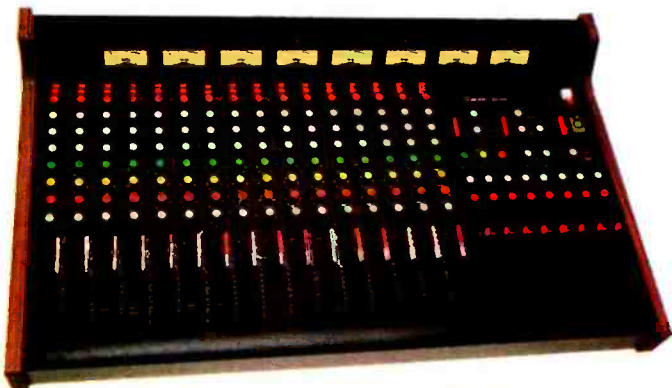
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Whereas some people collect stamps, Pete Townshend collects studios, their one common thread being London's River Thames, which physically links them all together (going to work by boat?).

Townshend owns, or has part-ownership in, several "Eel Pies," including The Boathouse Studio at Twickenham, West London; an attendant Barge (the Grand Cru) for use as a mobile for remotes; Broadwick Street in the Soho district of Central London; and private studios in his house at Goring-on-Thames, and his home in Twickenham. (Incidentally, the name Eel Pie originates from an island of the same name in the Thames near Twickenham, where Mr. Townshend Sr.'s dance band used to play.)

Pete Townshend built his first record-

ing studio in 1963, when the late Kit Lambert first took over management of The Who, and decided that Pete should try to write songs for the band. Lambert's film experience dictated the choice of two Vortexion portable recorders, rugged mono decks on which Townshend simply bounced material from machine to machine. Some of the remarkable results he achieved will be available soon on a demo album set of his early work, including such material as the original demos for *Tommy* and "My Generation," all of which were recorded at home before attempts were made to work on finished masters in the studio.

"I rapidly became aware that a lot of the mystique around recording was just bullshit," Pete recalls, "Simple recordings were often the best, and careful

mike placement with cleverly used, cheap echo devices often created better 'space' than that achieved in the four- and eight-track studios we used.

"When The Who recorded for the first time in New York I realized that I was right. We used a small four-track set-up owned by an ex-patriot Brit, Chris Huston. He had recorded The Young Rascals' hit 'Groovin' in his very basic room, and created a feeling of a slightly larger studio by feeding echo back into the room. We got great results from his intimate and specialized knowledge of his own set-up.

"Later in Nashville we encountered three-track and echo rooms for the first time; welded-down drum kits and fixed places for every instrument in a studio were the norm. Again, *great* results; the mystery of Abbey Road and other closed shops started to recede."

After a number of years moving his Vortexions from house to house, usually getting thrown out because of the noise, Townshend finally found an apartment in London that had a top room with no adjacent neighbors. He purchased a mixer and two tube compressors, some British-made Gramplan echo devices, switched to ReVox G36 tape machines and, with a few good studio mikes, proceeded to learn about equalization, phasing, tape editing and recording drums. This "home studio" progressed slowly and naturally through to a complete Neve-equipped studio in 1972, purchased with the writing royalties from *Tommy*. At that time, the Neve board cost \$24,000 and the 3M 16-track about \$25,000; both are still working hard.

This studio, finally relocated to a barn out in the country owing to the lack of suitable premises nearer Townshend's London home at Twickenham, has run well for a number of years, and is currently used in conjunction with his own home set-up comprising a small Neve BCM/10/2 console, 3M 16-track and large studio ARP 2500 synthesizer.

"Meanwhile," he continues, "I always dreamed about bigger premises. When I found The Boathouse it struck me that it was large enough to make a complete all-in home for all my pursuits."

A studio was built — initially four-track — film projection and dubbing facilities set up, a 16 mm editing suite added, and a performance stage. The large hall also was used for video projects in which new groups made half-inch, 8-track tapes, and a U-Matic videocassette.

"Making simple recordings at The Boathouse [initially using the old Neve 16-track console and 3M M56 from the country] taught me an incredible amount," he recalls. "I got to know the large, plaster-walled studio like a familiar book. Every corner had its value. I recorded everything from drums to small string sections, harps, solo flute, burundi drums, choirs, speech, and every type of electronic music. I knew the room had potential; I just needed a

PERSONAL-USE STUDIOS —

Musician, Producer and Studio Owner PETER TOWNSHEND Equipping and Operating his collection of "Eel Pie" Studios, and the Growing Importance of In-House Video Facilities

by Len Lewis



The Boathouse Studio, West London

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The Boathouse interior during studio construction . . .

'State-of-the-Art' control room that would make clients feel safe. So I ruminated at the expense for a few years, experimented with a wall here, a wall there, literally building and tearing down within months sometimes, then, having decided on a remote control room, jumped in!"

The current control room, attached vocal booth and lounge cost about \$600,000 to build and equip, and the hall was simply redesignated "studio." There is no direct visual communication between the studio and control room, for good reason. "As an artist," Townshend explains, "I *hate* being overlooked by a load of wise-cracking knob twiddlers in a cozy control room, smoking their spliffs and waiting, with little reverence, for me to get my act together. A lot of engineers I have worked with haven't discovered to this day that I am a *very* expert lip reader! I prefer to be on my own, and let them get on with it. There are video links, of course, but if I wish they can be cut off."

Video in the Studio

The reason Townshend decided to incorporate video logging facilities was because of difficulties he encountered one time trying to overdub on to some orchestral tracks. The project called for double string orchestra with guitar and voice.

The project had begun at EMI's Abbey Road studio, London, recording three tracks. When he subsequently came to add voice, however, Townshend ran into difficulties. "The strings played

loosely, there was a natural tempo shift, and often pauses for effect. Tacit sections where the voice or guitar were featured solo were open to total bluff. I realized then that had we had a locked-up video recording of the conductor, there would have been no problem."

As a result, Townshend tried video taping demo sessions, and found that other aspects proved to be valuable as a result of recording the backing track on videotape. Firstly, musicians arriving later to overdub literally were able to see the initial, vital session. They could relate to it on another level besides simply hearing what came down the earphones to them. They saw the conductor, or the leader could see the chit-chat leading up to and following the vital take. With a little advance notification they could see virtually whatever they wished: the drummer's feet, the guitarist's body movement, or just the river flowing by outside the studio window.

"I have many experiments still to make, but I know that this facility will produce the most valuable extra in studios of the future," Townshend confides. "Mark my words, everyone will want this facility once it can be provided simply and cheaply. With several high-quality U-Matic video recorders, remote cameras, and a small room provided for an operator, every important aspect of a session can be taped and logged for any eventuality.

"I actually attempted to make a complete film of my last album, *All The Best Cowboys Have Chinese Eyes*, but light-

ing proved our downfall. If the footage is for anything other than simply documenting the session, it needs to be lit the way we have come to expect. It's also quite tricky getting used to high light levels after years of recording in darkened rooms. Quite why this started to happen in Rock 'n' Roll I don't know, but often the most heavyweight rock singers in the business will clam up and go shy when asked to sing along to tape. The lights are dimmed 'for atmosphere,' but really it's to shut off that awful control room window that I — and I think many other artists — secretly hate so much".

Visual Communication

"Most good session players," he continues, "will tell you that they can shorten session times using eye contact with other players. The video-taping method is a crude attempt to achieve this eye contact for the overdubbing musician; it's not perfect, but a lot better than imagination, and absolutely vital during overdubs. For me as a writer, it's a great way of grabbing at the mood of an otherwise free performance, to assist in structuring a lyric or lead part. It's amazing how much you can learn by *watching*, as well as listening."

SMPTE-based synchronization systems, which many studios already have to lock up their multitracks, will hold down at least one U-Matic as well.

"My advice," Townshend urges, "is to try it; it's the first step to turning a sound stage into a video stage, and again de-mystifies TV. We all need more familiarity with television techniques as the impending video age looms; recording studios are going to be asked to approach TV dubbing and deal with live visuals more every day."

Returning to an earlier point though, one of the first video tapes Townshend made at The Boathouse was slightly different. He takes up the story: "I was asked to play in a Christmas Pantomime about four years ago, and the whole thing was video recorded in black and white. Sometimes I wish it hadn't been. My performance was, of course, exemplary, but I lost my beard in the process, and got a taste for amateur theatre that will never leave."

In the past, there have been several similar events at the studio — a Gong Show, an evening of Cole Porter melodies, a Grand Boeffe. Townshend now misses the way such events tended to gnaw away at the "stolid" laboratory feeling that inevitably builds up in the atmosphere of many studios. As he comments, "Most studios are large, friendly places capable of being great venues for wild parties, live music, and high sound levels once the precious gear is safely locked away. Once in a blue moon why not scratch your own varnished woodwork, rather than wait for clients to do it for you?"

Recording Facilities

The Boathouse studio features a mod-





— Peter Townshend —

est but full lighting rig, with separate controls to please Union operators. The studio recently was used to re-record an album track live on to 24-track, at the same time as the performance was being filmed. It is at times like this that a facility such as The Boathouse becomes invaluable, since the crew need make-up rooms, dressing room space with couches or beds, at least two separate lounges and, if possible, one or two other spare spaces for technicians to store gear and change film.

"I know this sounds over-the-top," Townshend admits, "but even in the days of instant video the smallest practicable crew must be about six people. With musicians, friends, a road crew and sound engineers as well, you end up with a lot of people."

The large amounts of space are never wasted either, because when rock bands come in they need storage for their road cases, and road crews like to have a room to themselves to set up as a workshop. Townshend has even been known to set up a small demo studio in a spare room while recording, so that any new ideas can be worked on and laid down quickly on a four-track Portastudio cassette while other people are overdubbing.

The technical side of the simultaneous video taping of *Chinese Eyes* was particularly interesting. SMPTE time-code required by the Solid State Logic

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Outboard Effects: EMT140 plate, Lexicon 224 digital reverb, MICMIX Master Room reverb, Lexicon Prime Time, AMS 15-80S digital delay with pitch-shift, MXR digital delay, Delta Lab DL4, UREI 1176 and LA-3 compressor limiter, Kepex and Neve gates, Eventide Harmonizer, BEL Flanger/Phaser, MXR Flanger and EMS Vocoder.

computer was used to lock up the Ampex one-inch video machine. Each take received a new code until overdubbing began, when fresh SMPTE code was laid on to the Ampex to be jam synced against the master code. The new code was laid via a comparator receiving the master code on each pass, so that time-code for each take was available during an overdub. This facility proved important for logging at a later stage.

"You end up with masses of tape," Townshend admits, "but that's not as bad as it sounds. Once you've edited what you require, you know which tapes are of out-takes, and they can be retrieved on future sessions."

One lesson learned — apart from the need to carefully light each shot, even if

it holds up the sound session — was that a separate control room for the video gear (even if it is rented for the session) is invaluable, if not vital. Video equipment racks buzz with cooling fans, and the sound engineer and video-tape operator need to be in constant communication between takes for marking or slating each tape. All this would be distracting to the artist if it went on in the studio itself, and murder for the sound engineer and producer too. Sound and video operators are used to their respective territories being sacrosanct, and are very loathe to give it up.

Plans for live video shoots include a video control room at the back of the studio close to the main control room. This will house the one-inch video

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Control room hardware at The Boathouse includes a Solid State Logic 4040E console, with Total Recall, a pair of Studer A800 24-track, Audio Kinetics Q-Lock 310 synchronizers, Ampex ATR-102 mastering machines, and a wide selection of outboard equipment.



recorders, TV monitors, additional SMPTE timecode equipment, etc.

"I already have a small off-line editing system for the U-Matic [1/4-inch], but if I get a windfall I would love to have a video editing suite with all the sweeteners now available," Townshend explains. Most important would be two or three good cameras, he concedes. At this time he tends to hire them as required, since they cost about \$50,000 each.

"Until people start video taping in sound studios regularly, that expense — even once — is not justified. It cost my record company [Atco] \$86,000 to tape all my *Chinese Eyes* album sessions. For another few thousand I believe the results could have been so much better; for example, time set aside before each take to establish tight positions for musicians and lighting.

Future Plans

Short-term plans for the future of The Boathouse include a new studio ceiling to provide improved sound isolation and offer more headroom, quieter air-conditioning, and a large, open booth where the performance stage is currently situated, since several clients have found the big room to be too live.

"Most of our clients would never use these extra facilities," Townshend confides, "but there's a simple reason for building them — I want them. I'm an important client to my own studio, and I feel it's worth keeping me happy. Incestuous . . . financially confusing . . . but worth it."

Pete Townshend remains very aware of the problems that still exist for young bands, and employs a young assistant whose job it is to get out and about, and write-up a weekly report of "What's

Happening." He's had an idea to build a low-cost studio for struggling bands to use very cheaply under a membership scheme, but with reservations about taking work away from the many small demo studios dotted around Britain.

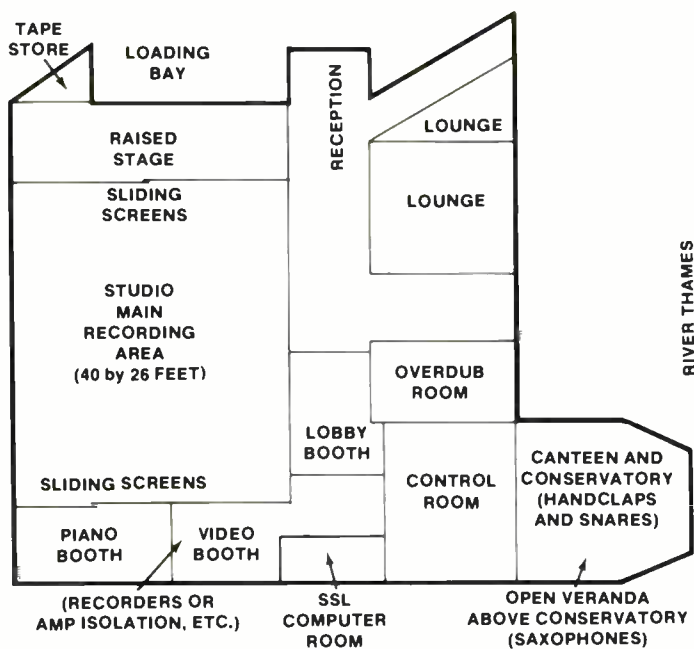
"It's hard to keep a balance," he says, "but I now see both sides and I'm not about to start giving away free recording time again. I've done it so often in the past and, strangely, without a single exception it has *never* produced a hit. I've done it at least a hundred times; more than a thousand free hours in all. Not *one* hit. Releases yes, but no big sellers so I can go to the artist and say, 'How about some dough so I can keep doing this for other acts?'"

"Why? The reason is that while working on the cheap people don't try hard. They neglect to get producers. They give any record company they approach a chance to listen, for sure, but also to react and improve on what they hear. Anyone who says that a record can't be improved is *nuts*. So the A&R person will always say, 'Right, good demos, but when you go into a *real* studio . . .' Free time in a real studio seems to add up to

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STUDIO AND CONTROL ROOM AREAS OF "THE BOATHOUSE"

demos; I don't know why, but it's a fact I've proved."

Townshend's home set-up now features a custom-built Neve console, equipped with a four-bus, 24-track playback unit with two foldback and two echo sends connected directly to a 3M

M79 multitrack. For mike mixing there is a separate six-channel Neve mixer and three of the company's compressors. With good mikes, what goes on tape is super quality, he says. Also, he often uses a Tascam 80-8 half-inch, eight track linked to TEAC or Sound-

craft boards, and TEAC Portastudios. "Anything I like I transfer to 24-track and use it. Forget doing it again! I've taken tapes into the best producers in the world and they say, 'Wow, what a great sound, how do you do it?' And I say 'On a Portastudio in my bathroom.' 'But this is a two-inch master!' 'Yeah, now it is.'

"I think the new home studio gear is nothing short of miraculous. If it had been around when I started I would have died of excitement. I saw my first Fostex quarter-inch, eight-track the other day; it would fit under an aircraft seat. I take a studio on the road, on holidays and, if I have my way, into the bathroom!"

Finally, The Barge will be making its first trip next year on the canals of France. Townshend intends to make a special record there based on a pastoral theme, hoping the countryside "vibes" will assist.

"I will equip [The Barge] when I need to, and leave it empty until then. We might get mooring for it outside The Boathouse, but even then I will only equip it for demos. It's a toy for a crazy, studio-mad, spoiled-brat rock star. But, much as I like the usual luxuries like yachts and stuff, when I look inside a big one I'm always finding myself thinking, 'If you ripped-out all the varnished wood, velvet sofas, and drinks cabinets, you could just fit in a Soundcraft Series 3...'"

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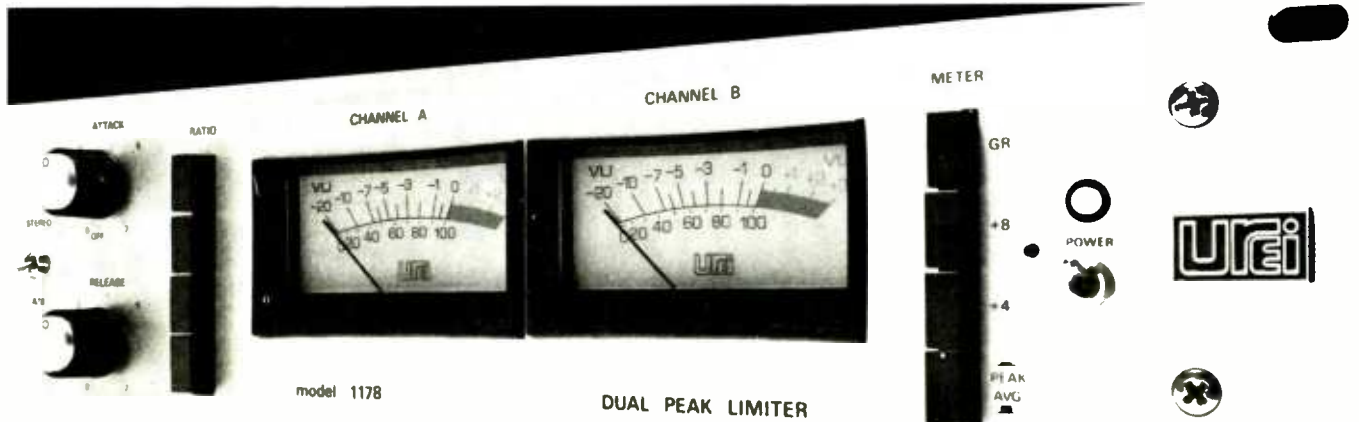
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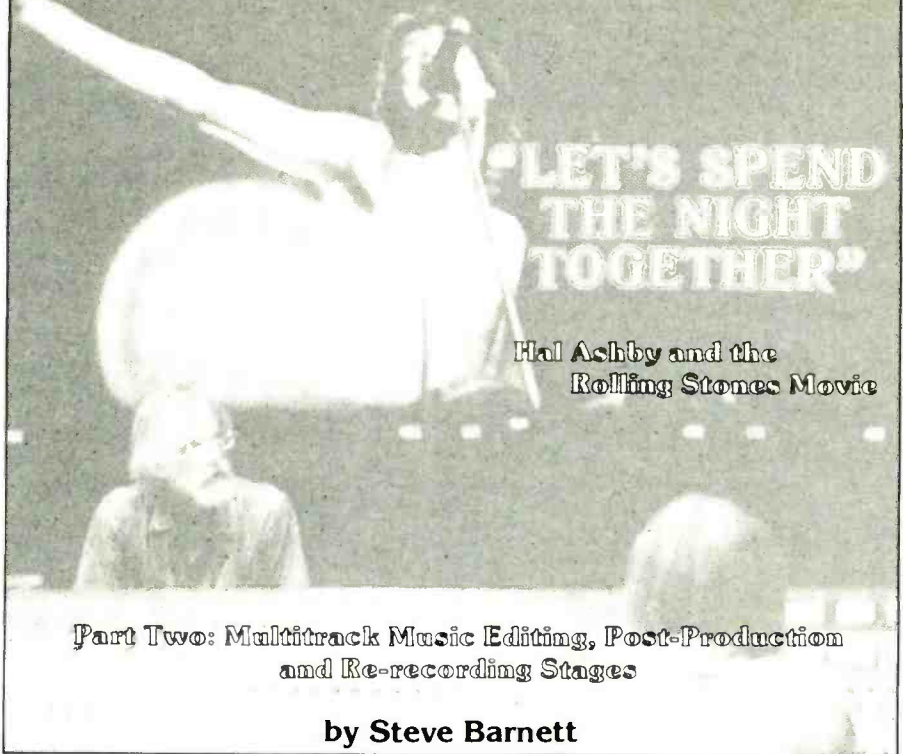
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Audio and Video in the Motion-Picture Arena



Part Two: Multitrack Music Editing, Post-Production and Re-recording Stages

by Steve Barnett

Having transferred the various film footage shot at the pair of Rolling Stones concerts in New Jersey and Arizona — approximately 60 hours in all, from up to a dozen camera positions — on to Sony Beta I half-inch videocassettes, director Hal Ashby and codirector Pablo Ferro began the long and complicated process of editing the visuals down to the movie's final 90-minute running time. To assist in shortening up the songs, music editor Michael Tronick was brought in at this stage. Tronick's background includes music editing on Bob Fosse's *All That Jazz*, and on the musical *Xanadu*.

Editing of the film began to take on a collaborative process. Usually, music is recorded to a cut picture, and the music editor works closely with the film score's composer, timing out sections, and later cutting them into the film. In this instance, however, the need to shorten the songs would effect the way in which the picture was cut.

"Neither Lisa Day nor I are music editors," explains assistant editor Lorinda Hollingshead, "so we would make some cuts that were pretty horrendous! Most of the edits worked, but needed a little polishing. And you had to get it down to time, so you'd lose one solo for another solo, or what have you."

"Michael [Tronick] came on a little bit later than normal," Day adds, "and corrected cuts that were out of tempo. Also at that particular time, when more cuts had to be made [to shorten songs], he would come in and make them, and we would sometimes arrange our picture around that. Initially we just played around with the songs, and then began to understand how you cut out bars and

beats."

"I would make the cuts," adds Ashby, "and ask Mike to come in and check them. Once in a while he would find one and say, 'Well, this can't be done here,' and then we'd look for some different place. The music would dictate it like in any musical."

"Lisa would tell me Hal wanted to go from this shot to this shot," says Tronick, "and can we do it from here to here. I'd listen to it and say, 'Okay. We can make an eight-bar deletion here. Let's see how that sounds.' Mainly my goal was to maintain the integrity of The Stones' music. Everyone is so familiar with their tunes, that you really can't cheat that much."

Musical Guidelines

"My criteria as a music editor is basically what sounds good; what maintains that integrity of the original song. You can't make a 3/4 bar out of a 4/4 bar or cut in the middle of a verse, and go to the chorus.

"I cut at beginnings of bars," he continues, "but sometimes I would cut on beat #3. I used Charlie [Watts] as my guide; usually his snare or kick drum. He'd play on one and three, or on two and four. Rock and roll has certain patterns that are established already, so basically that's where I'd go. I'd use the percussion as my guide."

Bill Morino, then with Regent Sound in New York City, would later become involved in conforming the 24-track master tape to match the edited picture. He comments on Michael Tronick's editing style: "He initiated the philosophy of short cuts for the picture. Let's say the

— continued on page 65 ...



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THE ROLLING STONES MOVIE PART II

band is doing a vamp, and they started out slowly and softly. It keeps building, and they keep dropping in the different instruments until they reach the beginning of the song where the vocal comes in. Now, if you were to take out just the downbeat of one of the first few measures, and then skip eight bars, you'd have this huge intensity change, even though the edit was *technically* correct, right on the beat and in time.

"If you were to make a series of shorter edits, just taking out a few bars of the vamp each time it went around, then you would still have the gradual build, but in less time; less gradual, but still not drastic. Most shows that I've done, there are very few musical edits within songs. On this show, we ran into cases where we were doing up to 22 edits per song. I think the average was 15."

As editing proceeded against the approaching deadline, the advantages of cutting on video became more apparent to those involved. It allowed the filmmakers to try things quickly and cleanly that otherwise might have proved inconvenient if they had been cutting initially on film.

"It was so much fun, and so easy," says Hollingshead. "You weren't hacking up your film, and if you wanted to try a three-frame cut to see what it looked like, you'd just go ahead and do it on the video. If you don't like it, you can erase it on the next pass, as opposed to having to splice over three frames of film. And when you finally did get to the film, it was virgin; you'd tried every option you could think of, but hadn't messed it up."

This feature came in particularly

— Northstar's Harry Howard —



— Director Hal Ashby —

handy in the editing of the several montage sequences in the film, including one of the band performing "Time Is On My Side" at the Sun Devil Stadium, intercut by Ferro with old footage of Stones' appearances, for example, on the TAMMI and Ed Sullivan shows. Additionally, co-director Pablo Ferro worked up what were called "motion sequences" from various parts of the motion picture.

"A good example," recalls Day, "is Keith throwing his guitar around at the

end of 'Satisfaction.' He throws it up into the air, and then throws it up again from another angle, and then throws it up again from another angle, and so on. Well, that whole thing we would call a motion sequence on Keith. We would take that and insert it into the song."

When the time came to conform the film to segments edited on video, certain adjustments had to be made beyond a cutting to match the edge code numbers. "An interesting thing we discovered, Day says, "was that what we thought was really clear on the video, when we looked at it on film on the KEM, we found that it didn't quite carry. Or maybe it was something we didn't carry out, and should have."

"The other thing," adds Hollingshead, "was that the timing was slightly different, so oftentimes you didn't end up making the cut on the film exactly where you thought it was going to be."

This refining process, however, follows with the normal process of editing a film. "The film tightened up here and there," adds Ferro, "because the video was off a frame or two, so you'd keep working on it and you'd find other ideas. You find new ideas when you're working on film."

Additionally, most of final music edits could be made only on the KEM. Working with a single piece of 35mm mag stock was more flexible than lay-

— continued overleaf —



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ing off the different tracks of the Beta cassettes. The degree of accuracy was greater as well, with cuts in increments of ¼ frame possible, versus the sometimes questionable single frame accuracy of the Beta decks. Indeed, Tronick describes himself as “the throwback to sprocket holes” to link the film, video, and audio worlds.

Multitrack Applications

The filmmakers finished to their satisfaction what would become the European version of the film, and “locked” a cut of the film work print and its matching 35mm mag stock. Now began the process of conforming the 24 tracks of the master tape to the edited picture, and the accompanying edited stereo scratch track. Time considerations were becoming critical, however, since the film was 90 minutes long, and contained the band performing 15 songs.

“Before this point,” recalls Howard, “the 2½-minute trailer [produced by Ferro for the Cannes Film Festival] had been done in the customary Hollywood approach to multitrack mixing, which was to transfer the 24 tracks to four reels of six-track, 35mm mag stock. The advantage of this in terms of the film community is that it allows the editor to cut the tracks to match the work print.

“One difficulty, however, is that you don’t preserve phase relationships terribly well. This is generally handled by choosing those elements that are phase sensitive to each other — such as vocals or any track where there is likely to be microphone leakage — and to place those on the same reel of 35mm stock. In that way the phase relationships are at least preserved between them. Another disadvantage is that it requires a generation for this purpose alone.

“Now at this stage we still had a fair amount of editing to do, and were really planning to complete the mix in a two-week period of time. It took two days to complete the mix of the preview [trailer], which was only one song. With that in mind, you can conclude that we were just not going to get through the film in 10 working days.”

A way had to be found to speed up the process, yet still achieve the quality of sound upon which The Rolling Stones insisted. Their music mixer, Bob Clearmountain, had been present at the dubbing of the preview from 35mm mag at Todd-AO, the theater sized re-recording stage preferred by Ashby, and engaged for the film. At the dates, however, union regulations prevented Clearmountain, who mixed the *Tattoo You*



— Co-director Pablo Ferro —

album, from actually handling the console. “I was more or less producing it,” he offers, “but it worked out well and sounded good because the people there are good, and very easy to work with.”

The process of mixing the entire film from scratch in this fashion promised to be as time-consuming as the mix for the trailer. At a dubbing stage rental cost of roughly \$450 per hour, not to mention Clearmountain’s added salary, this would exceed financial limitations as well.

