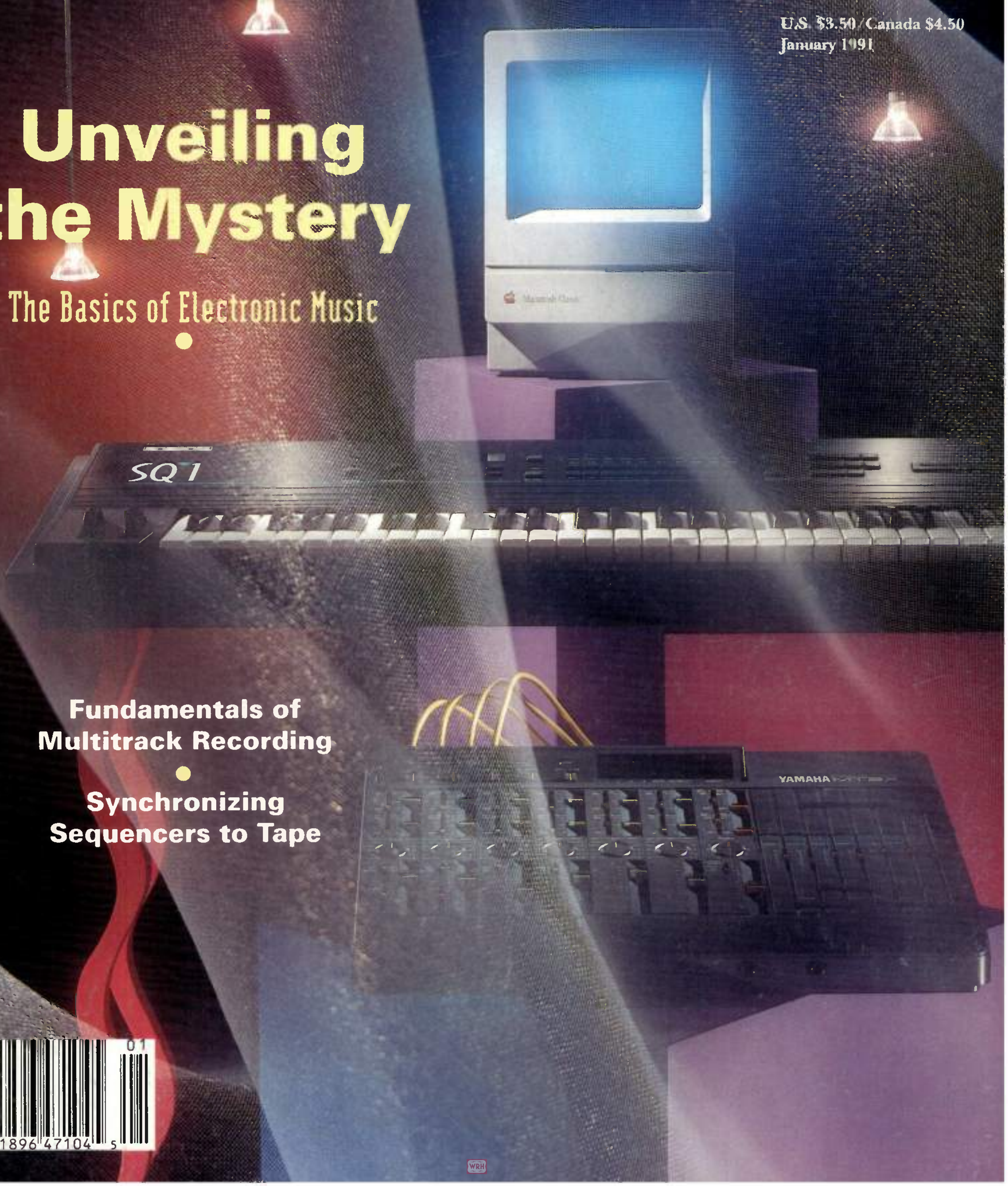
Reviews: Roland S770 • Dr. T's X-oR • Passport Sound Apprentice • and more