Pre-Dub and Editing on Multitrack

It was decided that Clearmountain would do a pre-dub of the original 24-track master tapes on to a second 24-track machine. Using a ¾-inch U-Matic copy of the film, with the edited 24 FPS timecode as a guide, he would also conform the 24-track to the picture during his mixing process. The “edited” 24-track pre-dub tape then would be returned to Todd-AO, and synchronized to their film chain for the final dub to 35mm mag.

Creative considerations played a part in the decision as well. “Because the Stones were in Europe,” Ashby

— Sound editor Bill Morino —



explains, “and Bob Clearmountain had done a lot of mixing for the band, I thought it would make everybody feel more comfortable if he was to do the original mixdown, even though it would have to be changed considerably due to the size of the room he’d be mixing in, and the size of the re-recording stage at Todd-AO.”

Clearmountain began his task at The Power Station in New York City. Utilizing the studio’s Solid State Logic automated console and Audio Kinetics Q-Lock synchronizer linking the two multitrack recorders and VCR, he set about the job of mixing and editing the tapes. “I was mixing from one multitrack to the other,” Clearmountain recalls. “Whenever I got to an edit, I would just figure out what was taken out, subtract that from the amount of time, enter it as an offset in the Q-Lock, and program it to punch in at the edit.

“This is no problem as long as there’s enough preroll time between edits, because with the video and two multitrack machines, the Q-Lock needs a good 5 to 10 seconds before you get to the edit point to lock up. In this film, there are places where there are cuts that last less than a second — like 10 frames cut out — and there was no way for the Q-Lock to deal with that. It’s not designed for that sort of thing, and it’s really ridiculous to ask it to do it. I didn’t realize this before I sat down with my edit decision list and tried to actually do it.”

“At about the same time,” says Harry Howard of the Northstar Media video and sound transfer house, “Pablo was in New York . . . when he came upon a company called Regent Sound, who do quite a bit with timecoded multitrack tapes.”

“I had a meeting with Pablo,” recalls Bob Liftin, president of Regent Sound, “and we discussed the problem. In order to edit the multitrack, you could not physically cut it; you had to electronically edit it. In essence, what we had to do was write some different software that would enable us to resolve the 24 FPS timecode, and then edit the 24-track tape on to another 24-track tape, which would then conform to picture.”

“The process was then divided into two operations,” explains Howard. “Editing, that is conforming the 24-track to a 35mm worktrack; and mixing Bob Clearmountain’s pre-dub. It now included an extra generation, but the ability to have Bob spend his energies on mixing, and not worry about sync, far outweighed that consideration.”

From the original 24-track “masters,” the first step would yield “edited” 24-track tapes which ran in sync with videocassettes of the film. Clearmountain then would use the edited 24-track tapes as masters in his mix, which result in 24-track “pre-dub” tapes. These would then be returned to Los Angeles and linked to the film chain at Todd-AO for the final mix.

Since some audio edits occurred regardless of whether or not a picture

A black AKG C460B condenser microphone is shown diagonally across the frame. The microphone has a silver-colored grille at the top and a silver-colored base with a switch. The background is a dark grid with a green waveform graphic. The text "AKG C460B" is visible on the microphone's body.

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edit was made, an "X" was placed on the film to provide Regent Sound with a visual indication of an edit on the audio track. Northstar Media then transferred the edited film workprint and its matching 35mm soundtrack to 3/4-inch videocassettes — one for each 10-minute segment or "reel" of the picture. Marked on each reel, nine feet before the head of the picture, was the visible start mark that corresponded to a tone on the 35mm track; these sync checks also were transferred to tape. On one of the two audio tracks was laid the mono scratch mix from the 35mm mag stock, and a newly generated, continuous non-drop frame 30 FPS timecode on the second. In addition, the digital readout of this timecode, along with edited 24 FPS timecode from the 35mm mag stock, was visibly burned into the video picture.

"Also," continues Howard, "we were able to prepare an edit decision list based on the cut points of that edited timecode. As the 35mm tracks were played, we had an Apple II [computer] attached to our timecode reader, and instructed it to look for any non-sequence in the code. We obtained a printout which identified these sequences in terms of their timecode address."

Mixed Timecode and Drop/Non-Drop References

"Another problem," Howard recalls, "was that Regent normally did not work with 24-frame timecode. They either had to find a way to 'translate' the code of the master 24-track tapes or, if a free track was available, place a fresh 30 FPS timecode on that track while holding phase lock with the 60 Hz pilot tone."

The videocassettes and 24-track master tapes were shipped to Regent Sound in New York, along with the edit decision list and a duplicate of the edited 35mm three-stripe with its scratch mix and cut timecode. There, engineer Bill Morino performed the editing.

His first step was to bring the whole operation into a "video world" for the duration of its stay at Regent. "We talked about the pros and cons," Morino explains, "and decided the best thing would be for us to handle it as *video*. Even though it's a film, we were working with a video copy of that film, which would always be referenced to the videocassette machine."

When the decision was made to mix from a 24-track machine linked to the film chain at Todd-AO, non-drop frame timecode was selected as the means of synchronization, because of its direct relationship to the 60 Hz tone control-

ling the dubbing units and projectors used throughout the motion-picture world. The 24 FPS code layed down on the original concert tapes was also recorded in phase relationship to the 60 Hz pilot tone used to control real-time playback.

Here at Regent, however, the task of editing the audio tapes was going to be performed in relationship to a video tape deck that found its time-base at 59.94 Hz. Drop-frame timecode, based on video's 59.94 Hz, would not later be utilized during playback at the Todd-AO mix session. These timecode numbers also were only going to be used to delineate edit addresses of 10-minute units of video material that would never be broadcast. There was no need to reconcile the code number's operating rate with real-clock time, the original purpose of drop-frame timecode.

Because the timecode utilized in editing would be the same code incorporated at Todd-AO, Regent also was required to use the non-drop (60 Hz) frame code for synchronization. This presented the problem of audio tapes and video cassettes running from *different* time bases. As the video tape could *not* vary from its 59.94 Hz sync reference, the

audio tapes would have to be brought down from their 60 Hz.

"The first step was to bring the audio tape, no matter what speed it was recorded at, into the video relationship," continues Morino, "because the video cassettes are *locked* to 59.94 Hz. Essentially, we have tape that was running with the 60 Hz sync tone on it. What I had to do was feed a phase comparator with their 60 Hz, and compare it to our house sync of 59.94. That generated an error voltage that runs the capstan of the machine, and slows it down until its 60 Hz is running at 59.94 Hz. We are now no longer running at real-time, just slightly slower while I'm editing."

Since the 24 frames per second SMPTE timecode was recorded in a relationship to 60 Hz, resolving its speed to 59.94 Hz to match the video timebase gave it a true rating of 23.97 FPS. When this timecode was later converted to 30-frame SMPTE, its actual rating would be 29.97 FPS. This speed matched the actual rate of the non-drop frame 30 FPS SMPTE on the videocassettes, and "edited" 24-track tapes, they also were operating on the same time base.

When the pre-dub masters later were played back during re-recording at

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	SEGMENT	START	STOP	LENGTH	CUMULATIVE LENGTH
	1)	12:10:36:01	→ 12:10:39:04	00:03:04	02:15:14
	2)	23:52:03:11	→ 23:54:14:19	02:06:09	04:22:25
"START ME UP" (NJ II/5)	3)	23:55:17:03	→ 23:55:31:10	00:14:09	04:37:05
	4)	23:55:45:22	→ 23:55:55:05	00:09:08	04:46:15
"HONKY TONK WOMAN" (PH)	5)	23:54:42:06	→ 23:55:02:11	00:20:06	05:06:23
	6)	23:56:07:24	→ 23:56:29:16	00:21:17	05:28:14
	7)	06:08:45:16	→ 06:09:11:23	00:26:09	05:54:24
"BROWN SUGAR" (NJ II/5)	8)	06:09:20:07	→ 06:12:23:02	03:02:20	08:57:17
	9)	06:12:24:15	→ 06:12:32:02	00:07:12	09:05:04
	10)	00:00:22:15	→ 00:01:14:03	00:51:13	09:56:20
"JUMPING JACK FLASH" (PH)	11)	00:01:25:24	→ 00:01:52:07	00:25:08	10:22:00
	12)	00:02:05:03	→ 00:02:44:12	00:41:10	11:03:13
	13)	00:03:04:24	→ 00:03:11:12	00:05:13	11:10:00
	14)	12:23:38:11	→ 12:23:39:08	00:00:12	11:10:27
	15)	00:03:12:12	→ 00:03:21:24	00:09:13	11:20:15
"SATISFACTION" (PH)	16)	00:03:22:13	→ 00:03:23:08	00:00:20	11:21:09
	17)	06:22:25:21	→ 06:22:55:24	00:29:04	11:51:13
	18)	06:24:09:09	→ 06:24:56:22	00:48:15	12:40:02
	19)	06:25:39:08	→ 06:25:43:16	00:04:07	12:44:13
	20)	06:25:45:15	→ 06:25:55:03	00:09:13	12:54:00
	21)	06:26:09:16	→ 06:26:23:17	00:14:02	13:08:02
	22)	06:27:14:20	→ 06:27:49:13	00:34:18	13:42:24
"STAR SPANGLED BANNER" (PH)	23)	06:28:10:01	→ 06:28:30:07	00:20:07	14:03:03
	24)	06:28:36:08	→ 06:28:55:23	00:19:16	14:22:23
	25)	06:29:31:16	→ 06:29:05:04	00:33:13	14:56:09
	26)	06:29:07:22	→ 06:29:13:21	00:04:00	15:00:09
	27)	06:32:00:18	→ 06:33:13:12	01:12:19	16:13:03
	28)	06:34:02:12	→ 06:34:51:05	00:48:18	17:01:25
	29)	06:34:54:02	→ 06:35:01:24	00:07:22	17:09:24
	30)	06:35:16:05	→ 06:35:40:01	00:23:21	17:33:20
"STAR SPANGLED BANNER" (PH)	31)	06:35:42:22	→ 06:35:49:02	00:06:05	17:39:27
	32)	06:35:51:22	→ 06:35:59:19	00:08:02	17:48:24
	33)	06:36:24:15	→ 06:36:30:17	00:06:05	17:53:29
	34)	06:36:36:13	→ 06:37:06:01	00:29:10	18:23:14
	35)	06:37:15:19	→ 06:37:27:03	00:11:10	19:33:27
	36)	06:37:54:10	→ 06:41:26:06	03:31:21	22:05:23

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THE ROLLING STONES MOVIE PART II

Todd-AO, they were resolved to a true 60 Hz, and consequently played back in real-time with the projected film, with timecodes at their actual rating.

"Now, by locking all the machines independently, rather than having one chase the code of the other," adds Morino, "you are adding absolutely no wow and flutter to any of the slave machines. My concern was that with slaving the 24-track from the videocassette, you would be adding the wow and flutter to the tape machines, and that is quite considerable. There are devices that decrease the flutter, but why add anything when you're starting with a very stable timebase that each machine can reference to independently?"

Multitrack Editing

The audio editing operation at Regent can more easily find its comparisons in the video world, where timecode on the source tape is used to specify a playback address, and timecode on the record tape specifies the drop-in point for the source material. With film, since the edge code and the image or track are physically on the same piece of material, code numbers on an edited reel jump back and forth continuously. In video, however, only the program material, be it audio and/or video, moves from the source deck to the recording machine; the timecode numbers do *not* intermingle.

The information is programmed into the editing controller and executed. Since Regent's facility utilizes 30-frame timecode to define playback and record addresses, the 24-frame timecode on the Rolling Stones' master tapes had to be converted. "We were able to synthesize 30-frame timecode from the 24-frame code," says Liftin. "The hours, minutes, and seconds were exactly the same. The only difference was that on one, 30 frames happen in one second, while on the other, 24 frames happen in that same second."

"The master audio tape had 24-frame code running continuously on track #24," Morino recalls. "Luckily, track #20 was empty, so what we did was take a jam sync generator, jammed sync to that code, and layed down the resulting 30-frame code on track #20 at a very low level. Now if you had both of the 24- and 30-frame codes played back on two SMPTE readers, you would notice that on each reader all the numbers would be the same, except for the frames, because 24 frames would go by every second on the film code, and 30 on the video code. That was the only discrepancy that we had to translate mathematically from the edit decision list."

This new 30 FPS timecode on track #20 of the master tapes would be used to specify the source deck playback addresses in the editing process, but the tapes on to which the audio was to be edited also needed timecode in order to program the "drop-in" points. To prepare this "basic," timecode is stripped on to one track of a blank 24-track tape. In this instance, the same non-drop 30-frame code numbers that Regent placed on the video cassettes were recorded on to track #24 of the basic tapes that would record the edited material. Later, during his pre-dub, Bob Clearmountain would

sync the videocassettes to the 24-track decks using this same timecode.

Timecode Regeneration

Since this timecode did not need any sort of change in its recording, it was not jam synced. However, a straight tape-to-tape dub also was not appropriate.

"The problem would not occur if we were using instrumentation-grade tape recorders," Howard explains. "Timecode is almost squarewave-type information, and if your signal travels through transformers and distribution amplifiers that are not of the cleanest design, you could begin to distort this signal, which would cause the code reader to make mistakes. The best advice, it seems, is to regenerate the timecode, and most code readers have a regenerated output on the back."

Morino used regeneration to duplicate timecode from videocassettes on to its corresponding "basic" 24-track tape. With this accomplished, the engineer began conforming the 24-track master tapes to match the cut picture on the videocassettes. This stage was accomplished with JVC U-Matic VCRs, two Ampex MM-1200 multitrack recorders, and an EECO MQS-103 synchronizer, augmented by Apple, Motorola, and MQS minicomputers running software written at Regent. It became apparent as the editing proceeded, however, that adjustments would have to be made in some of the edit points when they made their way from 35mm mag to 24-track tape.

Split Edits

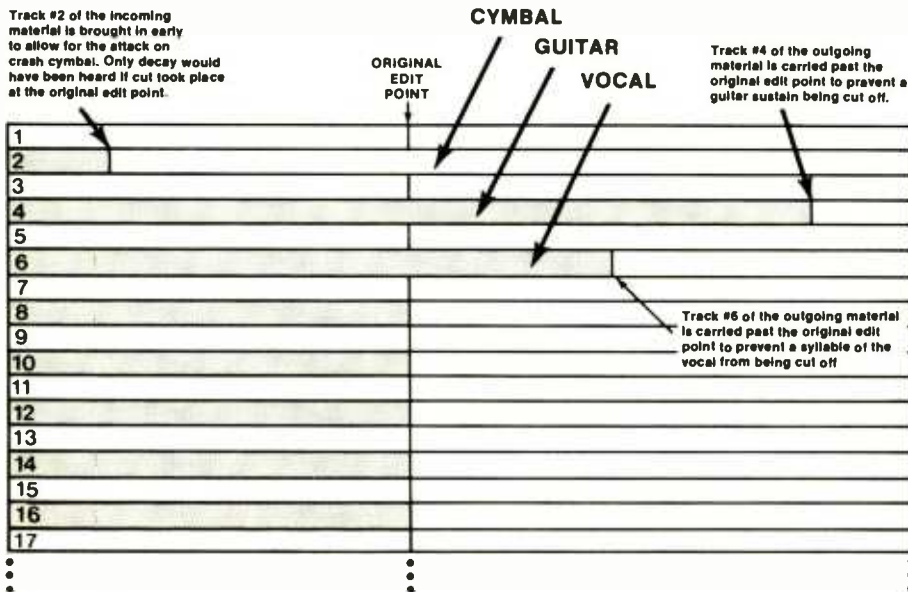
"We were listening to a rough track," picture editor Lorrinda Hollingshead explains, "and when you actually listened to the 24-track, there might have been stuff that we just couldn't hear in the rough mix."

"It would sound fine to us on our stereo mag track," says Lisa Day, "but we might be cutting off the end of a sax blow, or cutting into a guitar solo. There were so many layers of music with the different instruments, so Bill had to extend that sax solo over the cut [edit point]."

"They had a harder time monitoring than we did," explains Morino. "They didn't have the 24-track to monitor, so they would listen to a mix. Now, depending on what was hot in that mix, the edit would sound good, or not so good. For the sake of discussion, let's say it's the drums that were not hot in their mix on 35mm mag. So if you were to go through just the drum track and listen to the edit, it might sound horrendous. This is no reflection on anybody's artistic abilities. It was just that we had 24-tracks to listen to, and we might say, 'This edit makes it for all these instruments, but did you hear what happens to the crash cymbal on the incoming tracks? We have the sustain, but we don't get the attack.' What we'd do is bring the edit point in a little earlier for just that cymbal track so we would hear the attack."

MULTITRACK "SPLIT" EDITS

Track #2 of the incoming material is brought in early to allow for the attack on crash cymbal. Only decay would have been heard if cut took place at the original edit point.



Morino also could extend individual tracks past the pre-determined edit point to avoid abruptly cutting off material. "We did it on 'Let Me Go,'" he continues. "We wanted to make an edit on the down beat which, on the vocal track, was on the 'g' sound in the word 'go.' But we also wanted to hear Mick say 'Let Me Go,' for the 'o' part to linger over, because the incoming vocal track was empty. The edit was made from the verse into an instrumental solo."

While the rest of the band's tracks were all "cut" on the original edit point, the vocal track was extended to allow the end of the word to be heard. Then, the incoming track took over, bringing that section back into sync with the picture. These extensions could be as long as several seconds, or as short as 1/2 frame or less.

"We also have the ability to do fades and cross-fades in electronic editing," adds Regent Sound president Bob Liffin, "which gives you a tremendous edge because you're no longer dealing with hard cuts. We're also talking about a resolution in cross fades of less than one frame. They are really soft cuts that do not jar you as much as hard cuts."

"But when you're editing a 24-track," Morino offers, "the cross-fades are really not necessary."

Sometimes the split editing involves sub-frame increments. Although Regent has since upgraded its system to include this ability, explains Morino, "at that time we didn't have sub-frame capability in our equipment. In order to simulate it, we had to fool the synchronizer as to where the playback machine really was, by placing a digital delay line in the playback machine's timecode signal."

With this arrangement, the editing controller would read that the source deck was at the specified timecode address for playback, while in fact the tape would be half a frame advanced from that position.

These many special editing features at Regent Sound enabled the 24-track master tapes to be conformed to the edits in the 35mm with better technical and artistic results. The edited tapes now were ready for Bob Clearmountain's pre-dub. Individual tracks would be mixed to the six-track, 70mm film release format: five speakers left to right behind the theater screen, and the sixth feed for surround speakers.

Pre-dub Mix Session

"I had finished doing the live album," Clearmountain recalls, "but had never mixed a movie soundtrack before. I did the mix at The Power Station in New York, and they didn't have any six-track monitoring facility. So I just set up five Yamaha NS-10M monitors across the front of the console. The sixth track would be the surround but, because I was mixing in a control room, I figured that it would be rather difficult to get a perspective on what it should be doing, so I left it up to the guys at Todd-AO."

Todd-AO's engineers assigned the sixth channel primarily for audience reaction and, while the creative decisions on the material on the other five tracks primarily were left to Mick Jagger and Clearmountain, requirements of the film dubbing crew also played a part.

"Originally," explained Clearmountain, "I wanted to put the kick drum and the bass guitar on the middle three channels. But they had decided to derive all the other release formats — stereo optical and mono, and the rest — from the 70mm format, six-channel master, and didn't want me to double punch anything. Otherwise, when you melt it all down, anything that is double punched is going to get twice as much level as anything that is not. So I had to keep everything discrete."

After placing the kick, snare, and Jagger's vocal on the center #3 channel, Clearmountain made the basic assignments based on the Stones' stage setup. "The drum kit was divided left and right," he recalls, "so on the right center channel [#4], I had right cymbals and toms, bass, and Keith's vocal. I had Keith's guitar on the far right channel [#5], and though I didn't use it all the time, a lot of the time I put Keith's guitar through a Publison pitch shifter and brought that effect out of the right center [#4] just to give a little depth to the sound. On the left center channel [#2], I

had left drums and Ron's [Wood] guitar. The far left channel is where I had keyboards, because that's where they were on stage. Now the sax sort of moves around a bit because it comes in at different places. He's on the center when he's taking a solo, and sometimes right and left off center.

"Occasionally, for some particular numbers where they would pretty much use a side camera and things were different, I would, switch, say Keith's vocal over to the left side, because he'd appear on screen left." Any changes of this nature lasted an entire song; assignment shifts within a number were avoided.

Clearmountain mixed on to a second 24-track machine. Track #1 carried a mono mix of the primary five channels, which also were assigned individually on tracks #2 through #6. One track was utilized for the 30 FPS timecode used during Regent's editing, and which also provided sync to Clearmountain's VCR playback, and later would allow hook up of the 24-track tape to Todd-AO's 35mm film chain. A 60 Hz sync signal would occupy another track, while the cut 24 FPS timecode was regenerated on to another. On the remaining tape tracks, Clearmountain would record discretely the individual instruments he was mixing in to the five-channel film format.

"These were all post-fader," Clearmountain says, "the reason being that if

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THE ROLLING STONES MOVIE PART II

there was anything not working in the final dub, they'd have what amounted to an automated mix. They could pull down the five-channel composite mix, line up the faders for these individual instrument tracks, and then move things up and down. All of my rides were recorded on individual tracks, but now they could change the relationship of one instrument of another. Whatever echo I added was also on two separate tracks."

These individual channels were layed down with the same EQ, gating, and signal processing used during their integration into the five-channel mix. "So then, if Keith's guitar was not loud enough in that mix," says Todd-AO film mixer Don Digirolamo, "which was mostly channel #5, I could sweeten it with some of Keith's individual guitar track. Because they were all recorded at the same time, they were in dead sync and phase. If it had been strictly a film system, I wouldn't have had that flexibility."



Photography by Steven Barnett

Machine room operator Tim Jordon in the Ampex ATR-124 equipped Todd-AO Dubbing Stage A, Hollywood.

The Todd-AO mixers also were able to sweeten the pre-dub directly from the other discrete tracks; for example, should Jagger's vocal or an instrument solo need punching through. This was anticipated by Clearmountain. "I kept the vocal and the featured instruments back just a little bit," he explains, "knowing that if they wanted to, they

could still keep my five-channel mix up, and just add one or two of the other tracks. It would be a lot easier to make something louder, rather than softer, because otherwise they would have to use an alternate mix from all the individual tracks."

Clearmountain utilized a Solid State Logic 48-channel automated console, and an Audio Kinetics Q-Lock 3.10 linking his two Studer A800 24-tracks to the VCR. "It worked flawlessly, real well. The only problem was a very minor one, and that is that the SSL computer — which is floppy-disk based — runs off the 30 FPS timecode, and it wants to run the tape machines. Now if it has to cue up to the top of the mix, it just cues the audio tape. But you're slaving off the video, and it won't run the VCR. What it should do is just talk to the Q-Lock, and tell it what to do. That was the only hassle.

"The SSL console is an amazing piece of equipment. The automation controls the level and remembers everything else on the module — EQ, bus assignments, echo send; about 40 functions in all. These it displays on the video monitor, and you null each channel out manually. You can come back a week or a year later, and get your *exact* same setting."

Clearmountain sent his "Pre-dub," mixed 24-track tapes back to Regent, where, resolving to the 60 Hz pilot signal, were transferred on to 35mm three-stripe the mono mix, 30 FPS continuous timecode, and 24 FPS cut timecode. Back in Los Angeles, music editor Michael Tronick synchronized this reel of mag stock to its corresponding reel of picture, using the start marks that had been transferred before the tapes were sent to Regent. Tronick also rolled into Clearmountain's mono mix to get sync confirmation from the material itself. This reel of 35mm stock now could be put up on a playback machine at Todd-AO, and the 24-track tape would slave to

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its 30 FPS timecode. Since the 35mm dubber was linked to the film projector, the film and the 24-track tape could then be played back in perfect sync for mixing.

Re-Recording Stage

"At the time of deciding to do the re-recording from two-inch," Howard explains, "the only real objection we had from the film mixers was that the typical multitrack machine does not follow the film system backwards in sync, and film people have become accustomed to finding plot settings and equalization while going backwards to a new punch-in point. To satisfy them, we had to get a 24-track machine that could emulate a film transport. The Ampex ATR-124 was a natural for this, as it does not use a pinch wheel to drive the tape, and we were able to have it modified so that it could play backwards as well as play forwards.

"We were also able to have the Audio Kinetics Q-Lock synchronizer that we used modified. Although it would not synchronize going backwards — which later proved a little disappointing — it would determine that the film system was going backwards at real time, and direct the machine to play backwards at the same speed. Though not in sync, it was certainly better than not having the 24-track play backwards."

"The main thing that was different



Todd-AO re-recording room (left to right): chief mixer Buzz Knudsen, music mixer Don Digirolamo, and music editor Michael Tronick, with director Hal Ashby.

about it for us," says re-recording mixer Don Digirolamo, "was that the 24-track didn't quite keep up with the film system. Going backwards, it would overshoot a little bit, drop itself into play, and then, when it got to where it thought we were, it would stop. At that point, we'd hit forward and could continue what we were doing. But it was an inter-

ruption. If we went back at normal speed, it would be about a 6- or 7-second delay, but if we went back at high speed, we'd have to wait half a minute, or more. I'm told that it was a quirk of that particular hook-up, but it never did get resolved — in part because we thought it was going to be just a four-day dub."