Electronic Musician

U.S. $3.50/Canada $4.50
January 1991

Unveiling the Mystery

The Basics of Electronic Music



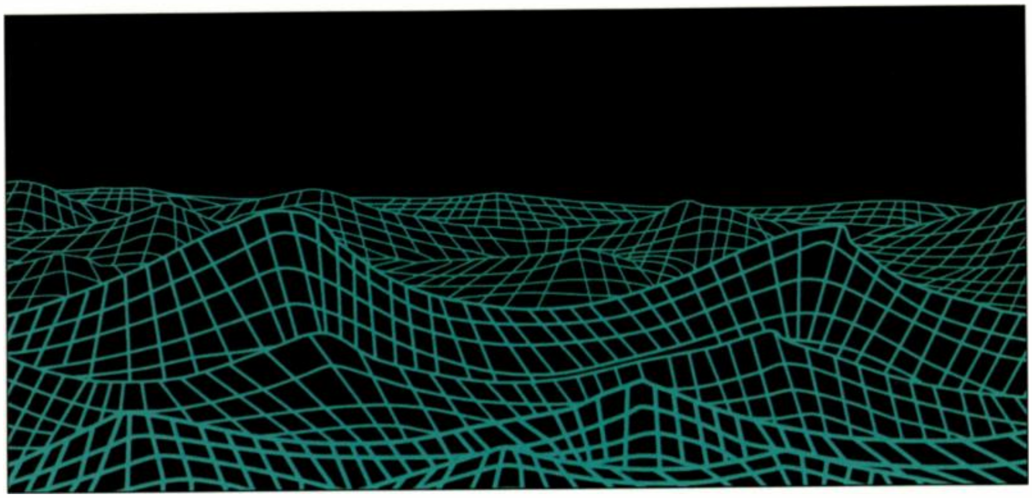
Fundamentals of Multitrack Recording

Synchronizing Sequencers to Tape

"What struck me immediately is that the sounds have an 'inner life'." — *Electronic Musician*, 11/90, reviewer Gary Hall.

"We predict that wavesequencing will become as much a part of our musical vernacular as analog synthesis, FM, and sampling have." — *Keyboard Magazine*, 9/90 Michael Marans.

MAKE WAVES.



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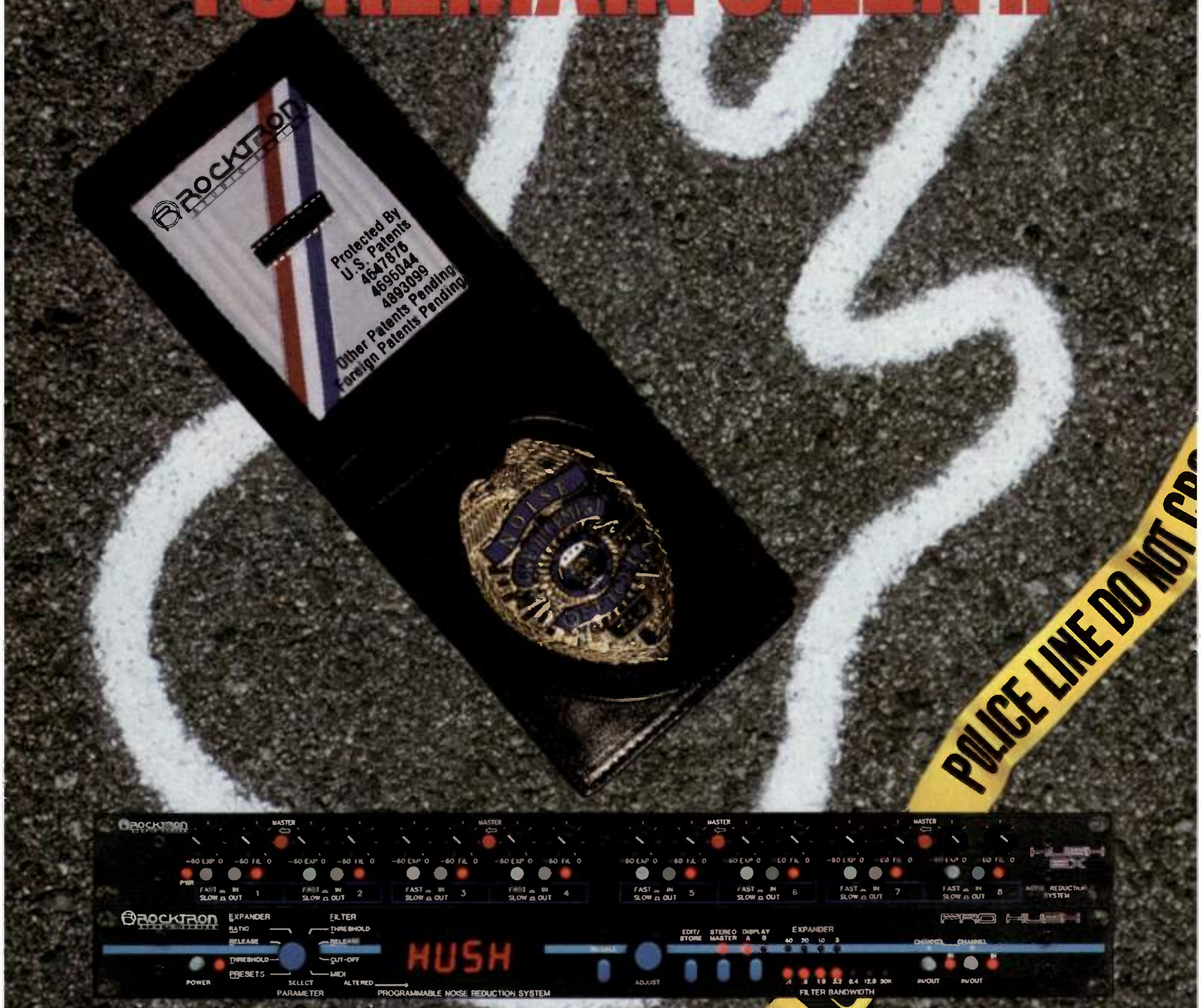
YOU HAVE THE RIGHT TO REMAIN SILENT.