It is interesting to note that the

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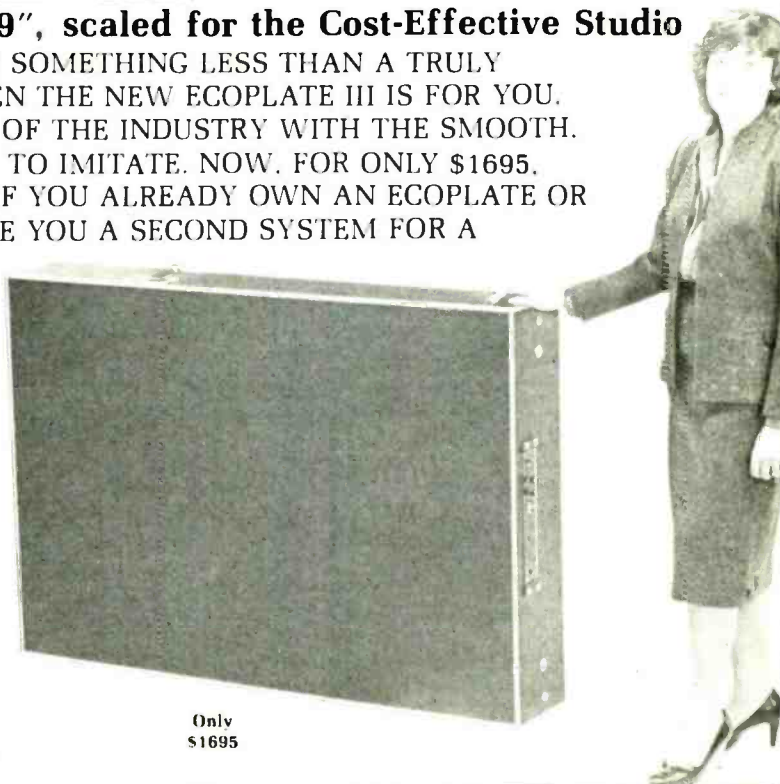
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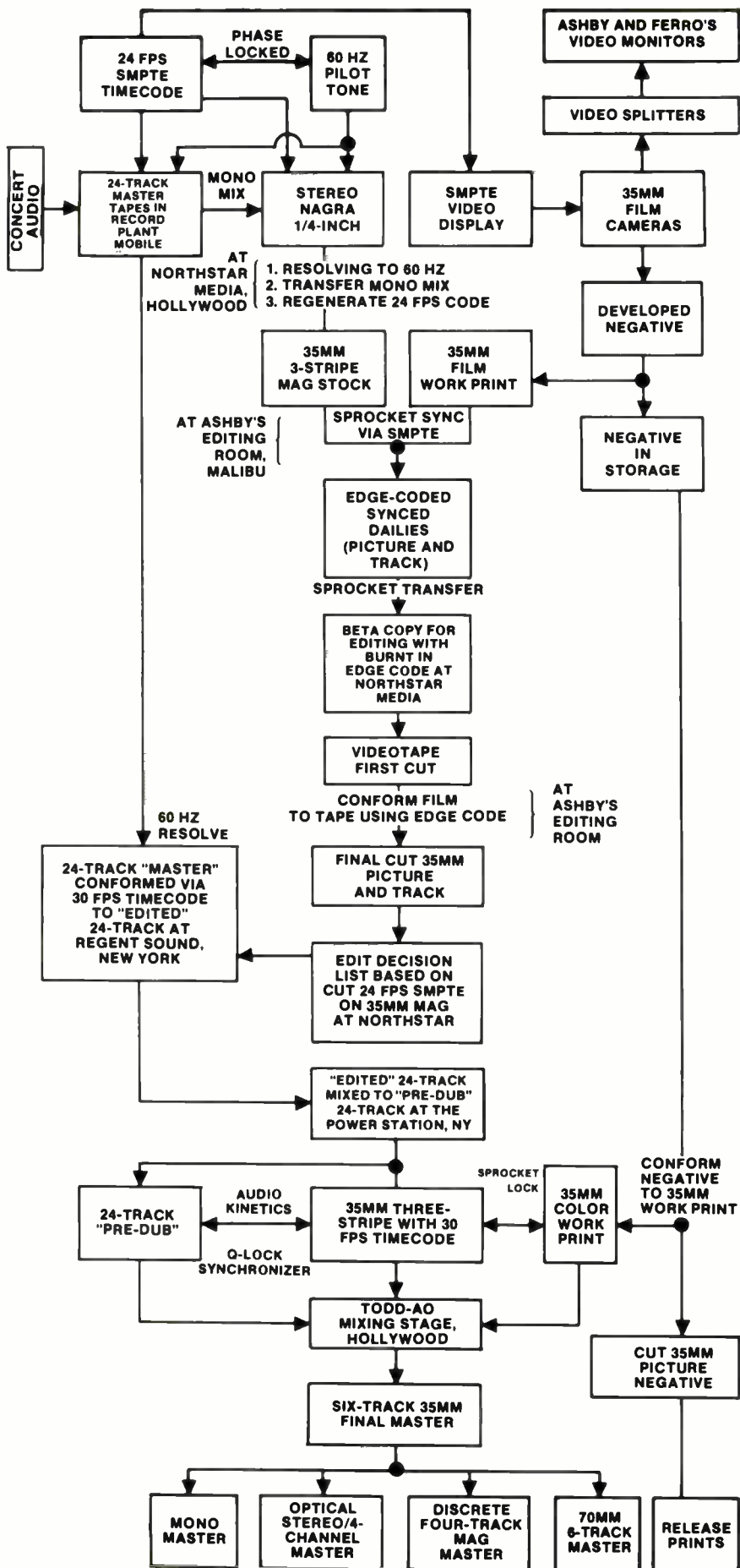
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requirements of film-score mixing are quite different from other audio situations. "When you mix a record," Digirolamo offers, "the object is to keep it all smooth, and if you want to favor an instrument here or there, you raise it a couple of dB. But the moves are all small in terms of volume change. In mixing for film, you usually have dialog and effects to contend with. So, in the middle of a great, moving piece of music, you have to lower the score unobtrusively by 8 or 10 dB so the words can be heard, and then get it back up again. The score of a dramatic piece is a player, another character, but the music in The Rolling Stones picture is not the score, it is the movie. It's the Rolling Stones.

"The balance between the instruments, the EQ, the limiting, and whatever else they wanted to do was basically done by Bob Clearmountain in New York. What I had to do was to re-EQ to play through the screen, and to rebalance it. We also ended up adding bottom-end throughout the mix. Bob's mix tended to come in with a little too little low end and a little too little of Mick's vocal. At The Power Station, his perspective of the five-channel mix was very different. In a theater, and here at Todd-AO, the five channels being mixed are 65 feet away from you with the speakers behind a movie screen. So all of Mick's vocals got sweetened.

"There was also a certain amount of bringing up someone who was featured on screen. But we didn't do any panning of musicians' tracks, because we wanted nothing on more than one channel at a time, so that we could later add the channels together to make the four-channel optical version, and so on. Otherwise we would have had to start over and 're-invent' the mix."

Sweetening and Overdubs

The audio sweetening process was facilitated by the 24-track machines. "Sprocket registration is not phase accurate," says Digirolamo. "If we'd have had, say, the five-channel pre-mix on a separate piece of 35mm mag, and all the individual tracks on separate film units, the individual instruments could not be added to the five-track mix without there being phasing difficulty. So, if we wanted to sweeten something on one of those five channels, we would have to reconstruct that entire channel from all the component parts. We would not have been able to lay more guitar over the guitar on the five-channel, for example.

"Later, after the first time the [European version of the] movie was mixed,

Mick wanted to replace the bass part and some other things on several tunes. The protection copies of the masters were shipped to Europe, and they got with Bill Wyman and overdubbed the bass."

"At the live shows," Clearmountain explains, "the drum riser that also contains the guitar amplifiers, and a good portion of the stage monitors, actually moves back and forth and turns around. Once in a while, they'd be playing, and suddenly couldn't hear anything. So, every now and then, you'd get something a little out of time."

"On 'Waiting on a Friend,'" Tronick adds, "we couldn't hear the acoustic guitar, so Mick came to The Record Plant and redid that. He didn't even do it to picture — he knew his part so well that it came up in dead sync and there was no problem."

"The only vocal he redid was the chorus on 'Twenty Flight Rock,' and the chorus on 'Time Is On My Side.' Bill Morino would lay the overdub from the safety 24-track copy on to Clearmountain's original 'pre-dub' tape."

In some instances, Clearmountain remixed his "pre-dub" to integrate the overdubs into the five-channel pre-mix, while at other times the Todd-AO crew made the changes.

"Now, since the new bass track had absolutely no phase relationship to the original recording," says Digirolamo, "we would have to recreate the channel #4 mix using all the discrete sweetener tracks, the left drums, harmony vocals, and saxophone on occasion. That *entire* right center channel would be replaced. Mick's vocal was replaced on one song, so I had to reconstruct the entire center channel on that one."

In addition to the overdubs, what would become the American release of the film underwent some picture alterations that necessitated some corresponding audio changes. "The song 'When the Whip Comes Down' was taken out," says Tronick, "and a verse was put back into 'Shattered,' and a cut was made in 'Let Me Go.'"

"There was a fair amount of additional editing done on the American version," Howard adds, "but it was not resubmitted to Regent Sound. Most of these edits were taken care of at Todd-AO, by punching in and out of the master track while adjusting the 35mm SMPTE guide track that controlled the 24-track machine."

In one instance, a song was deleted by physically cutting it out of all the 35mm material at the last minute. "For 'When the Whip Comes Down,'" Tronick says, "the picture and the 35mm work track was cut, and I had to conform the six-track mag master to that. It got to be a little hairy at four in the morning recutting the master."

This then was the last creative cut made in the picture, and it was accom-

plished in the world of sprocket holes and 35mm film after the project had come through nearly every technical format in the entertainment industry. The Rolling Stones movie encompassed the best elements of three diverse arenas: motion picture film, with its superior image and established methods of theatrical distribution; videotape, with its ease and convenience in editing and control during filming; and multitrack audio, with its numerous engineering options and flexibility, coupled with improved audio fidelity. And at the hub of the wheel was SMPTE timecode keeping all three arenas in perfect synchronization.

With the European version of the Rol-

ling Stones movie, entitled *Rocks Off*, currently playing overseas, and the American version, *Let's Spend the Night Together*, to be released in early 1983, Hal Ashby's vision of rock and roll will soon be filling screens worldwide, but there is an added event he would like to take place.

"I want to do a road show kind of thing," the director explains, "because the film has got a lot of energy in it. Everytime I screen it people come up to me afterwards and say, 'My God!', so I want to take a 70mm, six-channel stereo print and put it up where people can have some fun. I want to screen it where people can get up and dance." ■■■

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□ **TROD NOSSEL STUDIOS** (Wallingford, Connecticut) has updated its Altec 604E Big Reds with a custom-designed electronic crossover, incorporating time delay to correct for the driver offset inherent in the 604E's design. The results are said to include better frequency response, more accurate transients and greater monitoring accuracy. Also, a set of Auratone Sound Cube speakers has been added. 10 George St, P.O. Box 57, Wallingford, CT 06492. (203) 269-4465.

□ **PENNY LANE STUDIOS** (New York City) has installed a SMPTE interlock system and digital signal processor. According to Executive Engineer Alan Varner, "The Audio Kinetics Q-Lock 310, with additional specialized software, enables us to cover the full audio portion of video post-production. We can now take a project from the initial music recording through to completion, including dialog, sound effects, voice-overs, etc. This eliminates the client's need to use a separate facility for the final mix." In addition, the studio says it is the first facility in New York City to acquire the new Eventide SP2016 Digital Signal Processor, capable of producing high quality digital reverb plus various other time-related digital processing. 780 Greenwich Street, New York, NY 10014. (212) 691-7297.

□ **UNIQUE RECORDING** (New York City) has begun work on a new 8-track facility, to include a SoundWorkshop Series 30 24/24 console, Otari MX-5050B half-inch 8-track with dbx, Altec Big Red monitors, Eventide Harmonizer, Lexicon Prime Time, Studio Technologies Ecoplate, Pultec EQ, LA-4A compressor-limiters, Roland Juno 60 and Korg Polysix synthesizers, and mikes from Neumann and AKG. 701 South Avenue, New York, NY 10036. (212) 921-1711.

□ **PRESENCE STUDIOS** (East Haven, Connecticut) has added a Eumig FL-1000 cassette deck for copying duties. The studio's control room features a Live-End/Dead-End design, with Westlake HR-7 monitors powered by Hafler DH200 and Crown D150 amplifiers, and JBL 4311 and Auratone 5C Sound Cubes. According to chief engineer **Jon Russell**, **John Pehucelli** has joined the facility as audio technician. 461 Main Street, East Haven, CT 06515. (203) 467-9038.

Southeast:

□ **STRAWBERRY JAMM STUDIOS** (West Columbia, South Carolina) has installed a JBL 4435 Bi-Radial monitoring system. According to studio staff, the new system offers "extremely wide dispersion, flat power bandwidth, and highly accurate rendering of detail." Also added in the control room: a new TEAC cassette deck, and a third UREI 1176 compressor-limiter. 3964 Apian Way, West Columbia, SC 29169. (803) 356-4540.

South Central:

□ **TREASURE ISLE RECORDERS** (Nashville), owned and operated by **Fred Vail** (studio manager) and **Dave Shipley** (chief engineer), is described as the "reincarnation" of Island Recorders, a popular Nashville studio which was closed when the two partners were forced out of their leased space. Overall design of the new facility was done by Vail and Shipley, with acoustics designed by **Richard Lee and Associates**. The main room measures 42 by 30 feet, with a 23 foot ceiling, and it is enclosed in an outer concrete block shell built with non-parallel walls. The control room is a "live-" and "dead-end" type of design. Primary studio equipment includes a Trident Series 80 32/24 console, Studer A80VU 24-track and half-inch two-track machine, and a Studer B67 ¼-inch two-track deck. Main monitors feature TAD drivers and Northwest horns. Treasure Isle will soon offer the only "English-style" water-filled reverb chamber in Nashville. Outboards include a Sony digital reverb, Aphex, Audio + Design Scamp rack, and a wide assortment of limiters and compressors. Clients may choose 24-tracks of noise reduction by either dbx or Dolby. 2808 Azelea Place, Nashville, TN 37204. (615) 327-2580.



TREASURE ISLE

□ **BULLET RECORDING** (Nashville) has named **Piers Plaskitt** vice-president and director of audio operations, working extensively in audio marketing and client relations. Also, **Ted Riggs** has been promoted to vice-president and director of video operations. Nashville, TN.

□ **ROSEWOOD STUDIOS** (Tyler, Texas) has installed all MCI 24-track equipment, including a JH-636 console, JH-24 multitrack, and JH-110B mastering machines. Rosewood incorporates LEDE design control room, and 3,000 square foot studio facility, according to president **Tim Gillespie**. 2214 W. Erwin Street, Tyler, TX 75702. (214) 595-3763.

Mid-West:

□ **RIVER CITY STUDIOS** (Grand Rapids, Michigan) has completed a new and expanded multi-studio complex. Studio A offers large room, hard-surface acoustics for larger orchestral productions, and features an expanded Auditronics 501 console coupled to an MCI JH-24 multitrack with Autolocator III. Studio B features a low, natural reverberation soundstage for voice-overs and synthesized music production, and offers a second Auditronics 501 linked to Ampex MM-1000 multitrack. The two studios are interfaced with 16 tie lines for concurrent use of outboard gear, and for increased input capabilities. 129-B E. Fulton, Grand Rapids, MI 49503. (616) 456-1404.

□ **ECHO HILL RECORDING STUDIOS** (Cleveland, Ohio) has installed a Panasonic RAMSA console, Otari MX-5050 eight-track, and a Studer/Revox stereo half-track mastering machine. Owner **Eric Robertson** reports that the facility's acoustic design also has been upgraded, with the addition of both absorptive and reflective elements in both the control room and recording area, which have "helped smooth out the sound considerably." Assisting in the project were **Tom Arko** and **John Perousek** of Eighth Day Sound, Cleveland. 8184 Garfield Road, Mentor, OH 44060. (216) 255-6884.

□ **RITE RECORD PRODUCTIONS AND CONNECTION PRODUCTIONS** (Cincinnati, Ohio) has upgraded from 16- to 24-track with a new MCI JH-24 24-track, complete with Autolocator III. Other recent purchases include four AKG C414EB mikes. Extensive modifications to the facility's MCI board include additional modules and improved op-amps. 9745 Mangham Drive, Cincinnati, OH 45215. (513) 733-5533.

□ **SWEETWATER SOUND RECORDING STUDIO** (Fort Wayne, Indiana) has remodelled and upgraded its facilities, and added **Dick Swary** to its staff. Featured equipment includes a Tascam Model 85-16 16-track and customized Model 15 console, Electro-Voice Sentry 500 studio monitors, and Otari MX-5050-B2 half-track. The studio also utilizes an assortment of musical instruments, including a Yamaha Grand Piano, Oberheim OBSX Polyphonic Synthesizer, Fender Jazz Bass, and Twin Reverb amp, according to owner **Chuck Surack**. 2350 Getz Road, Fort Wayne, IN 46804. (219) 432-8176.

□ **TRACK RECORD STUDIOS** (Minneapolis, Minnesota) is a recently completed 8-track facility featuring an Auditronics 16/8 console, Tascam Model 38 8-track, Model 32 2-track, Model 3440 4-track, and Model 22-2 2-track, and TEAC A-2300SD ¼-track tape machines. Monitors are JBL 4312 units powered by Fisher amps. Outboards include a DeltaLab digital delay, Fostex digital delay, Intersound PRV-1, Bi-amp and MXR compressors, Omnicraft GT-4 noise gates, MXR, Furman, and DOD equalizers, and mikes by Shure, Audio-Technica, and Electro-Voice. Studio A (279 square feet) was built to be a "live" room with variable acoustics. There are curtains for some walls, and carpets for the floors, that can be in or out as needed. Both hard and soft gobos are available. The

TRACK RECORD



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System 8156
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Loudspeaker
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65 Hz (-3 dB)

System 8256
Two 15" High Performance
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STUDIO FACILITIES EQUIPMENT PEOPLE UPDATE

room also houses a special drum area and vocal isolation booth. Studio B (323 square feet) is a "dead" room with carpet permanently installed, an uneven ceiling, and up-parallel walls. Major equipment selection, says owners **Norton Lawellin** and "**Red**" **Freeberg**, was made with **Jon Bormann**, AVC Minneapolis. 13912 Thomas Ave. So., Minneapolis, MN 55337. (612) 890-1075.



ROSEWOOD RECORDING

Mountain States:

□ **ROSEWOOD RECORDING COMPANY** (Provo, Utah) has upgraded from 16 to 24 tracks with the addition of an MCI JH-114 multitrack. Other recent acquisitions include a pair of E-V Sentry 500 monitors with Hafler power amps, and a couple of DeltaLab digital delays, according to owner **Guy Randle**. 2288 W. 300 N. Provo, UT 84601. (801) 375-5764.

Southern California:

□ **SALTY DOG RECORDING** (Van Nuys) has added a 3M half-inch two-track with Saki Heads. According to owner **David Coe**, "This deck offers a better sounding top-end than the digital units that are currently available. It also lends itself to half-speed mastering, which digital does not." 14511 Delano, Van Nuys, CA 91411. (213) 994-9973.

Northern California:

□ **HYDE STREET STUDIOS** (San Francisco) has added API compressors in Studio A, and Valley People Kepex noise gates in Studio C. Also, the facility's four acoustic echo chambers have been revamped with new speakers and mikes. Other recent upgrades include an Eventide SP2016 Digital Reverb, an Otari MX-5050B2 two-track, and a transformerless Otari MTR-90 24-track for Studio D. 245 Hyde St., San Francisco, CA 94102. (415) 441-8934.

□ **RHYTHMIC RIVER PRODUCTIONS** (San Francisco) has added UREI Time-aligned monitors, an Audio + Design Scamp rack, and several ADR compressor-limiters. 250 Napoleon Street, San Francisco, CA 94124. (415) 285-2248.

□ **PACIFIC MOBILE RECORDERS** (Sacramento) has unveiled its new 24-track remote recording facility. Equipment permanently installed in the 18-foot mobile includes an Otari MTR-90 24-track, custom Tangent 3216 console, JBL monitors, a wide assortment of mikes and outboard gear, plus video monitoring. 2616 Garfield Avenue, Carmichael, CA 95608. (916) 483-2340.

□ **BEAR WEST STUDIOS** (San Francisco) has promoted engineer **Larry Kronen** as studio manager, to succeed owner **Ross J. Winetsky**. Also, handling traffic at the studio is **Susie Davis**. Bear West recently purchased an MCI 24-track for Studio A, new microphones, and more outboard gear. 915 Howard Street, San Francisco, CA 94103. (415) 543-2125.

Canadian Activity:

□ **SOUNDS INTERCHANGE** (Toronto) is remodeling its Studio 1 facility, with **Chips Davis** of LEDE Designs retained to design and supervise the construction of Live-End/Dead-End control room, along with an extensive renovation of the studio. **Neil Muncy**, of Neil Muncy Associates, has been commissioned to design and supervise the technical aspects of the installation. An MCI JH-532C automated console will be installed in the completed control room, along with a newly developed quintamplified, phase-coherent, four-way monitor loudspeaker system designed by **Claude Fortier**, of State of The Art Elektronik, Ottawa, Canada. The completed facility will permit double 24-track operation with SMPTE timecode interlock, video post-production, scoring to video, etc. Tape machines available will include MCI and Studer multitracks, and Ampex and Studer ¼- thru 1-inch machines. The console will be capable of simultaneously handling up to 48 inputs via a premix system developed by Muncy. A completely patchable 24-channel Dolby system, along with an extensive selection of outboard equipment, is also scheduled to be installed. 506 Adelaide Street E, Toronto, Ontario M5A 1N6.

AUDIO/VIDEO UPDATE

Eastern Activity:

□ **A&J RECORDING STUDIOS** (New York City) has unveiled a new ATC Research Real-Time Audio for Video Post-production Facility, used recently to create soundtracks for two Minolta video productions. At the heart of the new system, developed by A&J's **Gerald Kornbluth**, and **Irving Robbin**, is a bank of NAB broadcast cartridge machines, used to replay the voice, effects and music tracks against video. The audio sequence also can be controlled via SMPTE timecode locations to designate start points. According to **Dan Davenport**, producer for the Minolta pieces, "We saved many hours of tedious layup time over conventional sweetening approaches by utilizing this new system to create the complete soundtrack for these 20-minute productions." According to **Bernie Rubinstein** of A&J Recording, "The system's ability to audition, rehearse, layup and mix in real time allows producers to concentrate their time and budget on creative decisions." Audio sound elements are built up on eight-track, and then remixed to stereo for subsequent layback to the videotape. 225 W 57th Street, New York, NY 10019. (212) 247-4860.

□ **NATIONAL VIDEO** (New York City) has acquired a Lexicon 1200B Time Compressor/Expander/Controller. In addition to enabling clients to speed up (tighten) overlong programming, or to slow down (expand) material to fit specific time frames — all without loss of definition or bandwidth — the Lexicon 1200B can be used as a stand-alone audio processing unit, or in conjunction with video. The Model 1200B also is adaptable to both stereo and mono recording and mixing projects. New York, NY.

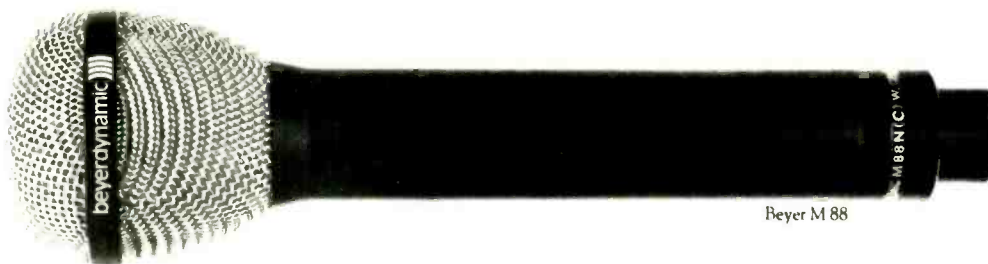
Central Activity:

□ **OMEGA AUDIO** (Dallas, Texas) recently provided its mobile vehicle to record a PBS Christmas Special aired nationwide in stereo, featuring the Concert Chorale of Houston, and the Texas Chamber Orchestra in a live performance of Handel's *Messiah*. Having recorded the show 24-track with SMPTE timecode, the show then was mixed to picture and sweetened in stereo at Omega's facility. Dbx noise reduction was utilized in the original recording, and Video Post & Transfer edited the show in stereo utilizing Dolby "A" noise reduction. The copy of the show released to PBS was third generation, with Dolby all through the editing process. Audio Engineers on the project were **Paul Christensen**, **Bob Singleton**, **Mike Eckstrom**, **Ken Paul**, **Marvin Hlavenka**, and **David Buell**. 8036 Aviation Place, Box 71, Dallas, TX 75235. (214) 350-9066.

Western Activity:

□ **ONE PASS FILM AND VIDEO** (San Francisco) recently taped a music-video of **Missing Persons** at San Francisco's Fox Warfield Theatre, using four Ikegami HL-79 and one HK-357 cameras, a Grass Valley 1600-3C switcher, two iso switchers, two Ampex VPR-2B one-inch machines, and two Sony BVH one-inch machines. **Ken Scott** of Missing Persons mixed sound using the Guerilla Audio truck, with two 24-track machines. Post-production was completed at One Pass by **Norm Miller** and **Bud Ryerson**, in the CMX 340 editing suite, for Keefco Productions; **John Weaver**, producer, and **Keith MacMillan** director. One China Basin Building, San Francisco, CA 94107. (415) 777-5777.

Why Beyer microphones give you more extraordinary performance for the most ordinary applications.



Beyer M 88



Beyer M 201



Beyer M 160

There are other microphone alternatives when high sound pressure is a factor.



As Sennheiser claims, the MD 421 undoubtedly stands up to extremely high decibel levels and has other features that have contributed to its popularity. But if you're already using the MD 421 to mike loud instruments or voices, we suggest that you investigate the Beyer M 88.

The Beyer Dynamic M 88's frequency response (30 to 20,000 Hz) enhances your ability to capture the true personality (including exaggerated transients) of bass drums, amplified instruments and self-indulgent lead vocalists.

The Beyer M 88 features a matte black, chromium-plated brass case for the ultimate in structural integrity. Beyer microphones are designed for specific recording and sound reinforcement applications.

When you need a rugged and versatile microphone, consider the alternatives.



For over 10 years, engineers have used mics like Shure's SM57 for the widest variety of applications in the studio. And we feel that one of the main reasons more engineers don't use the Beyer M 201 in this context is simply because they don't know about it. Those who have tried it in the full gamut of recording situations have discovered how it can distinguish itself when miking anything from vocals to acoustic guitar to tom toms.

The M 201's Hyper-Cardioid pattern means that you get focussed, accurate reproduction. Its wide and smooth frequency response (40 to 18,000 Hz) provides excellent definition for the greatest number of possible recording and sound reinforcement situations.

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Some engineers prefer condenser microphones like the AKG C 414 to accurately capture the subtle nuances of a violin or acoustic piano. But should you have to deal with the complexity of a condenser system every time this kind of situation comes up?

The Beyer Dynamic M 160 features a double-ribbon element for the unique transparency of sound image that ribbon mics are known for. While its performance is comparable to the finest condenser microphones, the M 160's compact size and ingenious design offers significant practical advantages for critical applications.

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The Dynamic Decision

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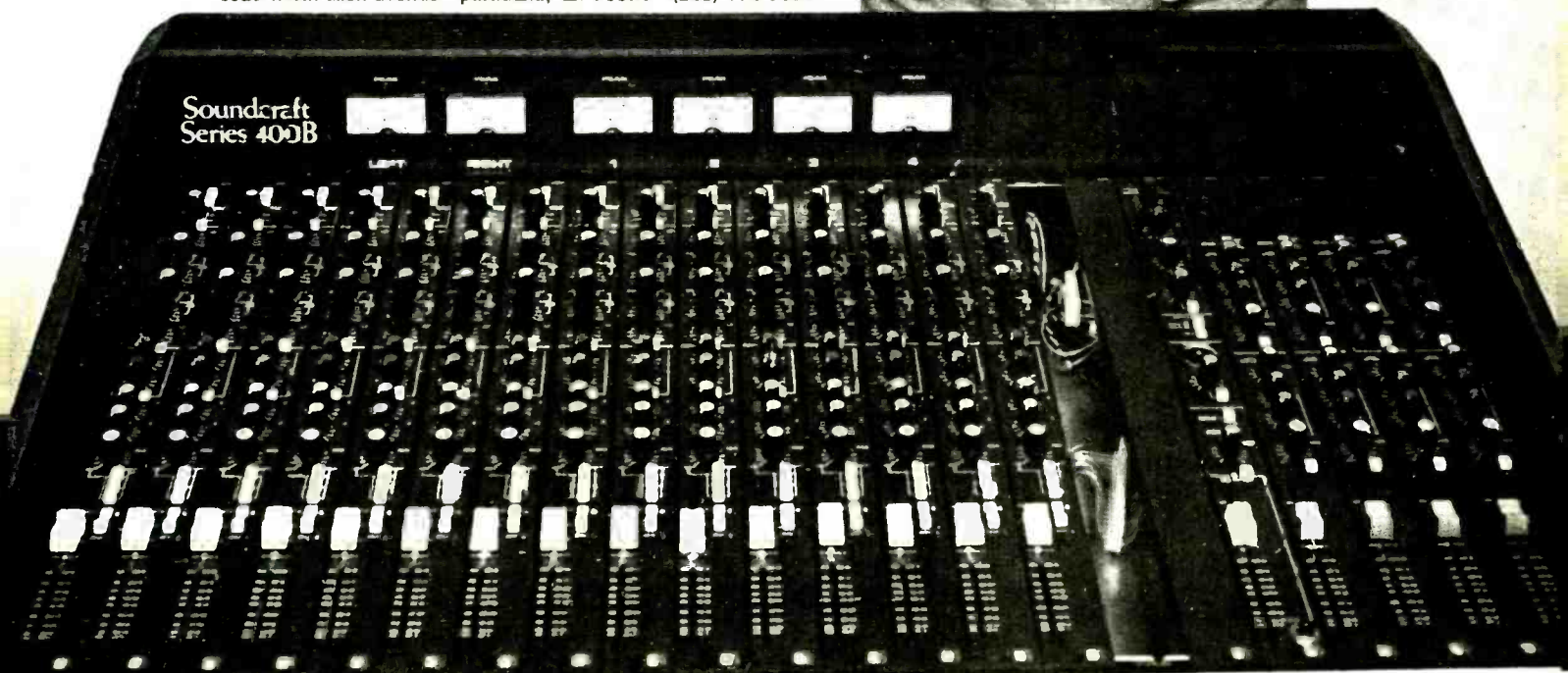
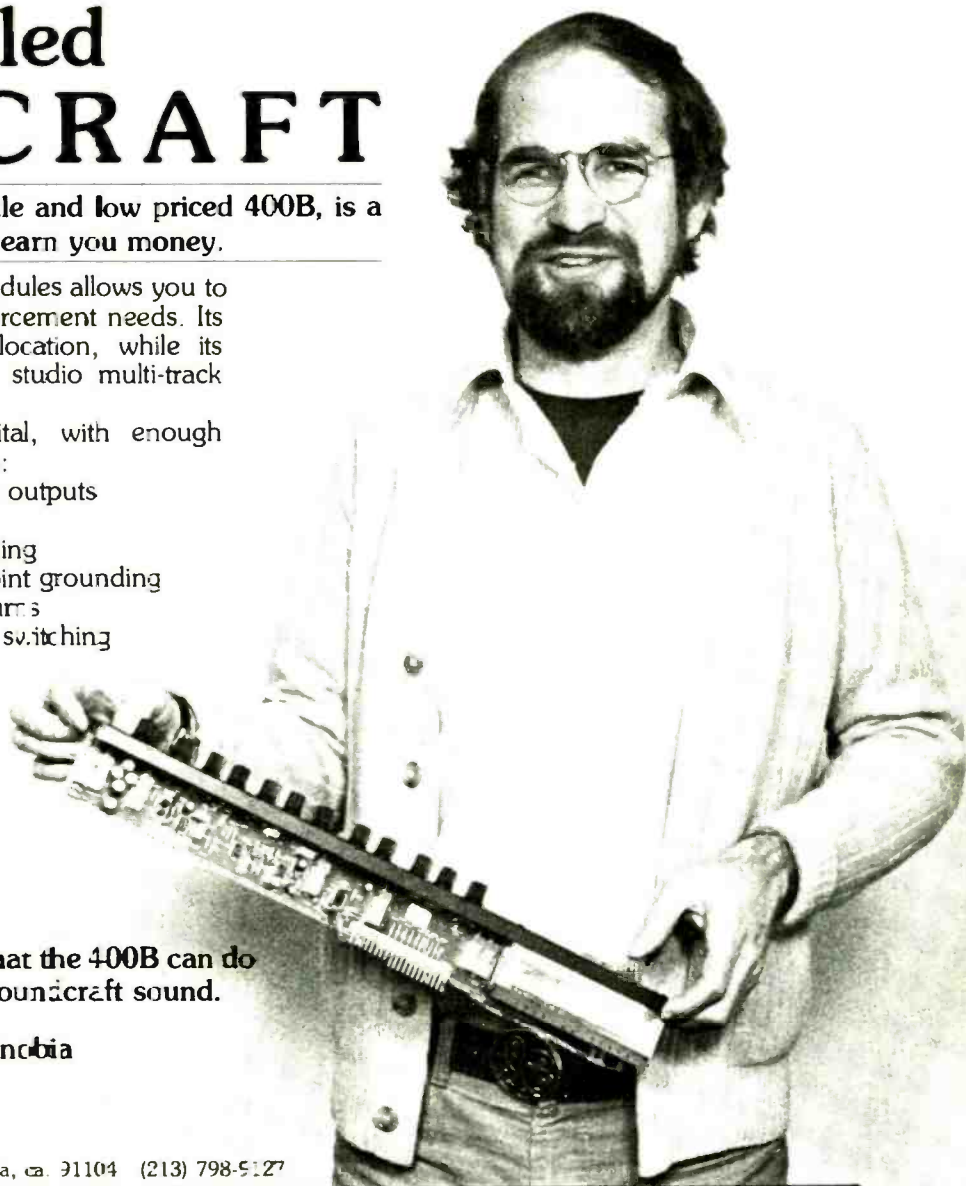
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ON THE STUDIO TRAIL

Mel Lambert at Large this month In . . . BOSTON



SYNCRO SOUND Isolation Room

A couple of spare days after my recent visit to New York provided an opportunity to check out several of Boston's varied studios. Given the high concentration of local musicians and music students, it's maybe not so surprising that such a variety of track formats and specialties exist in this New England city. The studios I managed to look over during my Boston visit included **Euphoria Studios**, **Sound Techniques**, **Downtown Recorders**, and **The Cars' Syncro Sound Studios**.

Euphoria is an eight-track studio, made up of a spacious recording area linked to a well-stocked control room. A pair of eight-input Tascam Model 5 four-group boards are ganged to provide an eight-in/stereo monitor section, while an Otari MX-5050 MkIII half-inch eight-track with dbx noise reduction handles multitrack duties.

According to chief engineer Gordon Hookailo, 70% of his sessions are for demos, around 30% for album and singles releases, plus the occasional commercial, jingle, and audio/video soundtrack. He considers that the primary requirement during demo sessions is a mixture of "psychology and diplomacy," plus technical expertise. As he puts it, "In this business you have to spend the majority of your time making the band members feel as comfortable as possible in the studio."

The key to achieving good results from eight-track, Hookailo offers, is to work out *before* the session gets under way how the song will be built up, the overdubs required, and how the tracks will be assigned in the mix. Since several instruments eventually will be sharing the same track, EQ changes during mixdown may present problems.

Regarding the question of upgrading to 16-track — a logical progression, one might assume, especially in light of Euphoria's average occupancy of around 65% of available session time — Hookailo feels that, for him, such a move would not be cost effective. "The studio is doing okay at the moment," he conceded, "but if we went 16-track it would cost around \$40,000. But what about the rates we would then need to charge?" Euphoria currently rents for \$25 per hour for 8-track; because of fierce com-

EUPHORIA/Gordon Hookailo



petition from other local studios, to remain competitive he could only charge around \$35 for 16-track. Considering the amount of investment needed to gain an extra \$10 an hour, "that's a good way of going out of business," Hookailo concludes.

One Boston studio that made a successful transition from eight-track on half-inch to Tascam 16-track/one-inch in 1980 is Sound Techniques, although until mid-1981 the facility continued to offer both formats. "We still had a 'brisk' eight-track business," says owner Leon Janikian, "but couldn't tell which of our regular clients would make the transition to 16-track. By 1981 around 60% of our sessions were on 16-track, so we decided to drop the 8-track side. Also, because there was only a \$15.00 difference in the hourly rates, we ended up competing with ourselves for work!"

Apart from the economics involved, Janikian and his chief engineer, Jim Anderson, had several reasons for upgrading to 16-track. "We were starting to lose clients to some of the bigger studios," Janikian recalls, "and we wanted to move into 'big-time' productions. Also, we were tired of having to make sacrifices in terms of quality, and wanted to work with less trackbouncing. Around 60% of our work now is for music sessions — split 50:50 between demos and records — plus 20% jingles, and 20% audio-video soundtracks. We've done a great number of single and EP sessions — destined for limited, 1,000- to 2,500-copy runs — but it's mainly been Jazz, 'ethnic,' and folk music albums. We want Sound Techniques to be a *music* studio, not just for rock and roll."

"We try to emphasize our personal concern with each session," Anderson adds. "We want the client to leave here with a good tape. A satisfied client will return to us, or spread the good word along about us. Equipment is only *part* of why people use a particular studio; 'feel,' 'mood,' and all the rest are more important."

Downtown Recorders has made its home in, of all things, an old orchid storeroom. Four of the rooms off a central lobby turned recording area now serve as iso booths; two of them feature the original refrigerator doors which, being well insulated, were retained for added sound isolation. Owner Mitch Benoff describes his facility as being a "live and bright studio, with a good ambient sound — the sound that is coming back into favor."

Control room hardware centers around a Tangent 32/16 console mated with an MCI JH-16 16-track with optional dbx, and an Otari MX-5050 two-track. Benoff says that, because of his 16-track on two-inch format, Downtown attracts a lot of local high-quality demo and private-label sessions. Music demos account for between 15 and 30 hours



DOWNTOWN/Mitch Benoff

a week, and recording budgets for single and EP dates range from \$500 to \$2,000 in studio time (albums for up to \$10,000); studio rates are \$35 per hour, including an engineer. The facility's reputation, he considers, is based on the sound of the room, and a professional attitude to recording.

The Car's MCI-equipped, 24-track Syncro Sound Studios, in the building formerly occupied by Intermedia, comprises a single control room and two recording areas connected via tie lines and video monitoring. The facility opened in late 1981, after extensive rebuilding and acoustic treatment.

The main studio area, redesigned as a cooperative effort between John Storyk and band producer Roy Thomas Baker, plus a lot of creative input from members of The Cars, features a mixture of live acoustic treatment on the walls, and carpeting — the idea being, says band engineer Thom Moore, "to make the room as live as possible is as small a space as possible." Off the rear of the main studio is a new isolation room designed for recording drums, and to provide ambience for backline cabinets, etc.

Moore tells me that the studio was built primarily for use by band members — Rik Ocasek recently completed his first solo album for Geffen at Syncro — but that it will be made available for other artists on an "as-available" basis. At the time of my visit, the booking schedule was running 50% for Cars' projects, 30-40% for local bands, and the remainder for label demos, and pre-production sessions.

Considering the closeness of Boston to New York City, with its wide variety of 24-track "state-of-the-art" studios, it is not too surprising that the majority of Boston studios have concentrated on the eight- and 16-track budget and demo markets. From all appearances, there would seem to be plenty of studios in the area that can accommodate just about every track format and recording budget that a band or artist might be contemplating. Certainly, the local studio community is very tightly knit, and communication between small and large alike is usually on a very candid and relaxed level.

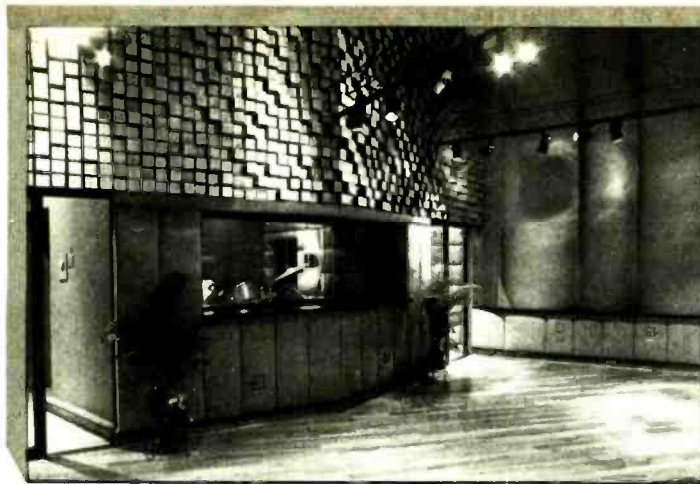
Next issue . . . LOS ANGELES. ■■■

SOUND TECHNIQUES/Leon Janikian (left) and Jim Anderson



STUDIO DESIGN & CONSTRUCTION

CRESCENDO AUDIO PRODUCTIONS, PUERTO RICO



"Operating a studio in Puerto Rico is very similar to anywhere else," remarks Alan Manger, VP Engineering for Crescendo Audio Productions. Manger served as the on-site supervisor of all design, construction, marketing game-plan, and equipment acquisition for the studio since the project was begun last year. "The pace here is a little slower than New York, for example," he offers, "but we are running a professional operation by anyone's standards. We're efficient, we don't waste the client's time, and we charge accordingly.

"The only difference here is that we need more spares, and we have to have relationships with people in the States to get equipment and supplies back and forth quickly. Other than that there is really no difference — this is a *big* city. It's not as if we were in, say, Montserrat, where you depend on block booking for all of your business."

Crescendo is located in the shell of a huge old movie house in Puerto Nuevo, a suburb of San Juan. The surrounding streets are full of colorful Spanish architecture, and the lush foliage typical of the tropics. Minutes away are freeways linking the business districts, and modern skyscrapers and hotels of the island's capital. San Juan is the second oldest city in the Western Hemisphere, and parts of the city have homes and fortresses dating back to the 16th Century.

Alan Manger has been an engineer for 20 years. He started his career in New York, where he managed various operations and started Good Vibrations Studio in the Sixties. Manger has produced numerous artists, and was in charge of all recording for Richie Havens' Stormy Weather label. He also has handled audio for film and commercial projects, and worked as a film editor for years, eventually becoming an independent filmmaker. His background, he offers, has educated him in all the uses

A Multifunction Audio Facility for Video and Film Featuring Live-End/Dead-End Acoustic Design

by David Gordon

of sound for media. "I have never looked at film and music as separate things — they were always related," he reflects.

Audio for Records, Video, and Film

As a facility structured to serve the recording industry as well as the film and television industries, Crescendo is considered unique on the island. Manger first researched the possibilities of a world-class studio in Puerto Rico after working with Jerry Masucci, president of Fania Records, and known as "King of Salsa." Masucci decided against building a studio when he discovered that Brooke Cadwallader, a musician/financer friend, already was planning one. Manger teamed up with Cadwallader, and the decision to create a multipurpose facility was made.

Brooke Cadwallader was born in the Philippines of Spanish and American

parents, and trained in classical music as a child. He worked professionally in big bands as bass player and arranger, and early on had the dream of building a studio and producing music. Feeling that music was, at best, a risky business, Cadwallader studied economics at the University of Arizona, where he earned a Masters degree. He later formed an international economic consulting firm, called Criterion, Inc., which was more than successful enough to finance Crescendo. This year he sold out his last shares in Criterion, and has put all his energies into the new facility.

Why Puerto Rico, many observers must have pondered at the time of Cadwallader and Masucci's decision to build Crescendo?

"I used to come here for business trips," explains Cadwallader. "I wanted a place that had good weather, and would be attractive all year round. I also



Photography by Oris George

Live-End/Dead-End™ is a trademark of Synergetic Audio Concepts, San Juan Capistrano, California.

"The Electro-Voice Sentry® 500 is a monitor by design."

Greg Silsby talks about the New Sentry® 500 studio monitor...

Everyone expects a studio monitor system to provide a means of quality control over audio in production.

True, other audio test equipment can supply you with valuable data. But that data by itself is incomplete and only displayed in visual form.

Only a true studio monitor speaker system can deliver an accurate indication of audio quality in... audio! After all, this is the language of the trained ear and doesn't require a complex interpretation process.

I believe the Electro-Voice Sentry 500 Studio Monitor System will meet your every expectation.

What's a "studio monitor?"

The term "studio monitor" is often a misnomer. It's easy to tack a label on a box and call it a "studio monitor" without including the best precision engineering available, and careful attention to application design. Too often, these all-important considerations are traded-off for such marketing reasons as high cosmetic appeal, a particular type of popular sound, and low component manufacturing cost. While all of this may translate into high profit margins for the manufacturer it does nothing to produce a reliable standard for audio testing and evaluation.

Linear frequency response

The Sentry 500 follows the well-established Electro-Voice tradition of combining the most advanced engineering and manufacturing technology available. The Sentry 500 has been carefully thought-out and built to meet the specific needs of the audio professional. Like the smaller Sentry 100A, the Sentry 500 provides linear response throughout its range (40-18,000 Hz \pm 3dB). In fact, because the two systems share this linearity, program material may be mixed on one, sweetened on the other, with



complete confidence in quality. Acoustic "Time Coherence" (the synchronous arrival of acoustic wave fronts from both high and low-frequency drivers) has been maintained through careful crossover design and driver positioning.

Constant Directivity

The Sentry 500 is a Constant Directivity System, benefitting from years of E-V experience in the design and application of constant directivity devices. Utilizing a unique E-V-exclusive high-frequency "Director", the Sentry 500 provides essentially uniform coverage over a 110° angle from 250 Hz on up to 10 kHz and 60° dispersion from 10 kHz clear out to 18,000 Hz! And it does this on both the vertical and horizontal axes. This means the "sweet spot", once a tightly restricted area large enough for only one set of ears, has been broadened to allow accurate monitoring by the engineer, producer, and talent—all at the same time. That's what we call Constant Directivity.

A monitor by design

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For additional information circle #52

February 1983 □ R-e/p 83

wanted a place where the studio competition was not as strong as in Dallas, the city where I have been living. Thirdly, I couldn't help but find the tax advantages attractive." (The Economic Development Administration of Puerto Rico has instituted programs to promote business ventures which benefit the island's economy, and Crescendo receives sizeable tax exemptions.)

In preparation for working on the acoustic design of Crescendo, Manger attended a seminar given by Synergetic Audio Concepts. Chips Davis, well known for developing the LEDE™ design, was being considered for Crescendo's acoustic design and, after a field trip to Northern California's Tres Virgos studio [see feature article in the December 1982 issue —Ed.], the final decision to go with Davis was made.

Studio Construction

The old movie house destined to become Crescendo Audio Productions was completely gutted, the roof removed, and the foundation bulldozed. After digging beneath the sloping floor of the old theater, it was discovered that some "funny" construction had taken place in the past, and it was necessary to go deeper and start from scratch. As many as 100 workers were employed at various stages during the reconstruction. "It looked like a bomb had gone off in the building when I got here," comments Davis.

Alan Manger devised the basic overall layout for the audio complex, with provisions for two large studios ("A" and "B"), plus a separate film mixing and dubbing theater ("C"). All recording areas and control rooms have isolated foundations. Following construction of the outer concrete walls, Davis designed and supervised the interior acoustic construction.

Studio A's recording area can only be described as mammoth; the ceiling, for example, is sloped from 18 feet to a height of 22 feet. Inside the interior walls are 2 by 6 studding packed with R19 high density, six-inch thick fiberglass. Surfaces vary between absorptive and reflective, the hard panels being 4 by 8 sheets of high-density industrial particle board, with a finished coat of vinyl paint. The control room juts into the studio proper with a subtle wedge

Control Room A from Studio Area



that eliminates parallel surfaces. Opposite the control room and above the drum booth is a wall covered with cross section cut blocks of 4 by 4, which provide a reflective surface with random diffusion.

Each wall area is treated separately, with variations in mass, stud spacing, and surface used to create what Davis considers to be "a very natural sounding room. I tried to make the room as pleasing to musicians as possible." Davis began his audio career as a musician, and then as a technical director and mixer for live performances. His extensive experience with orchestras and large concert halls provided him the necessary background for this type of work, he considers, as well as the specialized design of professional control rooms.

One entire wall of the studio is composed of polycylinders, in three different diameters, and stretching from floor to ceiling. The columns are tuned to work with the natural modal tendencies of the room, and act to prevent "bass frequencies from rumbling around and creating problems with such instruments as kettle drums, and others in the bass



Gutting studio shell during rebuilding

region," Davis offers. "They also become a diffuser for frequencies above certain wavelengths."

The studio's ceiling is covered with white porous vinyl material. Hidden above are random diffusion items, including inverted plastic skylights, creating a diffused field. The floor is hardwood, with carpets available for deadening, if desired. Further deadening of the room's acoustics can be achieved easily with a supply of gobos and camouflaged velcro tabs on the walls for the placement of Sonex acoustic foam panels. "Rather than resorting to the immense expense of acoustic louvers," adds Davis, "I would rather save that money for use elsewhere, and use Sonex for flexible deadening."

Time elements characterizing the movement of sound energy and reflections are crucial to the overall picture that Davis devises while planning a room, a factor which is at the heart of the LEDE concept. The studio proper is designed to work naturally with the volume, and the arrangement of walls.

"You have to start with the natural modal frequency response," continues



Wall studding for Control Room A

Davis, "and what will happen naturally in the room. For example, if an organ pipe is a certain width and length it will have a natural fundamental frequency. The resonance when you sing in the shower is a natural mode of the space you are in, where certain frequencies tend to sustain. You really have to start with what Mother Nature gives us, and progress from there."

Studio A also features two isolation rooms that offer "medium-dead" acoustics, with provisions for further deadening, and a drum booth with an isolated foundation. A separate large isolation room is designed for the recording of stringed instruments, and has clear visibility through a side window to the control room. A mirror livens the room's acoustics, and improves sightlines for the engineer. Again, polycylinders act as diffusers of sound, and also absorb at certain frequencies.

Crescendo is considered by many to represent not only a well designed building with a carefully researched business prospectus, but one that has the finer aesthetic touches to make working in Puerto Rico as comfortable as in any of the world's top studios. The island's leading interior designer, Jaime Cobas, was chosen to handle custom furnishings and decor. Three lighting trusses span Studio A, each of which handles four circuits and a broad selection of mood lighting controlled by means of a panel of 12 dimmers. Lighting in all areas can be varied from subtle, intimate mood lighting, to bright, orchestral requirements.

Finding construction workers, plumbers, electricians, and various subcontractors proved no problem in a city of one million inhabitants, but Manger was unable to find quality carpenters for finished woodworking. A versatile and resourceful supervisor, he wandered around the city's waterfront and discovered woodworkers experienced in carpentry for the island's boating industry. These he hired to put the final touches to the studio's custom cabinetry, producer's desks, framing, and doorways.

Control Room Layout

Built within the asymmetrical outer walls of Studio A's control room is a perfectly symmetrical inner shell. As

— continued on page 88 ...

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dictated by the LEDE design, the area of the room from the speakers to the console is deadened with absorptive materials, and covered with acoustically transparent cloth. The back of the room is surfaced with high density industrial particle board, each 4 by 8 sheet weighing over 100 pounds. USG acoustic sealant is used to provide an air-tight fit between the panels. Also, no nails were utilized during construction of the studio complex — everything is screwed and glued.

Davis made use of a prototype Time-Energy-Frequency computer to analyze and perfect the acoustic principles utilized in the control room. Capable of producing three-dimensional contours of frequency-time curves, and analyzing energy-density-time correlations, the new unit produces a graphic output of what is happening acoustically, and also can be used to analyze the electronics of a console or power amplifier. By studying the smoothness and distribution of the relevant curves, the designer can predict how the paper design will work in practical construction.

According to Davis, for example, two signals separated by approximately less than 20 milliseconds cannot be discerned as being distinct sounds by the brain. By avoiding cancellations from early reflections, and by keeping within the 20 millisecond boundaries, it is possible to cause reflections that retrigger the non-recognition aspect of human hearing, and theoretically cause the walls of the control room to disappear.

"It's essentially like mixing outdoors," comments Davis. "I am doing more than just making the front surface soft, and the back hard. A completely dead room would cause phasing. The back wall is made hard and diffused to fill in so that doesn't happen. We are controlling the energy density of certain time elements being reflected from certain angles. The most I have achieved in not being able to hear reflections is approximately 30 to 35 milliseconds. If we take away the early reflections in the front, and then make the brain say, 'I don't want to hear anything more for a certain time period,' the illusion of a much larger room is created. What we are trying to do is *remove* the room."

By working with angles and the time elements of reflections, and strategically focusing the sound around the console, the effect is a widening of the

Control Room C . . .



perceived stereo image. An engineer still has the perfect seat in the house, but a producer listening off-axis hears a balanced resultant of the stereo image.

"This room employs the latest research I have done using these time elements," Davis continues. "As a test, I took eight inches of absorptive material and put it on the console. There was very little difference in my frequency domain analysis with it on or off. The difference would be a dB, or a dB and a half in a couple of areas, but all very smooth — nothing drastic."

The console in Studio A is a 28-input, automated MCI JH-528B that was modified to be transformerless. For scoring sessions, the studio utilizes Sony BVU-200 3/4-inch U-Matic videotape recorders, with playback via monitors and large-screen video projection. An MCI JH-45 Auto-lock is used for timecode synchronization with the multitrack. When scoring for film, as opposed to video, film is transferred to video before the session.

Monitoring is handled by UREI 813s, with an identical pair in the recording area. Power amps are Crown 600s with the recently introduced Delta/Omega



. . . Studio B . . .

module. Monitor amps, cue amps, and power supplies for the entire facility are housed in a special amplifier room. Electrical power enters the building and is fed into three separate isolation transformers that maintain 110 volts, regardless of local power fluctuations. In the event of severe power failures, the transformers shut themselves down automatically, and must be reset manually. Each supply works separately, and power can be switched from any amp to any studio.

The control room outboards rack includes an Eventide H949 Harmonizer, Valley People Kepex II gates and Gain Brain II compressor-limiters, Ashly SC-68 notch filter, dbx compressor/limiters, Valley People Dyna-Mite 410 two-channel limiter/gate, DeltaLab DL-2 Acousticcomputer digital effects unit, Audio Arts Model 1500 tuneable notch filter and 4200A parametric equalizer, and an ADS Acoustic Dimension synthesizer. A UREI digital metronome is also available for use by composers and conductors.

Tape machines comprise an MCI JH-114 24-track, JH-110-4B four-track, and a pair of JH-110-2B two-tracks. "We



. . . Control Room A

chose MCI tape machines simply because they are reliable studio workhorses," comments Manger. Additional tape machines include an Ampex 440, three Eumig FL-1000 cassette decks, a Revox B-77 quarter-track, and a Scully 280B four-track. "The Scully has been highly modified to be able to make four-track cassette masters," explains Manger. "It runs very stably at 3 3/4 IPS, has a great frequency response, and a specialized head assembly for cassette mastering."

All tape machines are moveable, and can be placed in different studios to suit the requirements of various sessions. Dolby noise reduction is available for all multitrack and mastering machines.

To facilitate both local business, and to make it convenient for travelling artists, Crescendo boasts an impressive array of instruments: Yamaha drum kit; Roland guitar synthesizer; Oberheim OB-XA eight-voice synthesizer with digital sequencer; Yamaha CS-80 synthesizer; marimba, vibes, and an assortment of LP (Latin Percussion) instruments. The pride of the studio is a 105-year old Chickering & Sons nine-foot grand piano, rebuilt by the technician Mark Allen. Instrument amps include Yamaha bass, Fender Twin Reverb, and Fender Bassman.

Crescendo also has over 60 microphones, including Sennheiser, Shure, Beyer, Electro-Voice, Crown PZM, AKG, Neumann FET U-47, U-89, U-67, U-87, and some old RCA ribbon mike models. "We feel that some of the older microphones are still the best for certain applications," comments Manger. "I think the RCAs are the best mike for brass and vibes. They have a certain 'personality' you can't get anywhere else."

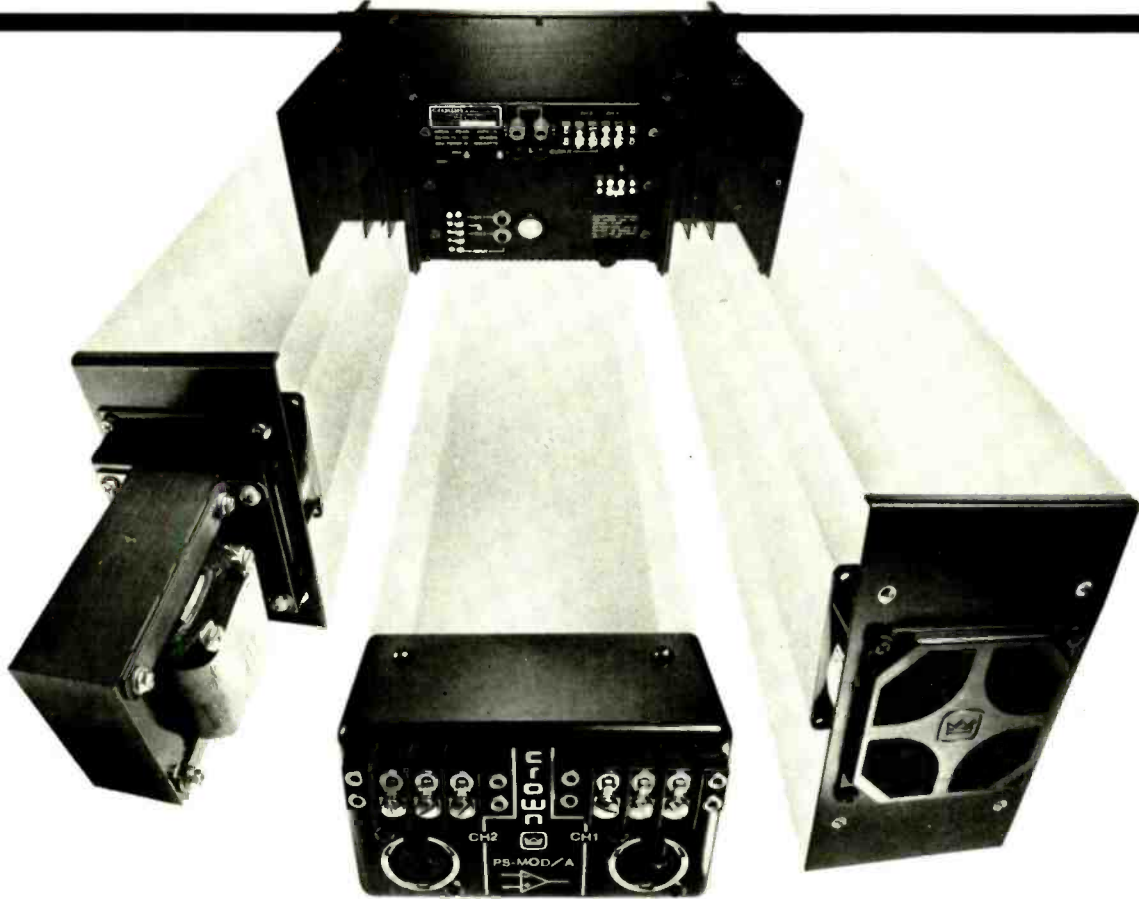
On the second floor of the complex are the studio's three Studio Technologies Ecoplate units, and AKG BX-10 spring reverb. Also located on the second floor are a tape library, and raw stock for recording and film dubbing. The library and storeroom are connected by a dumbwaiter to the ground floor.

Equipment storage at Crescendo is a well-considered detail. In the main studio, a large closet contains headsets, microphones, and cables. Rolling carts dispense recording hardware, as well as additional seating for larger sessions.

A musician's lounge contains the usual coffee and vending machines, and

— continued overleaf . . .

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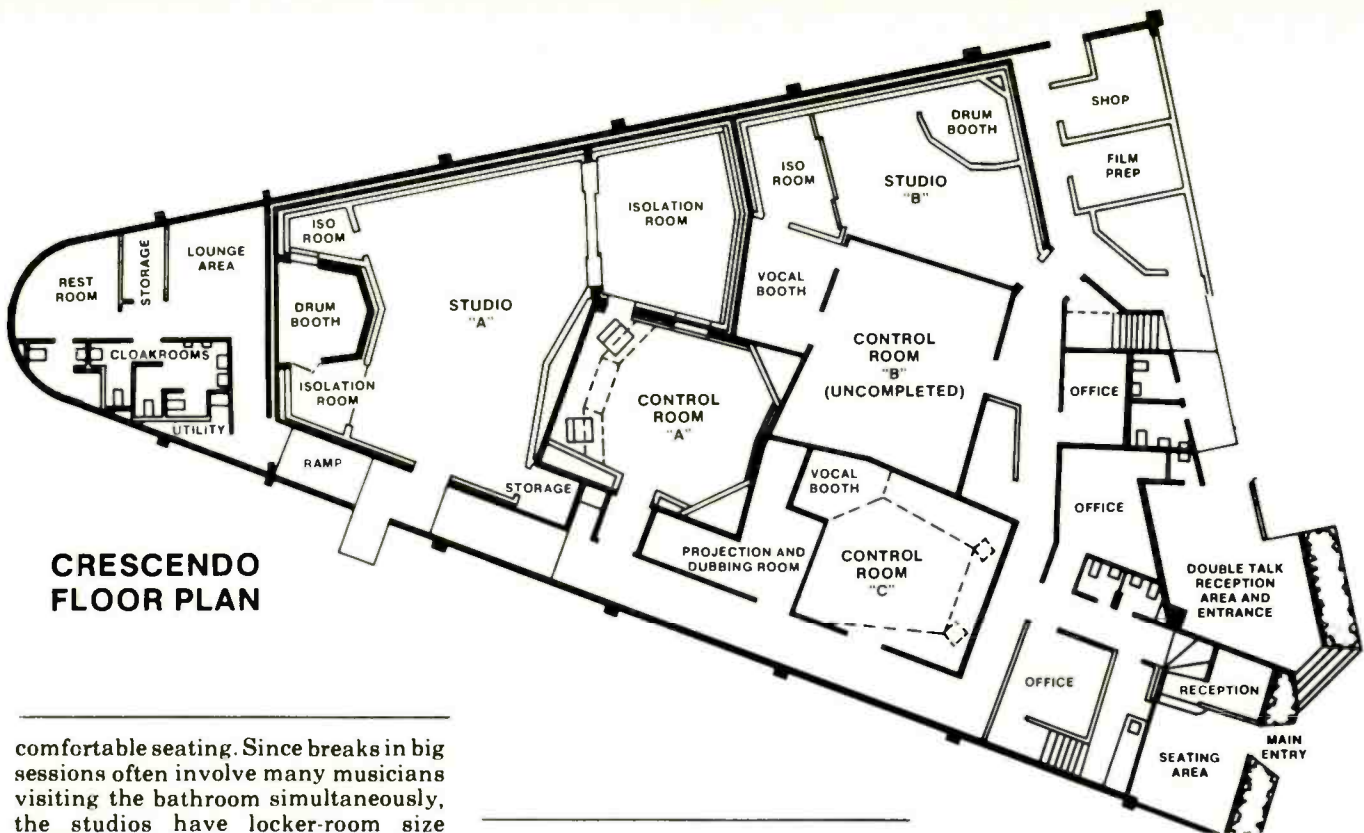


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comfortable seating. Since breaks in big sessions often involve many musicians visiting the bathroom simultaneously, the studios have locker-room size facilities.

Film Mixing Theater

With a general turndown currently being experienced by the record business, studios need to keep an eye on diversification these days, and it's no surprise that Crescendo is fully prepared to accommodate dubbing and mixing of sound to film or video. The island has a healthy film industry, with excellent support facilities, good cameramen, editors, and plenty of local actors and musicians. Previous to Crescendo coming into existence, there was no facility in Puerto Rico for mixing and dubbing film soundtracks, a convenience that can make location work both simpler, and cheaper. Quite often, espe-

cially in commercial projects, there will be a need to alter a sound mix, or to replace a line of narration. It's very handy for film production companies working on location to be able to gather additional local sounds, or to call back local talent for dialog replacement.

Studio C, the film mixing theater, is described as being the first LEDE control room designed specifically for film work. The room is equipped with a large retractable cine screen, flanked on either side by UREI 811 monitors. The console is a 32-input Spectra Sonics equipped with eight sub-groups. In the rear of the room is located an announce booth for dialog replacement, and radio production sessions. A separate alcove behind Studio C serves as a projection

room for the studio. The film projector chosen for Crescendo is a Magna-Tech convertible for both 16mm and 35mm film. A four-track Magna-Tech pickup recorder and four Magna-Tech dual dubbers round out the film equipment package, which is capable of handling a maximum of 32 audio tracks.

All film equipment is interlocked electronically, and capable of operating at speeds up to six times normal in forward and reverse for quick location of specific scenes, and searching through reels. Undetectable punch-ins are said to be possible, because the timing of record bias and erase current turn-on and -off have been set to provide electronic crossfades in milliseconds. Mixing is done to four-track mag film.

In addition, the entire equipment package in Control Room C is portable. Multitrack location recording is a prime area of business for Crescendo, with major acts performing regularly in the island's capital. The Spectra Sonics console has folding legs, while power amps and outboard gear are housed in portable rack cases. "We didn't modify the console to be transformerless," explains Manger, "because we felt it would be the best way to go for location work. You never know what you're going to run into." Everything plugs in and out of the console via multipin connectors on the pedestal, including the MCI 24-track.

While researching Crescendo, Manger supported himself as a freelance engineer, and handled location audio for numerous film and documentary projects, including many commercials. The

CHOICE OF STUDIO LOCATION — A COMBINATION OF STATE-OF-THE-ART AUDIO EQUIPMENT AND SERVICES, AND INDIGENOUS RESOURCES AND EXPERTISE

Jose Madera, head administrator of the Economic Development administration of Puerto Rico was on hand at last December's opening of Crescendo Audio Productions to perform a champagne christening. He pointed out the many advantages to filmmakers working on the island: year-round good weather; an array of scenery that includes jungles, rivers, arid areas, and quaint villages; and cosmopolitan San Juan. Since the island is only 100 miles long by 30 miles wide, and is crisscrossed by modern highways, it's possible for a film crew to work in exotic locations, and still operate from the capital with its modern accommodations and airports.

Crescendo plans to serve the needs of the local as well as the international recording market, and also to provide audio services for the film and television industries. As Madera stated during the opening ceremony, "We offer incentives to filmmaking on the island and, in so doing, we also help the artist sector of Puerto Rico. We are also talking about the pop music market — we have our \$25 million Center for the Arts, and are bringing plays from Broadway and world name artists. We would like artists to think of Puerto Rico as a beautiful place to come and relax, but also a place where they can do professional recording. We are developing the core businesses and the support services, of which Crescendo will play a very important part."

Alan Manger is chief engineer for the entire facility. Since the recording of Latin music will be a mainstay of the studio's operation, bilingualism is prevalent at Crescendo. Teresa

studio is equipped with a Nagra portable recorder, and a complete sound kit for travelling with crews. His knowledge of sound for the various media is considered to provide the expertise necessary for a well-rounded audio service facility.

"When you enter a project, you have to realize what the final product will be," Manger states. "If it's going to be 35mm or 16mm optical film, or a radio commercial, or a record, you deal differently

with your equalizations, the voicings of each instrument, and each aspect of the mix. If you don't take the final product into consideration, you're not going to have a first-class mix when you're finished."

Towards the Future

So far the cost of Crescendo has reached \$1.5 million, a sum that accounts for the two completed Studios A and C, as well as the foundations,

outer walls, and electrical wiring for the partially-completed Studio B. The way in which business develops for the two existing studios will determine the particulars of Studio B. If film scoring sessions dominate, for example, Studio B will develop accordingly; if film mixing and dubbing become a large percentage of Crescendo's work, provisions have been made for projection from the centrally located projection room. When completed, the cost of the total audio/video and film complex will reach approximately \$2 million.

On the second floor of the studio complex a second company will be located. All the rough construction, plumbing, and electrical work have been completed for Double Talk, Inc., a Spanish-English dialog replacement and dubbing facility. At one time, Puerto Rico had a large share of this type of work, operating as a focal point between the English- and Spanish-speaking countries of the Western Hemisphere. Presently, Mexico handles the majority of such dubbing sessions, but Manger and his associates feel that the time is ripe for Puerto Rico once again to enter the field. Much of the equipment now in storage was purchased with the assistance of the government's Economic Development Administration. With the completion of Double Talk, Inc later this year, the total cost of the audio recording complex is expected to approach around \$3 million. ■■■

CHOICE OF STUDIO LOCATION

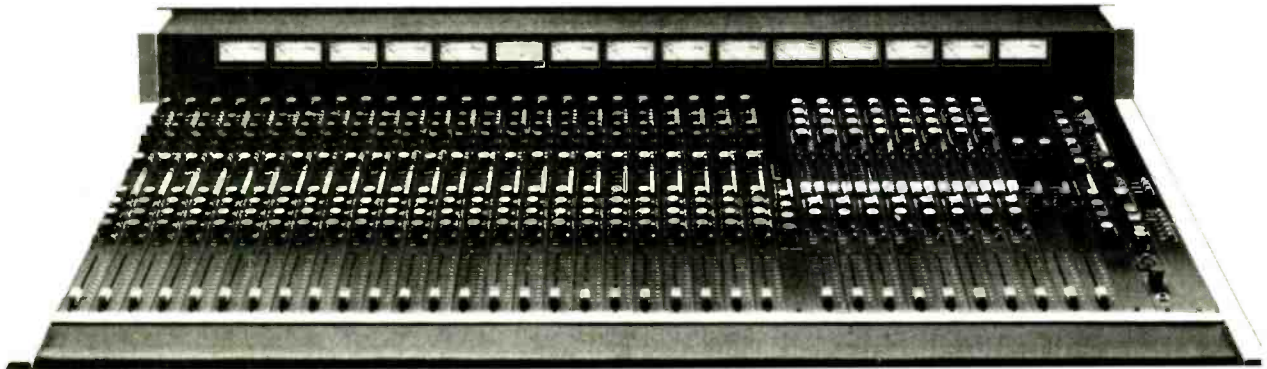
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Gonzalez, born in Puerto Rico, is one of the second engineers, with numerous solo record projects to her credit at the island's other two multitrack recording studios. Carlos Perot, born in South America, also has worked extensively as an engineer on the island. Both are being trained in what Manger describes as a "traditional apprenticeship program" to familiarize them with the varied disciplines of film, video, and location recording. Another resident, Alejandro Luciano, is maintenance engineer, and has not only handled recording studio technical responsibilities, but has installed radio stations on the island. Maya Acciani, Manger's wife, is studio manager of Crescendo, and has worked closely with her husband for many years on record, film, and video projects. She is directing promotion of the studio through the local press, as well as advertisements in major international recording, film, and advertising journals. The entire studio staff of 12 was drawn largely from the indigenous human resources of the island, creating the first generation of the Crescendo family.

The opening of such a large and versatile facility created a lot of excitement on the island. Attending the ceremonies were local radio and television personalities, musicians, composers, filmmakers, and representatives from major advertising agencies. Manger, as a familiar engineering face, provided tours of the facility that already have inspired bookings from his former clientele as a freelancer.

The success of Crescendo is contingent upon creating a healthy local business climate, as well as drawing work from around the world. As a footnote to the local scene, a family living across the street from the studio already has erected a large sign announcing that they are serving traditional Puerto Rican cuisine.

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**A Case Example at the Hotel Del Coronado,
San Diego, spotlighting the Increasing Effect
that Sound System Designers are Having on
Permanent In-House Installations**

by David Scheirman

The touring concert sound business has unique requirements and special problems, many of which have resulted in innovative solutions. And, in the related field of installed sound system design and installation, contractors have developed new methods and hardware that are leading to positive improvements in sound quality. Usually, these two segments of the "sound reinforcement" business have been treated as separate entities, with very little cross-communication between touring sound engineers, installation contractors, and equipment manufacturers. However, this situation is changing; sound engineers at both ends of the live-sound spectrum can benefit from an appreciation of each other's experiences.

Other than the obvious improvement in available hardware, perhaps the most notable aspect of the sound reinforcement industry's development over the past decade has been the softening of those hard boundaries that used to divide touring sound systems from installed systems. Travelling concert sound systems originally spawned a new industry, mainly because installed systems were not adequate to handle the new style of music that began to be presented by touring groups in the Sixties. As the public's taste for amplified music grew, it was evident that most auditoriums, arenas and resort hotels did not possess adequate sound reinforcement equipment. To satisfy this growing need, a number of concert sound companies came into existence to design, build and then cart new sound systems all over the country.

Now some of these same sound companies have been leading the current movement toward modernization of installed sound systems in many public and private buildings . . . from night-clubs to football stadiums. Recent examples of this development include Clair Brothers' system in the new Brendan J. Byrne arena at the Meadowlands in New Jersey; the Northwest Sound system at the Savoy Theater in New York City; and the Meyer Sound Systems in use at the Oakland Stadium and

Arena in the San Francisco Bay area. This "outside" pressure has caused old-line sound contractors to become more aggressive in their approach to new installations, and can help bring about the development of innovative new hardware that will be equally at home in church sanctuaries and rock-music venues.

Sound Systems at Hotel Del Coronado

For a detailed look at an old building whose sound reinforcement capabilities have gradually evolved over recent years, *R-e/p* chose the Hotel Del Coronado, San Diego's premier resort hotel and convention center. This complex of buildings was first constructed in 1887 on Coronado Island, and at that time could only be reached by ferry from downtown San Diego. Currently listed as a National Historic Landmark, the hotel has been the site of presidential summit meetings, and Hollywood film shoots. It is considered to be one of San

Diego's busiest convention centers, with often as many as 150 different meeting functions taking place on site each week. Nearly all of these gatherings rely on the hotel's audio-visual department to provide for their sound reinforcement needs.

Corporate convention expenditures have increased dramatically within the past decade, and the Hotel Del Coronado's audio purchasing budget reflects this in convention business: in 1983, twice as much will be spent on new sound equipment purchases as in 1982. According to Audio-Visual Department Manager Richard Glickman, "We have been choosing our new equipment very carefully. Our clients are becoming more knowledgeable about their own sound requirements, and many conventions are starting to come in with nationally-known entertainment groups — many of whom expect concert-quality sound."

The Hotel Del Coronado has a total of 36 rooms that can seat anywhere from 20 to 1,500 persons, and these meeting rooms comprise a very diverse set of acoustical environments. A large formal ballroom with a proscenium stage is available, and also a smaller ballroom with portable staging. A new addition, known as Grande Hall, can be used as a large, single meeting area, or may be split into three separate rooms, each

— the author —

David Scheirman is a concert sound consultant specializing in international assignments. He has had extensive touring experience with a wide variety of acts, and he is currently studying physics.

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requiring a permanently-installed sound system. In addition there are numerous other meeting rooms of all sizes and shapes. Eleven of the 36 meeting rooms have permanently-installed sound systems, while functions in other rooms are served by a variety of portable systems.

Ballroom System

The Formal ballroom received its first sound system in the days of such crooners as Rudi Valee, when the first primitive audio systems began to replace the megaphone. Then, around the time of World War II, an Altec-Lansing system with multicell horns and massive drivers was installed. The system utilized Stromberg-Carlson amplifiers, and the horns were equipped with resistance-type blocking networks. As such, it was typical of the "green-and-grey" installed equipment in most schools, churches and auditoriums built in that period, and this particular sound system served the ballroom for nearly 30 years. Finally, during a complete room reno-

vation in 1978, a new overhead cluster featuring JBL speaker components was installed by a local sound contracting firm. For the first time, music program material could be accurately reproduced with reasonably good fidelity (Figure 1).

The new cluster featured three front-loaded reflex speaker bins containing JBL 2220 cones, and a JBL radial horn on a 2440 driver. As originally installed, this speaker system could provide the ballroom's 1,200 patrons with good sound for most functions. Twenty four 10-inch speakers were placed on a 70-volt distributed line in the overhanging ceiling at the rear of the room. These, combined with the new cluster, resulted in a greatly-improved system, but problems still existed. Over the next few years, occasional comments included complaints such as: "Can't hear the highs," "Sounds fuzzy," and "Can't you do something about the echo?"

Recent "fixes" that have helped solve these problems include an increase in amplifier headroom, upgrading of speaker components, re-alignment of the high-frequency units, proper equalization, and the addition of cleaner mixers.

To increase the system's headroom, the 100-watt McM Martin tube amplifiers were replaced by Crown DC-300As. Each 15-inch low-frequency loudspeaker was placed on a separate output channel, providing 155 watts of RMS power to each 8-ohm speaker. According



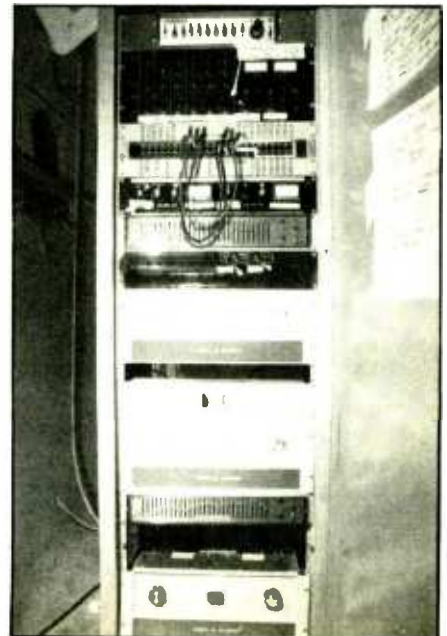
Figure 1: The Formal Ballroom's overhead cluster system is suspended above the proscenium stage, overlooking the dance floor.

to the manufacturer, each Crown DC-300A features output protection circuitry that enables the unit to safely drive any speaker load, resistive or reactive, with no fear of harming the amplifier. As a result, changing the load impedance affects only the maximum power available, not the unit's ability to produce clean sound. Thus, any minor impedance fluctuations caused by variable-frequency transients that the unit encounters during the reproduction of music program material present no problem for the system.

The DC-300A amplifier provides a practically fail-safe power section for an installed system, and often is considered by many touring sound engineers [and recording engineers for that matter — Ed.] to be the standard by which other amplifiers are judged — an example of one device proven "on the road" that has found its way into the sound installation contractor's arsenal of available weapons to combat poor sound (Figure 2).

In the loudspeaker section, high-frequency problems were solved by

Figure 2: The Ballroom backstage audio equipment rack contains the Crown DC-330A amplifiers along with crossover, equalizers, and mixer.



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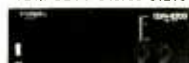
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adding JBL 2405 high-frequency units, passively-crossed over to add some additional presence to the highs above 10 kHz. Also, the horn driver was changed over to the new JBL 2441, which is characteristically brighter than the 2440. (The diaphragm on the 2440 was found to be "rubbing," which perhaps helped lead to the complaints of "fuzziness" in the system; the unit may have been in this condition for a year or more).

The perimeter system in the ceiling received new high-powered, co-axial full-range speakers built by Utah. The audio signal feeding the system then was placed on a digital delay line, 45 milliseconds of delay being added with a Lexicon Model 93 Prime Time processor. The Model 93 offers 60 possible delay settings which, when selected, are displayed on an LED readout. It is equipped with a delay bypass switch for quick signal comparison, and also boasts headroom indicators, high-end rolloff controls, and a phase inversion switch. The delayed perimeter speaker line, coupled with a re-alignment of the main cluster's HF components to prevent excessive reflection of the high frequencies off the wooden parquet ballroom floor, effectively solved the echo problem.

Proper system equalization was accomplished by installing a UREI third-octave graphic equalizer in both the main cluster signal line, and the delayed perimeter line. A day spent running pink noise through the system using a calibrated microphone into a real-time analyzer was sufficient to find and correct the "ring" modes in the room. Once the equalizers had been set, factory-provided plastic face-covers were installed with Allen-head setscrews to prevent tampering. A pair of dbx Model 160 compressor-limiter units then were installed in the output lines, to protect the loudspeaker systems.

The DuKane rack-mount, tube-type pre-amplifier and mixer unit was replaced with a permanently-installed Yamaha PM-180 six-channel mixer. In addition, two portable Yamaha PM-700 12-channel stereo mixers were purchased, to provide a total of 30 available input channels. A 27-pair multi-cable snake was run through the ceiling and dropped down through one of the ceiling support columns at the rear of the ballroom; the technicians now had their choice of doing a "from-the-house" mix for more complex functions, or sticking to a backstage-controlled operation for simpler events. The use of a snake cable and portable house mixing position is yet another example of a technique pioneered by touring sound engineers now being utilized by many audio staffs responsible for installed systems.

One System . . . Or Three

Grande Hall is a new addition to the Hotel Del Coronado, constructed in 1973. A high-ceilinged meeting complex with plush carpeting and fine wood

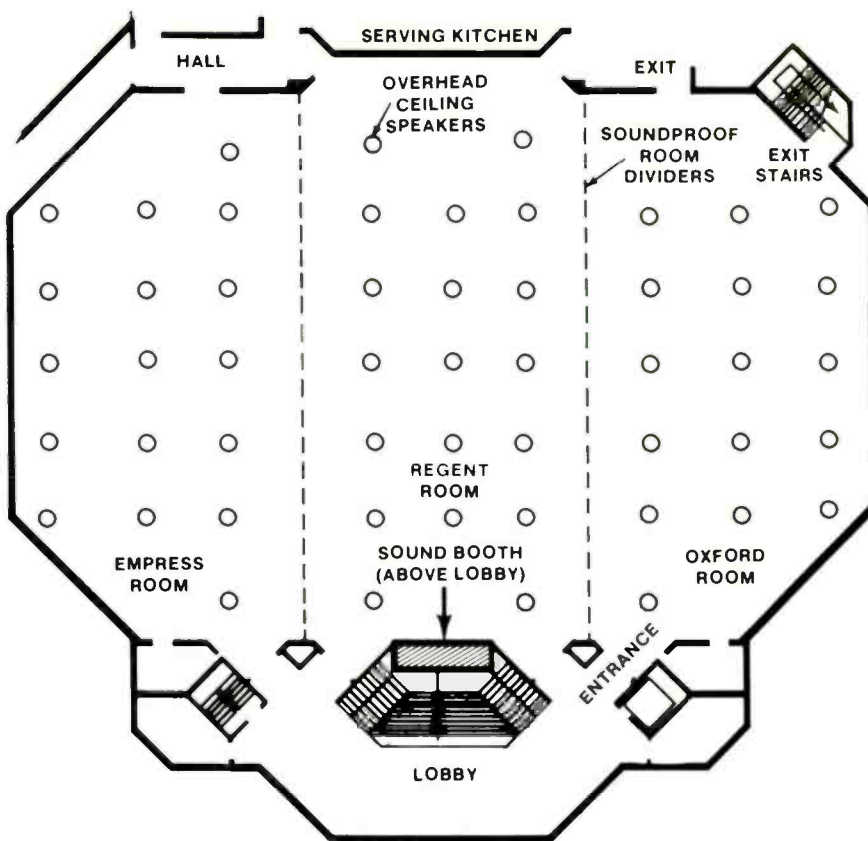


Figure 3: The Grande Hall can be divided into three separate areas with soundproof room dividers. Overhead ceiling speakers are easily switched over to become three individual systems, each with its own mixer.

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paneling, the Hall can accommodate up to 1,500 people when used as one room. It also features folding, soundproof room dividers that enable the area to be split into three, equal-sized smaller rooms (Figure 3). The entire complex is served by 42 ceiling speakers on a 70-volt distributed line. A sound booth overlooks the room. This arrangement works well when the area is used as one large room, but frequently the separate rooms need individual systems.

To prevent the necessity of bringing in portable sound systems for each area, a unique switching arrangement enables the audio technicians to split the ceiling speakers into three discrete groups, one group serving each area. Overhead speakers are powered by Rauland DX-250 solid-state amplifiers, which offer 325 watts RMS (commercial rating) at 15.4 ohms for a 70-volt line. Oversized transformers and all-silicon transistors help protect against overheating. Each amplifier section powers 14 ceiling speakers.

The power sections receive their signal from three separate Yamaha PM-180 six-channel mixers. An output switching panel enables the three banks of overhead speakers to be connected in any combination to each of the three mixers. Inputs can be picked up on the floor of each area, sent through the appropriate mixer, and then assigned to that room alone. Or, the signal can go to the adjacent room if the area is split into two sections — or to all three speaker banks at once (Figure 4). If one single, larger console had been chosen for the area, this added versatility would have been sacrificed. As it is now, the facility's portable Yamaha PM-700 12-channel mixers can be brought in and placed in the room when it is used as one large meeting area. Floor-mounted XLR input jacks are available in the center of each area, and around the perimeter, to accept a mixed-down signal into the system when these portable consoles are used.

Additional Meeting Room Systems

Most of the Hotel Del Coronado's remaining meeting rooms require a system capable of providing adequate vocal reinforcement to all parts of the room. The sound system also must provide accurate reproduction of music program material from cassette tape decks, and motion-picture projectors.

Figure 4: Grande Hall's sound booth.

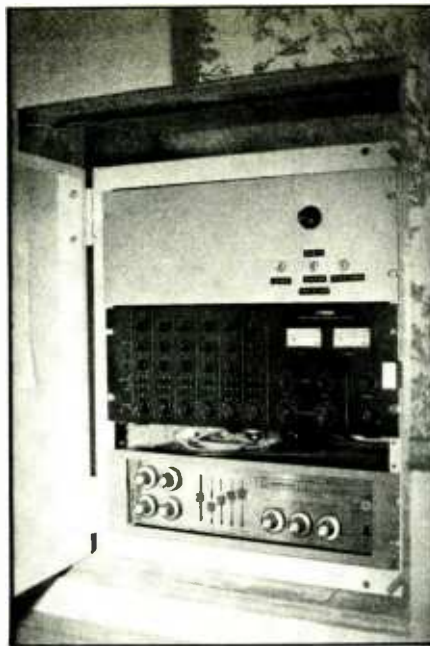


Figure 5: Larger meeting rooms are equipped with a Yamaha PM-180 mixer in addition to the Bogen CT-60.

According to hotel audio-visual technician Terry Burke, "We never know what to expect. Vocalists and pianists for womens' club luncheons. Foreign language classes. Disco dancing. One group of retired Navy officers even played a tape of their old ship's 21 mm guns giving a salute!"

In these medium-sized meeting rooms, overhead distributed systems were installed, utilizing Utah co-axial speakers. Originally, the rooms were provided with McMartin or Stromberg-Carlson tube-type mixer/amplifiers, recessed cabinets having been built into the room walls to house the equipment. As these older units were phased out, Bogen CT-60 public address amplifiers were brought in. These pre-amp mixer-amplifier units feature four low-impedance microphone inputs, and two auxiliary inputs with RCA connectors for phono-type signals; they are equipped with a five-band graphic equalizer section, and a built-in variable compression circuit.

Several of the larger rooms also have had a Yamaha PM-180 six-channel mixer added, boosting the input capacity of those systems to 10 channels (Figure 5). As in the larger rooms, input jacks are available around the perimeters of the rooms, and in floor pockets in the center of the meeting areas.

Other Installed Systems

The Hotel is equipped with a network of outdoor speakers that are connected to the same background music and paging circuit serving the indoor lobby and lounge areas. In the localized areas, wall-mounted resistance-type volume circuits have been installed to give a measure of control to the Muzak level in each environment. In the areas around the outdoor terrace restaurant, a portable podium

with microphone is available for local announcements (Figure 6). A Shure EM-28 microphone with a momentary-contact switch allows the signal to be connected to the paging circuit. The outdoor system relies on all-weather folded-horn type University Sound loudspeakers. Despite their somewhat limited frequency response, these speakers are well-designed to withstand the elements (Figure 7). Considering the hotel's oceanside setting, they have done well to resist deterioration, and rarely have any sort of malfunction.

Portable Systems

When a meeting function takes place in one of the rooms not equipped with an installed sound system, a variety of portable units are available. The simplest, and most unique, is a podium manufactured by the Ora-Visual Company (Figure 8). The unit houses a 10-watt amplifier to power an 8-inch vocal-range loudspeaker housed within a sealed compartment inside the podium. Capable of providing sound for up to 75 persons, the system's use beyond that range is limited due to the fact that the distance from the microphone to the loudspeaker is a mere 20 inches; trying to achieve excessive gain results in feedback.

Other portable gear available includes Shure M-68 mixers, self-powered loudspeaker cabinets for floor placement, and column-type sound systems. When a larger system is required, a two-way horn-loaded set-up is available that utilizes bass bins and radial horns manufactured by Forsythe Audio, and JBL speaker components (Figure 9). A signal processing and amplification rack contains Crown amplifiers and a VFX-2 electronic crossover, along with dbx Model 160 limiters, and a Yamaha PM-180 six-channel mixer. For greater input capacity, use of one of the 12-channel Yamaha PM-700 mixers can boost available channels to 30. Speaker line connections are made with Hubble twist-lock connectors, and the system

Figure 6: In the outdoor restaurant area, a hostess uses a Shure EM-28 microphone to announce seating availability.



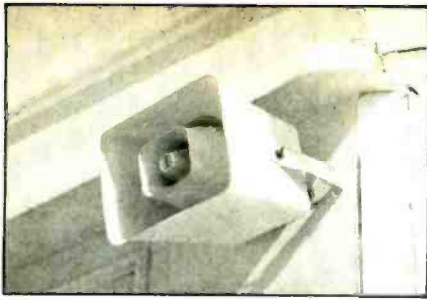


Figure 7: Outdoor paging speakers by University Sound.

electronics are hard-wired, making the set-up quick and easy.

Variable Sound Reinforcement Requirements

Many functions at the Hotel Del Coronado have relatively simple audio requirements. Oftentimes, a single microphone mounted on a podium is all that is required. A set-up as simple as this, however, can present challenges. In convention meeting situations, few of the individuals who are acting as public speakers know anything about proper microphone technique, which often leads to an excessive "critical distance" measurement. (Critical distance refers to the amount of space between the speaker's mouth and the microphone.) As the speaker moves too far away from the mike, the system's susceptibility to feedback is dramatically increased. More gain is required, and the mike begins to pick up the podium's natural resonances, which typically vary from 120 to 180 Hz. Thus, a microphone is required which has good frequency response in the vocal region at distances of up to 24 inches, and which has a slight low-frequency attenuation. The ElectroVoice DS-35 has been found to work well for this application (Figure 10).

Many clients request a lapel microphone, so they will be able to wander over to a blackboard or projection screen. This type of mike can provide very satisfactory results when used to

Figure 8: This Ora-Visual Company podium houses a self-contained sound system.



pick up a voice in a meeting room, but the results depend upon which microphone is used. The older, dynamic-type lavalier mike, which hangs on the speaker's chest, has been rendered obsolete by the new generation of battery-powered condenser models, which are smaller, lighter, and have an improved frequency response (Figure 11). Technicians at the Hotel use Sony ECM-30 electret condenser mikes, whose improved performance and increased available acoustic gain far outweigh the inconvenience of occasionally having to replace the unit's internal 1.4-volt batteries.

Many meeting functions often require multiple microphones; for example, a front table full of mikes for a speaker's

panel, or several standing aisle mikes for audience questions. For situations requiring up to four mikes, the Shure M-68 mixer is used to combine the signals, and a mike-level output then sent to the room's main sound system. The M-68 is placed at the disposal of the meeting chairman near the podium. More extensive set-ups that require a larger mixer also receive an operating technician.

Larger convention functions usually necessitate a high-fidelity stereo sound system being set up in the room to provide the hundreds of meeting participants with music. In addition, many of the larger conventions bring in live musical groups, which may involve a locally-hired trio for dinner music, or a

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nationally-known recording act presented in concert format. As the hotel's audio-visual department has expanded its sound reinforcement capabilities, it has been able to provide clients with gear and technicians which otherwise would have been brought in by outside companies.

A specific instance of this need to bring in outside equipment to supplement the hotel's in-house resources was a recent performance by The Osmonds at a meeting held by Brigham Young University. Concert sound requirements for the group normally are taken care of by a touring sound company. Upon hearing the specifications of the hotel's available sound gear, The Osmonds' sound engineer opted to utilize that system rather than bring in an outside company. But, because he did require a 32-channel console with eight discrete outputs, a Yamaha PM-2000-32 was rented in Los Angeles and brought down to supplement the hotel's equipment.

Troubleshooting and System Maintenance

Oftentimes the Hotel Del Coronado has the majority of its meeting rooms in use every day of the week. Most meetings run for hours at a time without interruption, and the majority of the systems are of the "set-it-and-leave-it" type; once levels are set, the system is not tended by a technician. This being

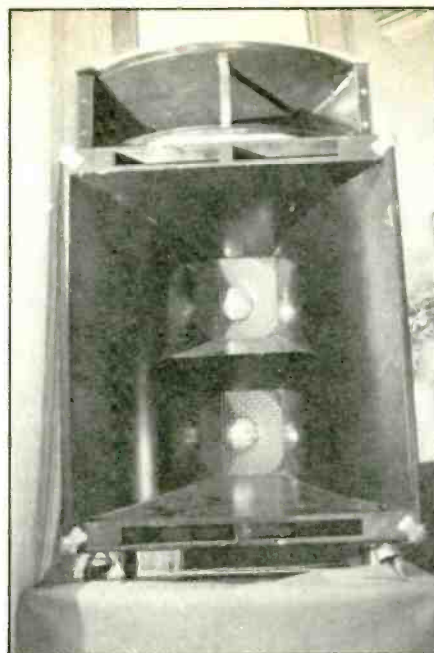


Figure 9: A portable bi-amplified Forsythe horn-loaded system.

the case, simplified systems are essential to ensure trouble-free operation.

One procedure that helps to keep problems to a minimum is a complete check-out of each piece of audio gear before it leaves the storage area for use in a particular room. Each mike, cable, mixer, amplifier, and loudspeaker is tested

before being dispatched by the audio-visual department, no matter how hectic things may get. (A peak day may see as many as 40 different set-ups and strikes involving audio gear at various locations throughout the hotel.)

During slack periods, routine maintenance is performed on the sound equipment: microphone windscreens are cleaned; hardware checked; and cables repaired. Periodically, a complete check of the installed systems is carried out, usually late at night when the meeting areas are not in use. The sound systems are swept with a B&K Model 3050 Sine/Square Wave Generator, a versatile signal source that provides a variable-frequency, low-distortion sine wave signal for checking the proper operation and frequency response of the overhead speaker systems in each room. Floor and wall input jacks are checked for correct grounding, and for line continuity, with a Shure A15TG Tone Generator. This pocket-sized, battery-powered device produces a continuous 700 Hz tone capable of driving low-impedance balanced lines. It also permits one technician to do the work of two, since the tone generator can be plugged into a line at any point in the signal chain, and left in operation while he or she proceeds to check levels, connections, mixer inputs, and cables.

Future Trends

The Hotel Del Coronado's available



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Figure 11: Sony ECM-30 electret, light-weight condenser microphone.

sound reinforcement equipment has evolved in the space of just a few years from a very few primitive systems to a large variety of contemporary hardware. Several different local sound contractors have installed equipment manufactured by a host of companies. More upgrading and system expansion is planned for the future. This is only part of a general, nationwide trend to modernize the audio systems in many hotels, auditoriums, and other public buildings that serve the convention and trade show market. Also, Las Vegas — once the “king” of the convention business — no longer has the apparent monopoly on such events; as well as major cities on both the east and west coasts, Chicago, Kansas City, Atlanta, and Denver all have become busy centers of convention activity. And new facilities to accommodate the increasing market presently are under construction, particularly in the Sun Belt — Miami, Houston, Phoenix, and San Diego.

Coupled with this increase in trade show and convention activity is the

Figure 10: Many public speakers do not understand the importance of correct microphone technique; a cardioid microphone with low-frequency proximity characteristics does not work well in this situation.



client's expectation of high-quality sound reinforcement products specifically designed to serve these functions, including small, inexpensive mixers with voice-operated input switching; podiums containing high-powered, self-contained audio systems with multi-input pre-amps; miniature table-top, high-fidelity speaker units with battery power packs; and perhaps speaker units specifically designed to sit on top of video monitors to provide greater sound projection than that from a built-in television audio circuit.

The convention market finally has accepted high-quality audio as being

just as important as the dinner menu. Dollars are being spent for sound equipment, and buildings are upgrading their in-house sound systems to be able to win over some of those dollars from outside rental firms. Hopefully, those sound companies that see their touring business slacking off may find it quite profitable to look at the increasing convention and trade show business in their own backyards. Audio equipment manufacturers possibly could find support for new devices designed specifically for such functions. Also, regional sound contractors may find requests for upgrading and new installation bids coming from unexpected areas, as more facilities try to modernize their own sound reinforcement systems. ■■■

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TROUBLESHOOTING MECHANICAL PROBLEMS IN TAPE TRANSPORTS

Having Optimized Electronic Performance, How is Your Recorder Handling Tape?

by *Wayne B. Graham,*
Tentel Corporation, Campbell, CA

Audio engineers, by their interest and background, usually are quite adept at locating electronic problems that occur in recording and production equipment. This article is intended to broaden an audio engineer's working knowledge of the sources of mechanical problems in reel-to-reel, cassette, and broadcast cartridge transports. Such knowledge will help an engineer to diagnose mechanical problems associated with tape stretch, wow and flutter, premature head wear, oxideslough, high-frequency loss, or other audio problems related to the tape handling portion of the machine.

Today's tape machines incorporate increasing sophisticated mechanisms for handling tape smoothly. However, many of the machines in daily use at recording studios and production facilities are of older design, and have deteriorated since new.

Tape Transport Layout

Let's take a closer look at a typical tape transport, and determine the mechanical tests that can be made to improve recording quality. A simple tape transport, as shown in Figure 1, would be operated by two or three motors. The capstan motor propels the tape at a constant speed past the heads. A second motor connects to the take-up reel, and pulls the tape in the same direction as the tape travel, thus taking up the tape spewed out by the capstan. A third motor connects to the supply reel and tries to pull the tape in the opposite direction from the capstan. Electrical power driving to the supply motor will determine the amount of hold-back tension being provided to the tape as it passes through the head area. (In some older transport designs the hold-back tension may be provided by a passive felt or cork clutch.)

An audio cassette deck is very similar to a reel-to-reel recorder, except the tape

is contained within the cassette shell, and is thus much easier to handle. When the cassette is placed into a machine, the capstan protrudes through a hole in the shell behind the tape; when the pinch roller is engaged the tape is driven forward. A take-up motor must then provide sufficient torque to allow the tape to be wrapped on to the take-up reel. Holdback tension is provided by either an active motor drive, or passive felt or cork clutch. A cassette transport system is quite difficult to check for mechanical diagnosis, due to inaccessibility of the tape. As a result, it is necessary to test the cassette and machine separately. A take-up problem may either be caused by a binding cassette, due to faulty components, or by a take-up motor with

insufficient torque. In the latter case, tape being spewed out by the capstan would not be taken up on the reel, and tape soon becomes wrapped around the capstan and pinch roller in a good imitation of spaghetti.

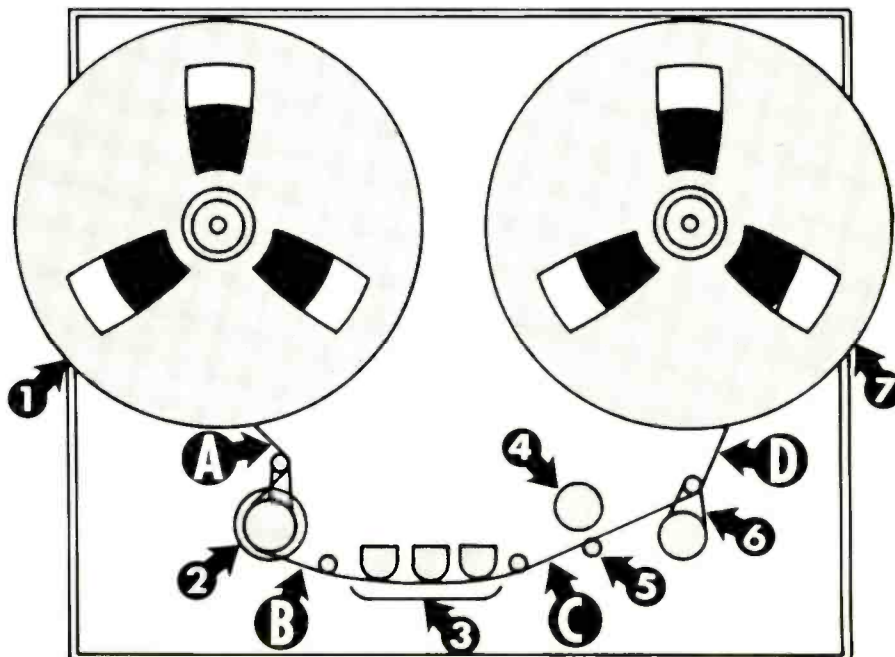
While hold-back tension should be smooth, it is not critically important since much of the tape-to-head pressure results from the integral pressure pad fitted to the cassette shell. This pressure pad exerts a force directly on the tape backing, and hence pushed the tape directly into the head. However, erratic hold-back tension may cause wow and flutter problems.

Electronic instruments are available to check both the torque required to drive the cassette, and the torque required to drive the cassette, and the torque available from the machine's take-up motor. A wow and flutter meter also can be used to check the actual electronic performance of the transport.

NAB broadcast cartridges present a completely different set of problems for diagnosis. Holdback and take-up tensions are a function of the cartridge design and tape path, and are virtually independent of the transport. Since it provides the capstan and pinch roller, the cartridge machine determines tape speed. Wow and flutter can result from either an erratic holdback tension (caused by the tape path or cartridge design), or from an erratic tape speed (caused by an irregularity of the capstan or pinch roller assembly).

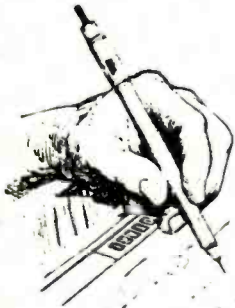
Probably the most positive method of identifying the problem is to check the cartridge machine with a standard reference tape, and a wow and flutter meter. If the machine checks out, then discard or rebuild any cartridge that "doesn't work right." Remember that the broadcast cartridge is very similar

Figure 1: Tape transport layout



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The new, second generation MTR-90 Series II multi-channel recorders are the embodiment of this philosophy. We have refined the features and extended the performance and capabilities of the MTR-90 by working closely with industry leaders who demand the extra measure of technology and commitment. With recording and film/video post-production facilities depending on the MTR-90, we've stayed close to the needs of today's media production houses. The new Series II machines are the logical result; a microprocessor-controlled recorder specifically designed to easily interface with any SMPTE-based video editing system, machine controller or synchronizer.

Once again, we've advanced the industry's most advanced recorders. And, kept the same dedication to the craftsmanship we've always had.

From our hands to yours, the new MTR-90 Series II recorders are engineered like no other tape machines in the world; with the quality you can hear and feel.



HY JAMES

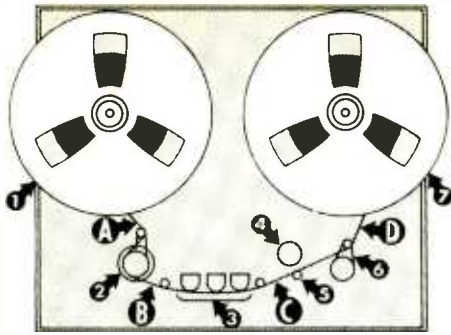
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appointment as your Michigan
Otari MTR-90 dealer.

HY JAMES *The Audio Professionals*

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from Detroit 552-0190



in design to the old eight-track, and requires that the tape continuously slip along its entire length to function properly.

Reel-to-Reel Transport Problems

Some of the problem identification logic gained with reel-to-reel recorders can be utilized directly in troubleshooting cassette or even cartridge-format machines. It is necessary to evaluate the transport in terms of its ability to move tape smoothly past the heads — after all, this is what it's all about! In order of importance then we have:

- (A) Erratic supply tension in the head area, causing wow and flutter problems.
- (B) Tape-speed oscillations causing wow and flutter or pitch problems.
- (C) Insufficient capstan to pinch roller pressure causing slippage of tape at the capstan, and hence wow and flutter or pitch problems.
- (D) Insufficient tape tension at the heads causing a loss of high frequencies.
- (E) Too much tape tension at the heads causing premature head wear, and tape sloughing.
- (F) Erratic take-up tension causing a poor wrap and subsequent tape edge damage.
- (G) Guiding problems causing tape edge damage.



In-line tape tension gauge

These "symptoms" can be broken down into "probable cause" areas that will provide problem areas to study, and are listed in Table 1. The diagnosis elements have been grouped and numbered, and are briefly explained below:

- (1) **Wow and flutter meter:** Note the scale of the meter (DIN, IEEE) and make sure it corresponds with the manufacturer's specifications for your particular equipment. You can generate your own test signal tape (usually 3.15 kHz, available as an output on most wow and flutter meters), but it is best to purchase a professionally recorded test signal to eliminate the possibility that your machine is faulty, and would not provide an accurate signal. A wow and flutter test tape recorded on a faulty machine will give strange readings when played back on the same machine, since errors can partially cancel or reinforce at random during playback.
- (2) **In-line tape tension gauge:** Insert the probes of the tension gauge

over the tape at a point just exiting the head area. (Point "C" in Figure 1). Tape speed oscillations will cause variations in tape tension due to the inertia of the machine's various rotating components. Although the magnitude of the wow and flutter cannot be determined, its presence can be detected, and oftentimes diagnosed by observing the rate of oscillation on the tension meter.

- (3) **Tape speed strobe:** This usually consists of a strobe disk that rotates when brought into contact with the tape. It is necessary to use a strobe light; most are designed for standard 60 Hz fluorescent lights. Depending on which lines "stand still," or at what speed they appear to rotate, the tape speed can be determined. If the rotational speed appears to change, it's a good indication that tape speed is oscillating. Rapid tape speed oscillations are almost impossible to detect with this method, due to the inertia of the speed indicator.
- (4) **Static tape pull test:** Place a short length (18 inches) of recording tape between the capstan and pinch roller. Engage the pinch roller fully into the capstan, having first disconnected the power to the capstan motor. Tie the take-up side of the tape sample to a fish scale-type tension pull scale. Pull the tape, thus forcing it to slide over the capstan. The magnitude of this force will be at least several pounds. The service manual for your particular machine should be consulted for the correct force.

(5) **In-line tape tension gauge:** This is a simple functional check to determine tape slippage at the capstan. With the machine in play mode, merely insert the in-line tension gauge over the tape just prior to the capstan/pinch roller (Point "C" in Figure 1). Using your left hand to hold the gauge in place, reach over to the take-up reel with your right hand, and attempt to "assist" the take-up motor to exert force on the tape. If the tension reading on the tension gauge increases when you assist, and decreases when you let go, it is an indication that slippage is taking place, and that pinch roller pressure should be increased.

- (6) **Pull scale and string:** This is the

TABLE 1: Troubleshooting Reel-to-Reel Transport Faults

Symptom	Problem	Diagnosis (See text for details 1-10)
Wow and flutter	Supply tension oscillations	(1) Wow and flutter meter (2) In-line tape tension gauge
Wow and flutter	Tape speed oscillations	(1) Wow and flutter meter (2) In-line tape tension gauge (3) Tape speed strobe
Wow and flutter	Slippage of tape at the pinch roller/capstan	(4) Static tape pull test (5) In-line tape tension gauge
Loss of high frequencies	Insufficient supply tension	(6) Pull scale and string (2) In-line tape tension gauge
Premature head wear	Supply tension too high	(6) Pull scale and string (7) In-line tape tension gauge
Tape sloughing	Supply tension too high	(6) Pull scale and string (7) In-line tape tension gauge
Tape sloughing	Faulty tape	(8) Manual test of tape oxide adhesion
Tape edge damage	Erratic take-up tension causing loose or irregular wrap	(9) In-line tape tension gauge
Tape edge damage	Guiding problems	(10) Visual examination of tape while in motion

old, standby method of checking tape tension. Because of such a procedure many engineers still confuse torque with tension: torque is a force acting at a distance, while tension is a pure force. While a torque usually is expressed in units of inch-ounces, or gram-centimeters, tension is usually given in units of ounces, or grams. The string method is only applicable to older, less complicated tape transports. An empty reel is placed on to the machine, and a string wrapped around the tape hub, in the same direction as the tape would wind. With the machine in play mode, pull the string in the direction and at the approximate speed of the tape, and measure the amount of force on the pull scale. (This method will *not* work, however, on virtually all of the newer machines fitted with constant tension servos). Once this torque has been determined, you can compare it with the factory specifications.

(7) **In-line tape tension gauge:** Slide the probes of the in-line tension gauge over the tape at a point next to the supply reel (Point "A" in Figure 1). Measure the radius of the tape pack on the supply reel to determine the torque of the holdback system. Compare this computed torque with the computed torque specified in the manual. (Note that on older machines without servo control, the torque remains constant.) Thus the computations are as follows:

Factory Specifications:

$$\text{Torque} = \text{Tension} \times \text{Radius}$$

(Constant) (String) (Hub)

Computed Values:

$$\text{Tension (Anywhere along tape)} = \frac{\text{Tension} \times \text{Radius (String) (Hub)}}{\text{Radius (Tape Pack)}}$$

or

Computed Values:

$$\text{Tension (Anywhere along tape)} = \frac{\text{Torque (Constant)}}{\text{Radius (Tape Pack)}}$$

(8) **Manual test of tape oxide adhesion:** A slight amount of oxide particles accumulated on and around head and tape guides after many hours of operation is fairly common. A simple test of suspect tape oxide adhesion can be performed by placing a short length of adhesive tape against the oxide side of a sample of magnetic tape. If oxide comes off when the adhesive tape is pulled away from the magnetic tape, contact your tape representative for disposition of suspected faulty tape.

(9) **In-line tape tension gauge:** Insert the probes of the tension gauge at a point just before the take-up reel (Point "D" in Figure 1). Low take-up and rewind tensions may cause the tape pack to shift during handling, and cause tape edge damage. Erratic tape

tension during take-up and rewind causes the tape to pack unevenly, again increasing the possibility of tape edge damage.

(10) **Visual examination of tape while in motion:** A portable diffused light is recommended for this inspection. (An auto inspection or "trouble" light can be obtained for just a few dollars.) Look along the tape, using the reflection of the light to determine if the tape is remaining flat against all guides and heads. A guide causing the tape to wrinkle or curl at one edge may be out of adjustment, and causing tape edge damage. The tape should remain flat and smooth during the entire path from one reel to the other.

Many of these basic checkout procedures also can be adapted to the newer, more sophisticated tape recorders. The tension servo system on constant-tension transports can be checked by using an in-line tape tension gauge to measure tension first with a full supply reel, then with a half full, and finally a near empty reel; the tension should remain constant throughout the entire reel of tape. For specifications and repair procedures it is always a good idea to consult the service manual for your particular machine. When in doubt regarding any repair problem, you may want to refer the machine, with your diagnosis, to a competent service technician for repair. You will be able now to determine if repairs were carried out properly. ■■■

This Should Settle It... Smallest Size/Biggest Sound!

HME's New System 85 Hand-Held Wireless Microphone System



HME just designed an all-new system around the superb Shure SM85 element. We did so well that Shure Brothers Engineering verified its audio performance as being identical in all respects to the SM85.

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simple, easily-understood operation.

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hme

HM ELECTRONICS, INC.

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San Diego, CA 92120
Phone (619) 280-6050
Telex: 697-122



SEE US AT NAB SHOW, BOOTH #1130

New Products

DISKMIX SWITCHES TO IBM PC AS CONTROL COMPUTER

Sound Workshop's DISKMIX Automation Storage/Editing system now includes the IBM PC 1550 as the controlling keyboard computer. Commenting on the recent change, Sound Workshop president Michael Tapes stated: "We are extremely excited about the change from the NEC to the IBM as the control computer for DISKMIX. Our original concept was for us to design the host computer that 'speaks' to the console through the existing automation system in the console, while using an existing 'personal computer' for the human interface.



"We originally chose the NEC because of its relatively small size, good keyboard layout, and technical compatibility with DISKMIX. We also investigated the IBM, but at that time there weren't enough available to consider them as a viable alternative. At this point, the IBM computer is in plentiful supply, and offers the finest keyboard set-up in the industry.

"Since the mixing engineer is in direct contact only with the keyboard (in addition to the console), it is a *critical* link in the human/machine interface. Simply put, the IBM PC 1550 is slick. It looks great, feels great, has considerable prestige, and is small and light enough to sit in the console or the engineer's lap. In addition, the IBM is technically superb.

"Besides all of the obvious technical user advantage, there is an entire segment of the [computer] industry exclusively devoted to creating both software and hardware for the IBM PC. During non-mixing hours, the IBM can also be used to run business application programs with the addition of the appropriate software and hardware."

SOUND WORKSHOP
1324 MOTOR PARKWAY
HAUPPAUGE, NY 11788
(516) 582-6210

For additional information circle #65

BBSM-12 PORTABLE NEAR FIELD MONITOR FROM WESTLAKE AUDIO

In the second of the series, the BBSM-12 medium power, three-way monitors are available in either black or walnut. The new monitor consists of two 12-inch low-frequency drivers, a 6½-inch mid-frequency cone, and 1¼-inch dome tweeter, crossed over at 500 Hz and 4 kHz.



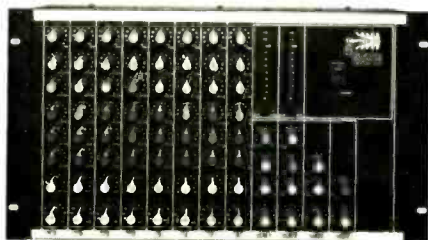
The BBSM-12 incorporates the 24 dB per octave crossover slopes used throughout the Westlake monitor line. The unit's prime listening features are said to include exceptional stereo imaging and clarity, due to low intermodulation distortion at the two crossover points.

WESTLAKE AUDIO
2696 LAVERY COURT, UNIT 18
NEWBURY PARK, CA 91320
(805) 499-3686

For additional information circle #66

NEW 883-B EIGHT-CHANNEL BOARD FROM BIAMP SYSTEMS

The 883B, an eight-channel version of the 83B Series mixers, is described as a compact, ultra low-noise board with some unique high-tech features. Biamp has developed new system architecture and circuit topology, with discrete transistors in critical areas instead of conventional ICs, resulting in a quoted 25% to 50% less noise than most comparable mixers.



Total harmonic distortion and intermodulation distortion have been reduced to new levels, while hum and crosstalk have been virtually eliminated by condensed, symmetrical circuit board layout techniques. All components are easily accessible for fast, efficient servicing. High-density

mechanical packaging allows the 883B to be used as a rack mount or console without compromising connector placement.

Other features include floating and balanced outputs incorporating Biamp's exclusive "Autobalance"; metering on all outputs; separate reverb control in the monitor; reverb routing into the subs; three-band EQ; and 10-segment LED output display.

BIAMP SYSTEMS, INC.
P.O. BOX 728
BEAVERTON, OR 97075
(503) 641-6767

For additional information circle #67

EFFECT SWITCHER FROM J.L. COOPER ELECTRONICS

A total of 14 effects devices may be plugged into the Effect Switcher, which then may be switched into the signal-path in any order desired. In addition, two different inputs and two different outputs may be used, allowing stereo signal paths and mono-to-stereo conversions.



Signal path flow is defined by simply pressing a front-panel switch to hook-up an effect. The associated LED turns on, and the corresponding letter code appears on the alpha/numeric display. Once the desired path has been defined, the patch information may easily be stored into memory for later recall. A total of 64 of these patches may be stored. Along with the signal-path information, up to eight control voltages and three switch-closures also may be memorized.

Control voltages may be used to control external devices, such as delay lines and transposers that have external CV inputs. The switch-closures may be used to replace footswitches. A two-digit LED readout shows the patch number, and a 12-character alpha-numeric display shows the signal-path order and displays various messages. Contents of the memory may be dumped to and reloaded from cassette tape for safe keeping.

Price for the Effects Switcher is \$2,000; customized units also are available.

J.L. COOPER ELECTRONICS
2800 S WASHINGTON BLVD.
MARINA DEL REY, CA 90291
(213) 827-4884

For additional information circle #68

Now you control how much better you'll sound!

Wait until you hear how good you sound with a new Audio-Technica AT831 picking up your guitar, mandolin, violin, or other acoustic instrument. And, if you think all ultra-miniature mikes are about alike, read on:


The AT831 is a *cardioid* (directional pickup) microphone. Which means it picks up more of you and less of the stage noise around you. It also means better feedback control, even when you're playing *ppp*. It's a more intimate sound, well

balanced and smooth, with just enough presence to clarify without harshness. And the sound stays constant no matter how or where you move.

There's a major bonus only with the AT831. Want a "fatter," fuller sound? Just slide it closer to the strings on its adjustable mount. Want a "leaner" sound? Simply slide the AT831 further away. The felt-covered slip-on mount holds with gentle pressure, so there's nothing to mar the finish of your instrument

Or you can use the traditional "tie clasp" mount to put the AT831 almost anywhere you can imagine (even on a *tie*, if you're into that)! And with eight feet of super-flexible cable between microphone and battery module, your freedom to move is assured.

Better sound and more convenience...just what you've come to expect from Audio-Technica. Find out more at your nearest dealer, or write for our latest catalog. Your audience will love you for it!



New AT831 *Directional*
ultra-miniature electret
microphone with adjustable
slip-on mount.
Under \$120.

audio-technica.



AUDIO-TECHNICA U.S., INC., 1221 Commerce Dr., Stow, OH 44224 216/686-2600

For additional information circle #69

February 1983 □ R-ε/p 105

THE FINEST DIRECT BOX

Simon Systems proudly introduces the DB-1A Active Direct Box and makes this challenge. Test this DI against any other, and discover why many major artists and studios refer to it as "The Finest Direct Box." State of the art specifications, unique features, and affordable pricing set new standards for the industry.



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Simon Systems Products are available at (Demos Available):

Martin Audio
423 W. 55th St.
NY, NY 10019
(212) 541-5900

Professional Audio Services
99 E. Magnolia Blvd. Suite 215
Burbank, CA 91502
(213) 843-6320



SIMON SYSTEMS
20224 Sherman Way #23
Canoga Park, CA 91306
(213) 716-7905
Dealer Inquiries Invited



Also Available:
Model CB-4
Headphone
Cue Box
System

For additional information circle #70

New Products

CROWN OFFERS NEW PZM® LITERATURE

The new 12-page brochure includes general specifications for Crown's full line of PZM Microphones and application suggestions, together with an explanation of the pressure recording process invented by Ed Long and Ron Wickersham.

Also included is a full complement of accessory information on the PH-4 phantom power supply system and the standard switchable battery/phantom PZM power supplies; PX-18 Transformer and PA-18 Active circuits; tubular impedance converters; and the PX-T transformer interface.

CROWN INTERNATIONAL
1718 W MISHAWAKA ROAD
ELKHART, IN 46517
(219) 294-5571

For additional information circle #72

KLARK TEKNIK UNVEILS DN700 DIGITAL DELAY LINE AND DN301 EQUALIZER

The DN700 Digital Delay Unit is the first of a series of products primarily designed for engineered sound systems, including theatres, conference centers, and multimedia installations. A single-input device with three independently adjustable outputs, delay times for each output can be varied from 0 to 435 milliseconds in 26.5 microsecond steps.



The DN700 has a perpetual memory of all delay settings, and features a unique lock-out system to prevent tampering with front panel controls. In-house designed AD/DA converters give 15 kHz bandwidth at maximum delay, with a quoted dynamic range greater than 86 dB. The delay line is housed in a compact 1 3/4-inch package, and can be supplied with transformer balanced inputs and outputs.

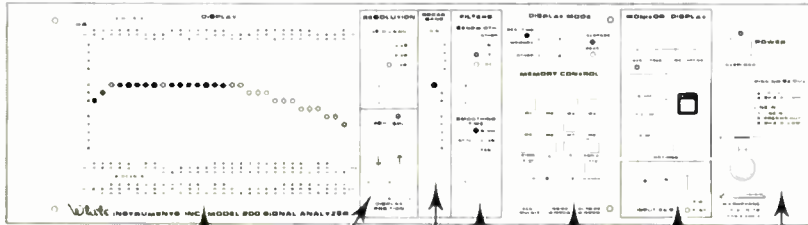
The DN301 Attenuating Equalizer features 15 dB of cut at 30, third-octave ISO center frequencies between 25 Hz and 20 kHz. The filters have been designed to give smooth combining action, even with large amounts of attenuation applied. Sweepable high and lowpass filters are also included, with the lowpass filter featuring switchable slope (6 or 12 dB per octave). Up to 20 dB of overall gain is available to restore the signal to unity gain.

The DN301 has a professional user price of \$980.00, and the DN700 \$1,295.00.

KLARK-TEKNIK
ELECTRONICS, INC.
262A EASTERN PARKWAY
FARMINGDALE, NY 11735
(516) 249-3660

For additional information circle #73

THE EXPANDABLE SYSTEM 200



Advanced Microprocessor Controlled Real Time Analyzer.

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For additional information circle #71

2nd Annual

Synclavier® II Seminar

June 19 - 25, 1983

Hosted by Dartmouth College, Hanover, N.H.
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Lectures · Private Instruction · Workshops

Due to the overwhelming success of the first Synclavier II seminar, New England Digital has decided to schedule another in 1983.

Enjoy a week of your summer vacation at Dartmouth College in beautiful Hanover, New Hampshire learning about the future of music while meeting some of the music industry's most influential and prominent musicians. As a seminar student, you will receive daily small group and private instructions on the world's most advanced computer music system . . . the Synclavier II, featuring real-time digital synthesis, Sample-to-Disk , and *enhanced* automated Music Printing. N.E.D.'s staff will also be on hand to lecture on advanced hardware and software developments for the Synclavier II.

To complete the curriculum, you will also attend daily lectures and hear prominent Synclavier II owners describe how they use the Synclavier to realize and implement their creative ideas. Plus, there will be *special musical events*. Attendance is strictly limited and all participants must have a basic knowledge of synthesis or computers.

New England Digital Corporation reserves the right to select all seminar students.

SPECIAL OSCAR PETERSON CONCERT

Oscar Peterson will give a solo piano concert on June 24 in Spaulding Auditorium at Dartmouth College



Lecturers:

Sydney Alonso
President and chief of hardware design

Jon Appleton
Dartmouth College professor and worldwide performer on the Synclavier

Suzanne Ciani
Commercial Soundtrack Producer and Film Composer

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Tom Moody
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Please remit \$495.00 tuition and a brief resume with your return address and phone number to:



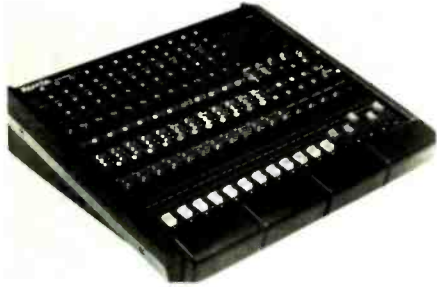
New England Digital Corporation
Dept. SEM#2
P.O. Box 546
White River Junction, VT 05001

Synclavier® II is a registered trademark of New England Digital Corporation.

New Products

RAMSA COMBINATION SOUND REINFORCEMENT/RECORDING CONSOLES FROM PANASONIC

Model WR-8118 is a PA mixer that accommodates up to 18 mike and line signals or, with the push of a button, a recording mixer whose numerous tape inputs handle multichannel recording, overdubbing, and mixdown. Both modes are controlled by the same set of controls, including a three-band equalization section on each input. High and low EQ can be set to one of two center



frequencies, while the sweepable, peak-dip mid-range knob covers a more varied range. In addition, direct outputs are provided on all input channels.

Output levels can be visually metered with a 12-point LED bargraph section, including Mono Master, Left and/or

Right, groups 1 through 4, or Send outputs. In addition, the Solo function provides the option to isolate and meter any of the 18 input or four group signals.

Model WR-8112 is designed with 12 mike and line inputs. Outputs include four Group, two Master, and one Mono Master. Further, the 12-point LED meter can measure any signal that travels through the console. Other features include a three-band equalization section on each input, and direct outputs.

Suggested retail price of the WR-8118 is \$3,150, and of the WR-8112 \$2,495.

PANASONIC
ONE PANASONIC WAY
SECAUCUS, NJ 07094
(201) 348-7183

For additional information circle #76

OBERHEIM ANNOUNCES OB-8 POLYPHONIC SYNTHESIZER

The OB-8 boasts all of the features of the OB-Xa, while adding Programmable Arpeggiator, expanded LFOs, Programmable Pitch Bend, Programmable Volume, external panpots, and provision for volume pedal. Program memory has also been expanded to include 12 splits and 12 double programs, in addition to the 120 sound programs. Further, the OB-8 features a selectable program cassette recall.

Standard OB-Xa features retained in the OB-8 are: eight-voice polyphony, each voice having two Oscillators, two Envelope Generators, selectable two- or



four-pole filter, and amplifier; five-octave keyboard with programmable split point, pitch bend and modulation levers; plus complete compatibility with the Oberheim System.

Suggested retail price of the OB-8 is \$4,395.

OBERHEIM ELECTRONICS, INC.
2250 S. BARRINGTON AVE.
LOS ANGELES, CA 90064
(213) 473-6574

For additional information circle #77

NEW 1200 AND 2400 POWER AMPLIFIERS FROM BIAMP

Both the 1200 and 2400, which share the same basic packaging and circuit topology, are designed to deliver maximum power at 4 ohms and drive two-ohm speaker loads with total stability. This gives the advantages of more speakers per amplifier, freedom from overload, less load sensitivity and lower distortion, Biamp says. The 1200 is rated at 250 watts per channel into two ohms, and the 2400 at 650 watts per channel.

RMX 16 DIGITAL REVERBERATOR



The RMX 16 is a digital reverberation system of unparalleled sophistication.

The unit is housed in a 3 1/2" high, 19" rack-mounting case, and offers 9 different programs of reverberation ranging from the smallest room to the largest hall. Unique special effects programs are also included.

Specifications are the most impressive available with a full 18kHz bandwidth and 90dB dynamic range.

A hand-held remote terminal is available which can also store 90 user programmed settings as well as supporting a light pen input for ease of program updating.



Advanced Music Systems
England: Tel. (0282) 36943
U.S.A.:
Quintek Tel. (213) 980-5717
Trident Tel. (203) 357-8337

Australia	A.M.S. (Int'l) Pty Ltd. . . . Sydney	Finland	Into Oy Helsinki
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Canada	Octopus Audio Toronto	Italy	Professional Eqpt. Milan
Japan	Continental Far East Inc. Tokyo	Singapore	Aurvi Private Singapore
Spain	Singleton Productions. . . Barcelona	Denmark	Sweet Silence Copenhagen
Hong Kong	Audio Consultants Kowloon	Holland	Audio Script Loosdrecht

Distortion caused by amplifier clipping is claimed to be virtually eliminated by Biamp's exclusive Auto Limit, a true complementary, dual slope, soft clipping amplifier limiter, first introduced on Biamp's 29 Series powered mixers. Circuit operation takes place only on signal peaks, thereby eliminating common compression-limiter problems, such as breathing, pumping, and dunking.



The heat sink configuration of the 1200/2400 design provides a simple and lightweight method of maximizing thermal dissipation. Instead of large cast or extruded aluminum heat sinks, and/or noisy fans, the new units feature Biamp's turbulent flow heat exchanger, which is thermally more efficient and about half the weight.

BIAMP SYSTEMS, INC.
P.O. BOX 728
BEAVERTON, OR 97075
(503) 641-6767

For additional information circle #79

**ELECTRO-VOICE INTRODUCES
EVT 5212 CONCERT
SOUND MIXER**

Priced at under \$1,000, the 12-channel EVT 5212 Tapco stereo mixer accepts balanced, low-impedance mike-level or unbalanced high-impedance line-level sources. A channel effects insert is provided on each input, as well as on the two subgroup outputs. The three-band EQ section consists of ± 15 dB bass (100 Hz), ± 12 dB midrange (3 kHz), and ± 15 dB treble (10 kHz) controls. Each channel also features an effects/reverb send, monitor send, pan control, peak LED, and channel fader.



According to Greg Hockman, E-V's director of marketing/music products, "We gave a lot of thought to the actual needs of our users, and have incorporated several handy features, such as additional gain, proper gain structure, and a built-in BNC connector for a plug-in, high-intensity mini light. Among the

new board's other special features are color-coded controls and panel graphics designed for greater visibility; individual plug-in PCBs that can be serviced easily; and complete hook-up diagrams silk-screened on the rear panel.

Besides mono, stereo, and monitor outputs, the EVT 5212's output section offers effects return master, aux input master, and reverb return master, each pannable to the stereo sub-groups; effects send master; and meter assign switch.

The new EVT 5212 mixer is available for a pro net price of \$995.

ELECTRO-VOICE, INC.
600 CECIL STREET
BUCHANAN, MI 49107
(616) 695-6831

For additional information circle #80

**WHIRLWIND UPGRADES
MEDUSA SERIES
MULTI-WIRING SYSTEMS**

As of September, the Medusa 19 (16-in/3-out) was changed to the Medusa 20 (16-in/4-out). In November, the Medusa 15 (12-in/3-out) was replaced by the Medusa 16 (12-in/4-out). In March 1983, the Medusa 27 (24-in/3-out) will be replaced by the Medusa 30 (24-in/6-out). Each of these changes will not add to the cost of Medusa multi-wiring systems.

The company also has introduced a new series of transformers for impedance matching, with specifications reported to exceed those of any competitive transformers designed for similar purposes.

The TRSP-1 and TRSP-2 transformers are designed to split a single micro-



Mr. Randy Goodrum—
Composer, Artist, Musician, Producer,
Arranger, Writer of such hits as: "You
Needed Me", "Bluer Than
Blue", "A Broken Hearted Me"

"When I needed recording equipment for my home studio, I turned to Valley Audio. They installed an Otari MX-5050-MKIII-8 1/2" 8 Track with a Sound Workshop Logex 8 Console. The entire system has worked flawlessly and makes great recordings. The people at Valley Audio were informative and very helpful. I now turn to Valley Audio for all my recording needs. You should too."

Randy Goodrum

**VALLEY
AUDIO**

New Products

phone signal into two or three separate signals. They feature an exceptionally flat frequency response (between 10k and 50 kHz), and can handle up to 6 volts at the input stage before saturation with virtually no distortion.

The TRHL-M and TRHL transformers are designed for high-to-low impedance matching. They feature the same specs as the TRSP-1 and TRSP-2 transformers; the TRH2-M, packaged in a Mu-metal can, carries an extended frequency response. All transformers have electrostatic shielding between the

windings, and are available in bulk or installed in Whirlwind products.

WHIRLWIND MUSIC, INC.
100 BOXART ST.
ROCHESTER, NY 14603
(716) 663-8820

For additional information circle #82

TELEFUNKEN M21 TAPE MACHINE WITH 12½-INCH REEL CAPABILITY

The new compact M21 studio tape machine accommodates 12½-inch reels, giving a capacity of 3,600 feet of standard tape, and features microprocessor controls for operation and front-panel displays.

The M21 is offered with four tape speeds of 3¾, 7½, 15, and 30 IPS, and is



designed for mono, stereo and two-track recording. The tape drive is via a crystal-reference, brushless DC motor, and the braked capstan drives also are driven with an electronically-regulated DC motor. Other features include a cue-zero locator, five-digit electrical counter, and ±10% varispeed.

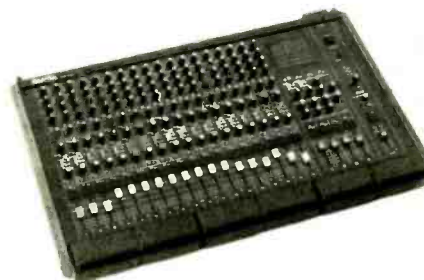
US price is expected to be around \$7,500.

GOTHAM AUDIO
741 WASHINGTON STREET
NEW YORK, NY 10014
(212) 741-7411

For additional information circle #83

PANASONIC INTRODUCES COMPACT RAMSA MULTITRACK CONSOLE

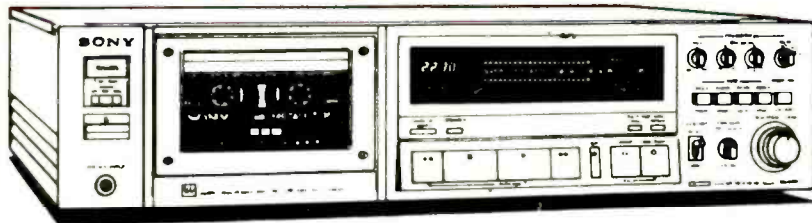
The new RAMSA Model WR-8616 is able to be used with either a 4-track or 16-track recorder. Special features include 16 electronically-balanced mike and 16 line inputs, plus 16 direct line outputs. In this way, the mike-in signals may be sent to a 16-track tape recorder, then fed back into the 16 line-in inputs. Thus, the input signals may be mixed using the tape monitor controls in the group modules, with no changes in the wiring arrangements. Send controls in the group modules enable signals to be routed directly from the line-in inputs to the left and right cue send busses in the Master module. This permits independent control from monitoring and headphone cue send mixes to be performed simultaneously.



The mike inputs of the monitor section may be employed without altering the patch connections, so that recordings can be made while monitoring the actual input signals. All tracks going into the tape machine can be visually and audibly monitored.

Model WR-8616 provides a total of 10 mixing busses, which include four Group, two Master, two Send, and two Echo. Additional flexibility is featured through 16 insertion jacks on the Input modules, for connecting external

Sony's Top-of-the-Line! Above and Beyond Every Other Cassette Deck! The Reference Machine in use at Major Tape Duplicators!



True Studio Performance... The sound quality of Sony's TC-K777 fully realizes the expectations of its designers. As such, it fulfills the needs of the most demanding studio professionals.

OUTSTANDING FEATURES: • Sony's exclusive Independent Suspension three-head design for superior performance and off-the-tape monitoring while you record. • Anti-resonant transport design to minimize modulation noise. • Direct-drive system with Linear Torque BSL (brushless, slotless) motor for efficient and precise capstan drive. • Quartz-lock prevents even minute speed variations • Closed-loop dual-capstan system for superior control of tape tension and reduced modulation noise. • Digital Linear Counter of playing time, for the most precise index of tape location available. Count remains accurate even in fast-forward and rewind.

OUTSTANDING SPECIFICATIONS: • WOW & FLUTTER, WRMS — 0.025%; Din-45507 — ±0.07% • FAST FORWARD REWIND TIME, C-60, — 80 sec. • FREQUENCY RESPONSE, ±3dB, re: -20dB guaranteed: Type IV (Metalic) - 20Hz-20kHz, Type III (FeCr) -20Hz-20kHz, Type II (UCX-S) - 20Hz-18kHz, Type IV (Metalic) (±3dB, re: 0dB) -20Hz-13kHz • SIGNAL-TO-NOISE-RATIO, (Dolby NR off, re: 3% THD, peak wtd.): Type IV (Metalic) — 60dB, Type III (FeCr) — 60dB, Type II (UCX-S) — 59dB, Type I (SHF) — 56dB • TOTAL HARMONIC DISTORTION (1kHz re: 0dB record level): Type IV (Metalic) — 0.8%, Type II (UCX-S) — 0.8%.

OUTSTANDING TECHNOLOGY: • Sendust and Ferrite (S&F) record and playback heads for long life and metal tape capability. • Adjustable bias to achieve flat high-frequency response and low distortion for any tape. • Record level calibration for accurate high-frequency sound in Dolby-encoded record and playback. • Two-motor tape drive with frequency servo control. • Dolby B noise reduction with Sony's exclusive Dolby IC.

An ADRAY'S BLOCKBUSTER best deal: \$530.00

Manufacturer's suggested retail price: \$950.00

Add the NR-500 Dolby C noise reduction module: \$125.00

(Mrs. sug. List: \$190.00)

At either location, or send check or money order for freight collect delivery.

5575 WILSHIRE BOULEVARD
LOS ANGELES, CA 90036
(213) 936-5118

Adray's

6609 VAN NUYS BOULEVARD
VAN NUYS, CA 91405
(213) 908-1500

equipment. In addition, four return jacks are provided to connect a second mixing console, or to return effects to the Group modules.

Each input module offers separately adjustable three-band EQ, echo, and left and right send controls, plus input faders. The unit's monitoring system permits direct monitoring without altering patch cord connections through complete access to all 16 inputs. On a multi-track tape machine, monitoring of up to 16 channels can take place while recording is in progress.

**PANASONIC
ONE PANASONIC WAY
SECAUCUS, NY 07094
(201) 348-7183**

For additional information circle #84

HARBINGER AUDIO ISO-BOX FOR STUDIO AND STAGE MIKING

The Iso-Box, designed in cooperation with guitarist Ronnie Montrose, is an isolation chamber for an instrument speaker that provides a high degree of SPL attenuation from its interior to the external environment. The new unit functions as a "direct box" for studio or live reinforcement use, permitting its output to be added directly to a recording or sound reinforcement mix.



An internal microphone picks up the output of a speaker housed in an isolated subchamber. The user chooses a speaker and external amplifier source to drive it that will give the desired tonal characteristics. The extensive sound absorptive materials are said to allow the speaker to operate at any level without interfering acoustically with other instruments.

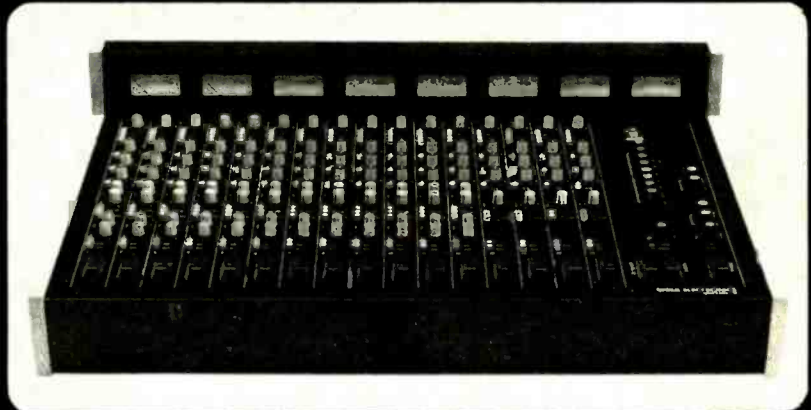
The unit is compact (less than 3 feet tall) and occupies only 2.5 square feet of floor space. Banana jack input and three-pin mike output are provided on a prewired recessed jackplate. Microphone mounting hardware is provided. Large recessed handles and rubber feet are standard.

**HARBINGER AUDIO
960 O'BRIEN DRIVE
MENLO PARK, CA 94025
(415) 329-8282**

For additional information circle #85

**"Recording game show theme songs
or music for a "Norman Lear" T.V. series
demands my very best...
and a very good
Recording Console."**

HAL HIDEY/HAL HIDEY STUDIOS



The "Speckmix 16" is a 16 input, 8 output recording console...researched, designed, and intended specifically for professional and semi-professional 8 and 16 track studios.

There are many things that can be said about the "Speckmix 16" to compliment the functions, versatility, and styling of this mixer, but one word that explains the console the best is "smart". Smart, because this 16 input, 8 output console was designed to facilitate an 8 or 16 track recorder without the traditional patching, reconnecting, or control changes associated with conventional 16 in 8 out consoles.

12455 BRANFORD ST. UNIT 2
ARLETA, CA 91331 (213) 897-4188

We all know that mixing consoles come in all shapes and sizes, can come in all price ranges, and offer features to meet any application. With the "Speckmix 16", Speck Electronics used ideas gained from many years of experience in console manufacturing to include the features you really need to operate your recording facility...eliminate the gimmicks or options you don't need, and offer it at an affordable price. Starting under \$4,000.

**SPECK
ELECTRONICS**

For additional information circle #86

New Products

MXR ANNOUNCES NEW MODEL 151-1 TIME DELAY

With selectable delay of up to 3.2 seconds in its full-memory configuration, the Model 151-1 provides a very wide variety of delay effects, ranging from flanging, chorusing, vibrato, Doppler shifting, hard reverb to discrete echo. A half-memory version is also available (Model 151) which offers delay times of up to 1.6 seconds, and it can easily be upgraded with the addition of an optional memory module.



The new Delay System II also features a Repeat-Hold capability. Normally used at the outer end of the delay range — from about 500 to 3,200 milliseconds — this feature allows entire musical phrases to be captured and replayed indefinitely, eliminating troublesome tape loops.

Additional features include digital readout of delay time in milliseconds and bandwidth at the selected delay, Sweep Speed and Width controls, Mix, Dry Defeat and Invert Delay controls,

Master Level and Bypass, Aux Loop In and Out capability, and switchable instrument/line inputs.

Suggested retail price of the Model 151-1 Delay System II is \$1,350.

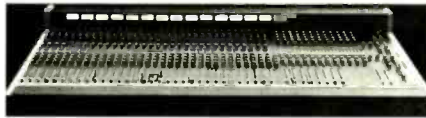
MXR INNOVATIONS, INC.
740 DRIVING PARK AVENUE
ROCHESTER, NY 14613
(716) 254-2910

For additional information circle #88

AUDIOARTS ENGINEERING ANNOUNCES R-16 AND R-24 SERIES CONSOLES

The new R-16 and R-24 Series consoles are of a modular plug-in design intended for 8- and 16-track recording. With the addition of R-24 expander modules, 24-track recording can be accomplished as well.

The consoles employ separate input and group/output modules. R-16 and R-24 consoles have four individual channel cue/effects feeds and two bus cue/effects controls to accommodate musicians with varying cue requirements. Standard input module features include three-band, fully sweepable equalization, switchable phantom power, phase switching, HPF, left/right and odd/even bus assignment, and precision conductive plastic faders.



Console systems include LED clip overload indicators throughout the signal path, separate effects send and return modules, master left and right output modules, and a special CS-8 control module housing studio, control room and headphone monitor, talkback, slate, oscillator, and solo functions.

R-16 and R-24 Series consoles are available in 24, 32, and 40 input mainframe sizes, and range in price from \$10,000 to \$17,000.

AUDIOARTS ENGINEERING
5 COLLINS ROAD
BETHANY, CT 06525
(203) 393-0887

For additional information circle #89

RETROFIT MEMORY EXPANSION FOR EVENTIDE 1745M DIGITAL DELAY

A new version of the 1745M modular digital delay offers maximum delay lengths eight times longer than previous models. Delays of up to 2.5 seconds (5 seconds in Double mode) are now available to each output (up to 5 output modules can be installed in the mainframe). Frequency response remains a quoted 50 Hz to 15 kHz, ±1 dB, at all delays up to the new 2.5 second maximum. The increase in performance — made possible by the new generation of random access memory chips — is offered at no increase in price.

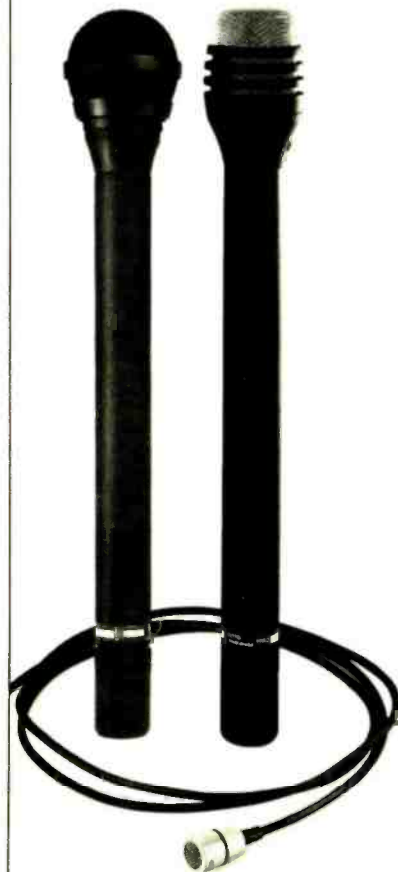
To accommodate the many 1745M units currently in the field, Eventide is

UNCOMPROMISING WIRELESS MICROPHONES

Finally, you can choose a wireless mic to fit the application. The Telex WHM-300, the electret wireless transmitter mic for uncompromising speech clarity. Or a Telex WHM-400 dynamic wireless transmitting mic for vocal entertainment with rich, full bodied audio quality. Both elegantly tapered and without trailing antenna wires. Or select the miniature electret WLM-100 lavalier mic (or any standard dynamic mic) with our belt-pack transmitter.

Combined with the superb Telex dual diversity* FM receiver, you'll have a wireless system that is as good as any hard wired mic, and at a reasonable price. Write us today for full details.

Quality products for the Audio Professional



TELEX

TELEX COMMUNICATIONS, INC.

9600 Aldrich Ave. So. Minneapolis, MN 55420 U.S.A.
Europe: Le Bonaparte, Office 711, Centre Affaires Paris-Nord, 93153 Le Blanc-Mesnil, France

*U.S. Patent No. 4293955 Other patents applied for

making a retrofit upgrade kit available for \$995.

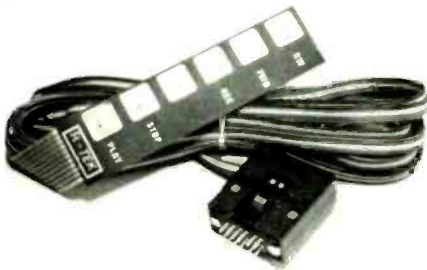
"We are please to further extend its versatility with this new 8-times longer maximum delay capability," an Eventide spokesperson commented. "But most of all, we're delighted to make this improvement available to all 1745 users . . . right back to the first unit off the line."

EVENTIDE CLOCKWORKS, INC
265 WEST 54TH STREET
NEW YORK, NY 10019
(212) 581-9290

For additional information circle #90

**R-TEK INTRODUCES NOVEL
REMOTE CONTROL STRIP FOR
TASCAM, OTARI AND
FOSTEX MACHINES**

The RS-1 Remote Control Strip will interface with TEAC/Tascam tape recorders, and can be special ordered to interface with Fostex and Otari machines.



Features include 20 foot ribbon cable, interface connector, record, play, fast forward, rewind, stop, and pause functions. The RS-1 has an adhesive backing which permits mounting on any flat surface, such as a blank mixer module, thereby doing away with the need for a bulky remote box.

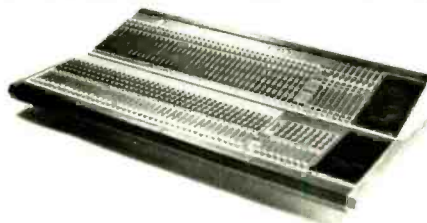
The RS-1 Remote Control Strip, which measures 5¼ by 1¼ inches, has a professional list price of \$49.95.

R-TEK, A SUNTRONICS CO.
11151 PIERCE
RIVERSIDE, CA 92515
(714) 359-6058

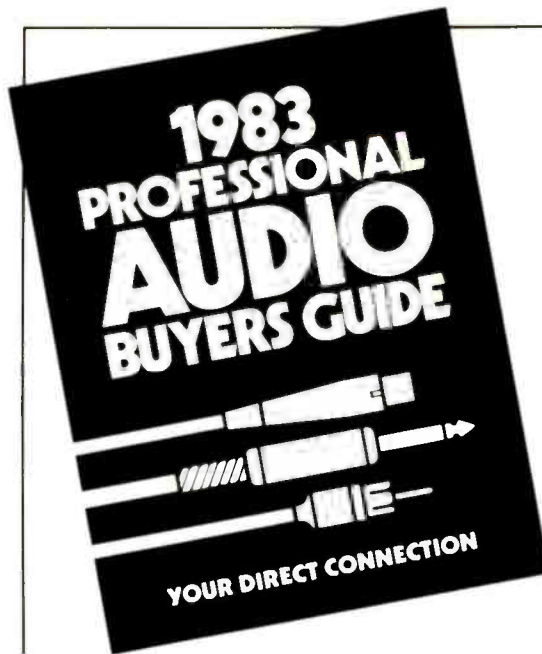
For additional information circle #91

**SOUNDCRAFT ANNOUNCES
SERIES 4 CONCERT SOUND
AND THEATER BOARD**

The Series 4 is a custom console series designed for large sound companies and theaters. Typical channel facilities include: phantom power, pad, balanced line in, individual channel VU meters,



variable high and low pass filters, four-band fully parametric EQ, six aux sends selectable pre or post, eight stereo sub-groups, and eight mute busses.



AKG — ALTEC
ANCHOR SYSTEMS
ARGOS SOUND
AUDIO TECHNICA
ALLEN & HEATH BRENNELL
BOGEN — CLEAR COM
COMMUNITY LIGHT & SOUND
CREST — CROWN
DOD ELECTRONICS
EDCOR
ELECTRO VOICE
FOSTEX
FRAZIER
GALAXY AUDIO
HME — JBL
JENSEN
LEXICON
MIC MIX
MXR — NADY — NEI
OTARI
PHASE LINEAR
QSC AUDIO PRODUCTS
QUAM NICHOLS
RAMSA-TECHNICS
SHURE — SONY
SOUND WORKSHOP
STUDER REVOK
STUDIO MASTER
SWINTEK
TANDBERG
TASCAM/TEAC
AND MANY OTHERS!

**BEFORE YOU BUY ANYTHING,
BUY THIS!**

Now there's a better way to shop for professional sound equipment. The 1983 Professional Audio Buyers Guide brings it all to you for less than the price of a tank of gas. Everything from amps, speakers, mixers and mikes, to recorders, duplicators and lighting. The best products available in the industry from over 70 manufacturers of PA and recording equipment. All in one easy-to-use book, complete with a cross-referenced index, pictures, model numbers, features, specs, and most importantly — prices.

Whether you're planning to buy a complete sound system, or just the right mike, the 1983 Professional Audio Buyers Guide is your direct connection. Save time and money by comparing equipment and features before you buy anything. Manufacturers are listed with addresses, names to contact, and phone numbers — often toll-free. And you'll find pro audio gear you've never seen before, because no dealer can show you as much as we can. But hurry. Last year the Buyers Guide sold out at \$15.95 each. Now you can have it for only \$9.95 while publications last.

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R-e/p

For additional information circle #94

THE CONNECTION

FOR USED AUDIO & VIDEO EQUIPMENT

CONSOLES • TAPE MACHINES
OUTBOARD EQUIPMENT
BOUGHT & SOLD

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Summit Audio

P.O. BOX 1678 LOS GATOS, CA 95031 408/395-2448

For additional information circle #93

STL

PRECISION



MAGNETIC TEST TAPES

STANDARD TAPE LABORATORY, INC.

26120 EDEN LANDING ROAD #5, HAYWARD, CALIFORNIA 94545 • (415) 786-3546

R-e/p 114 □ February 1983

New Products

The console also has eight effects return channels with EQ, a complete integrated patch bay on TT sockets, and multipin connections custom-wired for any connector.

The Series 4 comes in a 40-input/16-output mainframe, and may be ordered in a monitor configuration, or for a front-of-house application.

SOUNDCRAFT, INC.
20610 MANHATTAN PLACE #120
TORRANCE, CA 90501
(213) 328-2595

For additional information circle #95

AUDIO + DESIGN LAUNCHES AMPACK 8 MONITOR AMP

The new AmPack 8 monitor amplifier is described as being ideal for use wherever line-level signals will need to be monitored, and where headphones cannot be easily supplied.



Input is via a latching female XLR connector. Output is via two sprung wire-clamps, and can be connected to any 8 ohm speaker. Power rating is 8 watts.

AUDIO + DESIGN RECORDING
P.O. BOX 786
BREMERTON, WA 98310
(206) 275-5009

For additional information circle #96

NEW BROCHURE FROM JRF MAGNETIC SCIENCES

JRF Magnetic Sciences supplies a series of tape heads, and offers precision relapping services.

The new brochure, available at no charge, contains a set of eight spec sheets explaining in detail the type of recording heads, and the relapping services available from the company. JRF's Studio Mastering Series includes two- and four-track half-inch, eight-track one-inch, and 16- and 24-track two-inch heads. Also available are high-speed tape duplicating and master playback heads.

JRF MAGNETIC SCIENCES
101 LANDING ROAD
LANDING, NJ 07850
(201) 398-7426

For additional information circle #97

please mention . . .
YOU SAW IT IN R-E/P

... continued from page 28 —

FENDER TAKES AIM AT PROFESSIONAL AUDIO MARKET WITH NEW DIVISION

Fender Musical Instruments has created a Professional Sound Products Division, according to Roger Balmer, vice-president, sales/marketing/R&D. Realizing that an essential part of the success of any new venture is a solid foundation of experienced and knowledgeable team members, Balmer set out over a year ago to acquire the talent necessary to conceive, design and produce a cost-effective and performance-oriented product line.

Balmer was with Yamaha from 1968 to 1979, and is said to have been instrumental in that company's success in the pro and combo sound divisions.

The new Fender division includes Roger Cox, who heads up the Fullerton R&D project; Bob Haigler, engineering manager and electronics designer; Cal Perkins, manager of audio products design; and Steve Woolley who recently joined the company as marketing director for professional sound products.

According to Woolley, "Our new products will cover the entire system, from a complete line of microphones, with some very unique features, to a full line

of sound reinforcement loudspeakers, and including a range of powered mixers and two-bus output mixing consoles, along with power amplifiers."

Release date for specific products will be announced this spring. Products are scheduled to be in-store by summer.

EASTERN ACOUSTIC WORKS SUPPLIES SUB-WOOFERS FOR KENNEDY SPACE CENTER

A new sub-woofer system supplied by EAW is now in operation at the Kennedy Space Center Visitor Information Center, to enable visitors to experience the sight, sound, and feel of a Space Shuttle launch.

The system, designed by Communitechnics of Florida, Inc., is said to be capable of reproducing the full sonic impact of a Shuttle launch, complete with exceptionally low-frequency, high-output pulses. Communitechnics' director of systems design, C. Steven Meyer, opted to use EAW BH-880-LRs for these special low-frequency requirements, since the unit is designed to offer substantially more output capability below 50 Hz than any other system reviewed.

By using a pair of sub-woofer systems, a number of significant advantages are said to have been realized over vented systems, which are popular for this type of application. Two BH-880-LRs offer the equivalent output of approximately 16 vented systems. Additionally, the vented systems would require a min-

imum of four times the amplifier costs. The horn loaded approach also benefits from increased directivity for a more defined bass throughout the room.

ELECTRO-VOICE OFFERS BINDER FOR PA BIBLE

"Since many sound contractors and others involved in sound reinforcement find the PA Bible an invaluable reference tool, and keep their dog-eared copies close at hand, we are making available a special binder," says EV's Thomas Zoss.

The three-ring binder will accommodate the PA Bible and the 11 current supplements, plus future additions. It can be ordered for \$5.00 postpaid from: Electro-Voice, Inc., 600 Cecil Street, Buchanan, MI 49107. (616) 695-6831.

SOUNDSTREAM ANNOUNCES MAJOR EXPANSION OF SERVICES AND PERSONNEL

The wholly-owned subsidiary of Digital Recording Corporation has announced a variety of changes at its Los Angeles digital recording and editing facilities, located on the Paramount studio lot in Hollywood. The office now will become the center for the company's worldwide digital recording and editing activities.

According to company president Robert Ingebretsen, "The Los Angeles facilities will now offer Soundstream clients additional two-, four-, and eight-

New... Less Expensive... 8-Track Recording/Mixing/Production SYSTEM:

With each of the individual equipment units selected for their technical excellence, operational efficiency, and above all, their accuracy and reliability, the Suntronics 8-track production system has been studio-tested, and packaged in two ranges. The *Maxi* system to meet the requirements of a start-up facility... or the *Mini* to meet the requirements of an operator who already has a power and monitoring system...

The Maxi System: \$8,150



The Mini System: \$6,750

The Suntronics *Mini System* consists of the incomparable Sound Workshop 12x8 Logex control console, matched to the newly introduced Tascam Model 38, 8-track recorder. The *Maxi System* adds a BGW Model 250-D power amplifier and a pair of JBL 4312's for an ideal monitoring environment. Both systems include interface cabling.

in stock, ready for set-up!



1620 W Foothill Blvd
Upland, CA 91786
(714) 985-2547 - 985-5307

7760 Balboa Blvd
Van Nuys, CA 91406
(213) 781-2537 - 781-2604

7560 Garden Grove Blvd
Westminster, CA 92683
(714) 898-6368 - 898-9036

11151 Pierce Street
Riverside, CA 92515
(714) 359-5102 - 359-6058
February 1983 □ R-e/p 117

For additional information circle #98

track digital recording equipment, comprehensive digital Instant Access Editing capability, combined with Soundstream's SMPTE compatible recording and Instant Access computerized editing system."

Also announced was the appointment of Richard Baccigaluppi as vice president of marketing and operations for Soundstream. His responsibilities will include the broadening of applications to better serve the digital needs of the audio, video, film and communications industries. Jim Wolvington will continue as manager of the Los Angeles editing center, and Richard Feldman has been promoted to recordings manager.

CROWN ANNOUNCES SECOND PZM CHALLENGE CONTEST

The PZM Challenge II, a contest for professional and amateur recordists, now in its second year, rewards excellence in recordings made with PZM microphones.

"Through last year's PZM Challenge, we discovered many exciting applications for PZM microphones," said Gerry Barclay, Crown's promotions manager. "We're anticipating a larger participation for Challenge II and, of course,

some creative PZM entries."

Entries must be excerpts from original stereo recordings made using two or more PZM microphones as the principle pick-ups. They are judged on the basis of how the recording reflects the attributes of the PZM mike, overall sound quality of the recorded material (including microphone placement and techniques) and, for multiple microphone recordings, the quality of the mix.

Winners will receive a pair of PZM microphones; one grand prize winner, chosen from the category winners in each Challenge, will receive a set of Crown components.

Deadline for entries is May 1, 1983, and winners will be notified by June 15, 1983. For an entry form and more information, contact any Crown PZM dealer, or write to Crown International, PZM Challenge II, 1718 W. Mishawaka Road, Elkhart, IN 46517.

AMEK SYSTEMS SETS UP US OFFICE HEADED BY TIM MUNGOVAN

After many years with Everything Audio, Tim Mungovan has made mutually agreeable plans to head the United States office for AMEK Systems and Controls, of Salford, England. Having gained much experience with AMEK while at Everything Audio, Mungovan starts the US operation with a full line of audio desks, according to Everything Audio president, Brian Cornfield, and

AMEK director Nick Franks.

Everything Audio, having recently been appointed Harrison Systems, Inc., sales representative for Southern California, will cooperate with the new US Amek office to facilitate a smooth transition.

The new address for AMEK of America, is: 5600 Collins Place, Woodland Hills, CA 91364. (213) 704-0165.

REVOX MACHINES NOW PACKED WITH TAPE, HUBS AND REEL

Each new Revox PR99 and B77 tape machine will be packed with two standard NAB adapter hubs, a metal take-up reel, and a 10½-inch reel of 3M/Scotch 226 tape, according to Lawrence Jaffe, Revox director of marketing and sales. "We're offering a complete package," Jaffe explains. "The working professional now can unpack his Revox, and be ready to record within minutes. Also, because the recorders are set-up and QC'd using Scotch 226, we can guarantee optimum performance right out of the box."

In addition, all Revox B710 MKII cassette decks now will be packed with three free TDK cassettes.

QUINCY JONES COLLECTS BEST-OF-BEST SCOTTY AWARD

A creative team headed by composer-arranger-artist Quincy Jones has won the Best-of-the-Best "Scotty" Award

ACCURATE TAPE TENSION MAKES BETTER RECORDINGS



The Tentele Tape Tension Gage is designed to diagnose problems in your magnetic tape equipment. Virtually all recorder manufacturers use and recommend the TENTELOMETER® for use with their equipment. The TENTELOMETER® measures tape tension while your transport is in operation, so you can "see" how your transport is handling your tape; high tension causing premature head and tape wear, low tension causing loss of high frequencies, or oscillations causing wow and flutter. Send for the Tentele "Tape Tips Guide". The T2-H20-ML sells for \$279 -complete.

TENDEL (408) 379-1881
1506 Dell Avenue Toll Free
Campbell, CA 95008 800-538-8894
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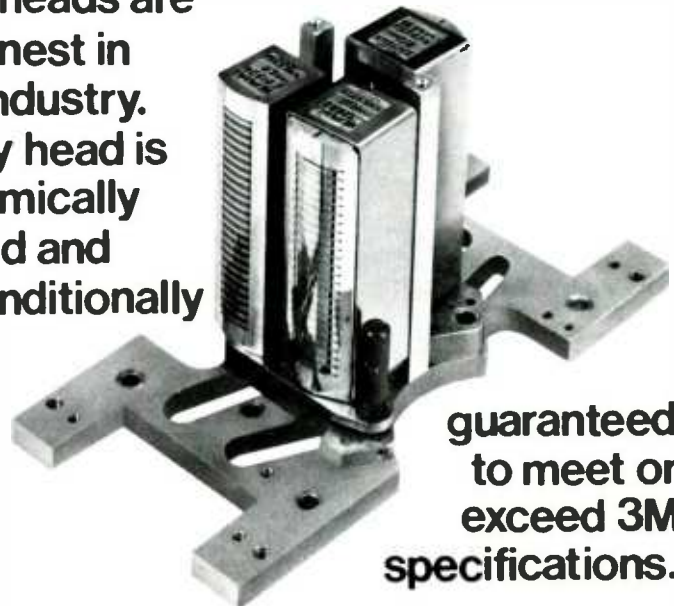
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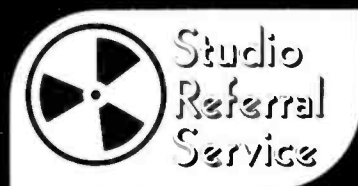
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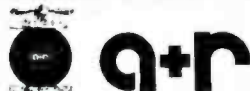
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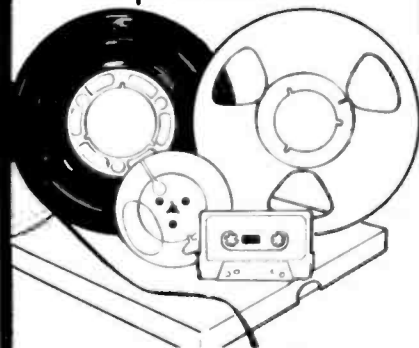
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For additional information circle #108

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PEOPLE ON THE MOVE . . .

- **Robert Cavin** has been promoted to the newly-created office of vice president, engineering and computers, at McCune Audio/Visual. In his new position, Cavin holds primary responsibility for McCune's computer marketing department, which introduces the concept of short-term rentals of the Apple computer line.
- **Kenneth J. Rolnicki** has been appointed vice president of marketing at Electro-Voice, Inc. and will oversee and coordinate the activities of EV's four marketing divisions. **Douglas W. MacCallum** has joined the company as western regional sales manager. The firm also has hired four new engineers: **Allen F. Eberts**, EV's new director of engineering; **Robert Dure**, chief

mechanical engineer; **Christoph Heidelberger**, senior product engineer; and **Mike Miles**, design engineer.

- **Tracy Battle** has been appointed director of marketing at Quad/Eight Electronics. Formerly with Quantum Audio Labs, Battle comes to Quad/Eight with over six years of experience with professional audio systems.

- **Irwin Laskey** has been promoted to director of sales and marketing at BGW Systems. In his new capacity, Laskey will continue to develop BGW's expanding domestic and international network of distributors and dealers, as well as supervise the marketing of the newly introduced line of Professional Mobile Audio products.

- **Charles V. Kish** has been named vice president of finance at Altec Lansing. Kish received his degree in Accounting from Cal State Long Beach, and maintains his Certified Public Accountant status within the state of California.

- **Tony Hawkins** has been named as Beyer Dynamic national sales manager. Hawkins was actively involved in the original distribution of Beyer product in the US. From there, he spent six years with Martin Audio in New York City, as a salesman/consultant specializing in microphones.

- **Ernest L. Heisser** has been appointed international market manager professional business for 3M's Magnetic Audio/Video Products Division. In his new assignment, Heisser will be responsible for the development of business plans and strategies for outside-the-United-States broadcast and recording markets. Also, **Dennis A. Farmer** has been appointed business development manager, professional business, Magnetic Audio/Video Products Division, responsible for the division's media products sold into the broadcast and commercial markets, while **James J. Farrell** is the division's new national sales manager.

- **John Hoge** has been appointed manager of transducer research and development at JBL. As department manager, Hoge directs the transducer engineering staff in investigating, developing, and improving component loudspeaker and system designs. Also, **Steve Armstrong** has been named western regional sales manager for the company's professional products division. Armstrong will supervise all sales of JBL professional products in 13 Western states, including Alaska and Hawaii.

- **Terence D. O'Kelly** has been appointed product manager for BASF System Corporation's line of flexible magnetic recording media. Prior to his appointment, O'Kelly spent five years with BASF's audio/video product group, most recently as manager of technical marketing services.

- **Arnold Toshner** and **Craig Hunter** have joined Everything Audio, the LA-based equipment supplier, as sales staff. Toshner brings with him the knowledge and experience gained through many years of tour mixing on the road with many prominent groups, both in the US and abroad. Hunter comes to Everything Audio with studio experience in both the equipment and the studio construction fields. Also, the company recently opened an Orange County field office, to be headed by **Paul Svenson**, with assistant **Bruce Bell**.

- **John Strand** has joined Klipsch & Associates as sales engineer/professional products, a new position with the firm. Strand will begin a technical assistance program, working as a liaison between Klipsch, sound contractors, and end-users of the company's professional products.

- **Tony Satariano** has been appointed eastern regional sales manager for Crown International. Satariano's 10 years of audio experience includes service with Electro-Voice, InterAudio systems, and Koss. ■■■

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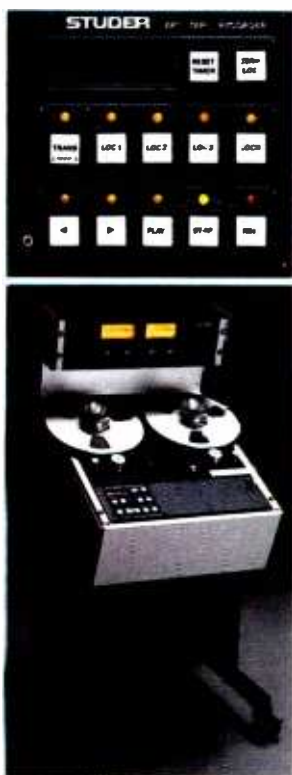
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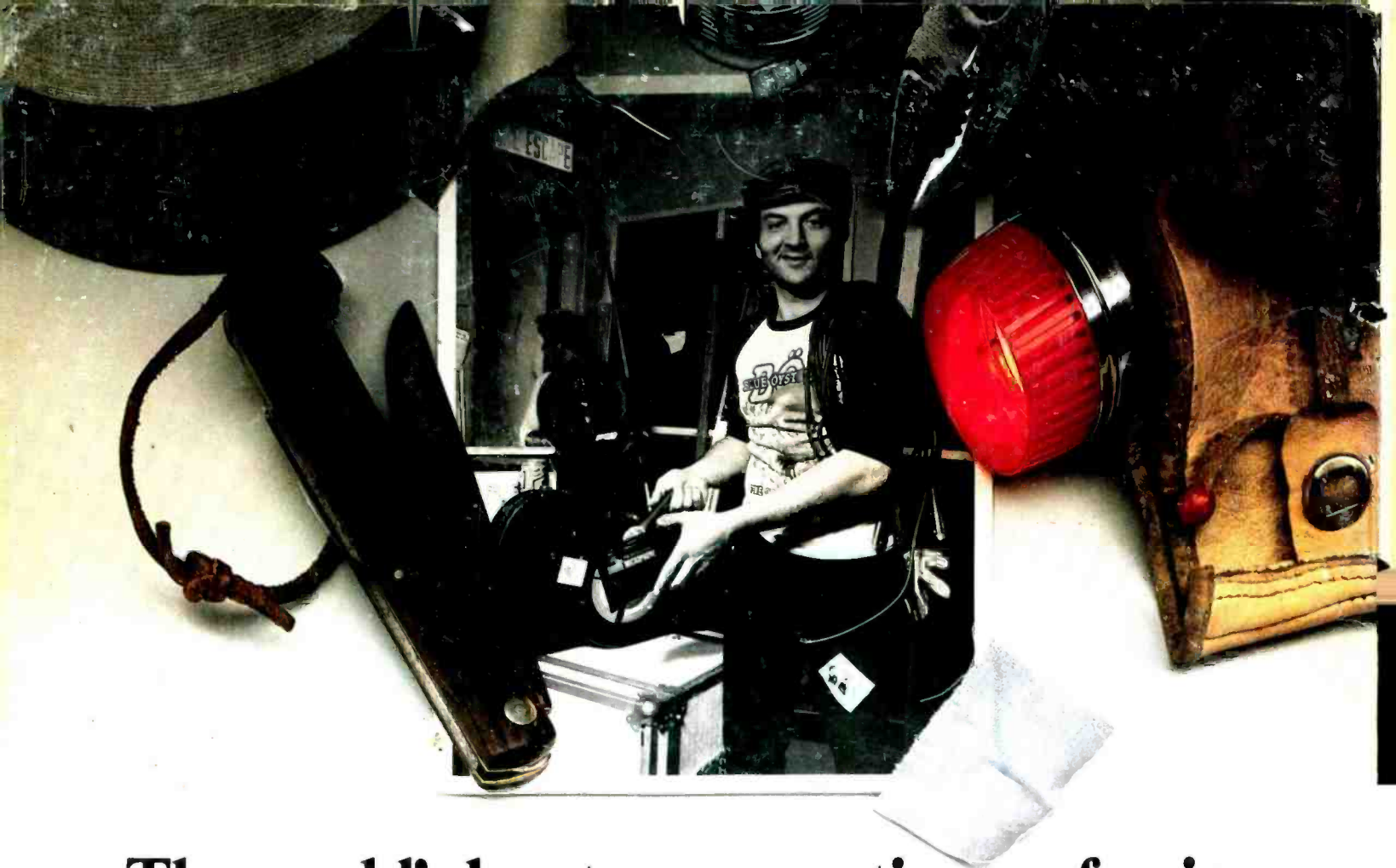
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For additional information circle #113



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