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STUDIO SERIES

Electronic Musician

AN ACT III PUBLICATION
JANUARY 1991 VOL. 7, NO. 1

features

columns

PAGE 26

PAGE 20

reviews

departments

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Coming of Age

***EM** marks its fifth anniversary with a return to the basics.*

At **EM**, the start of 1991 and the arrival of this January issue provide particularly appropriate and exciting opportunities for reflection because they mark our fifth anniversary of continuous publication. (Two pilot issues were produced, in June and September of 1985, but monthly publication in the magazine's present form began in January of 1986.) According to those in the magazine publishing business, five years represents an important milestone, one that a small percentage of magazines ever reach, so it's an accomplishment we're very pleased to have achieved.

The past year was an excellent one for **EM**. Our circulation figures, which reflect the number of readers, reached new heights, and thanks to the support of more advertisers, the average issue size increased, allowing us to include more articles than ever. The year 1990 also marked the beginning of our active presence online with the PAN network, an area we believe will be of growing importance for magazines and other information-providers as we enter the '90s.

In the future, we're planning to offer more of the same. **EM**'s original mission to inform and entertain anyone interested in learning how to best use (and, occasionally, build) electronic musical equipment is still valid and will continue to be our guidepost for the future. Where change seems appropriate, however, particularly with regard to your emerging interests, we plan to respond accordingly.

Among the tools we use to discover your interests are reader surveys, the most recent of which was bound into certain copies of the September 1990 issue. While we're still awaiting a formal tabulation of the results, a completely unscientific scanning of the comments that many of you included offered some intriguing clues. An increase in home recording-related coverage, for example, was requested with regularity. Consequently, we plan to do just that, both in terms of products to be reviewed and applications to be shared.

Even more requests were made for basic, explanatory information. Our "From the Top" column was conceived to address some of those needs, but we felt a comprehensive introduction to many of the important terms and concepts involved with electronic music would be an appropriate way to start off the new year. Hence, this issue.

In the three articles that comprise the special back-to-basics coverage offered here, we explain important terminology and concepts from a number of different subgroups within the genre of electronic music. The first piece covers synthesizers, samplers, and sequencing—the foundation of most home music studios; the second moves onto multitrack recording, another essential element; and the third concludes with tape synchronization, a process that allows you to combine the power of sequencing and recording into a single, coherent system. The topic of MIDI, which cuts across the subject matter of the first and third pieces, is explained in "From the Top."

Armed with a few definitions and a clear understanding of several essential concepts, you can start spending less of your time wondering how to make electronic music and more of your time actually doing it.

In a sense, that has always been and will continue to be the challenge faced by the magazine. It's been a gas so far; here's to five more.

*On another note, I'm pleased to introduce **EM**'s new art department: Art director Andrew Faulkner, who comes from* Macworld, *and assistant art director Frankie Winter, formerly of Clement Mok designs, join art assistant Linda Birch. Their outstanding work is on display in this issue, and we're looking forward to even more creative efforts from them in the future.*

Bob O'Donnell

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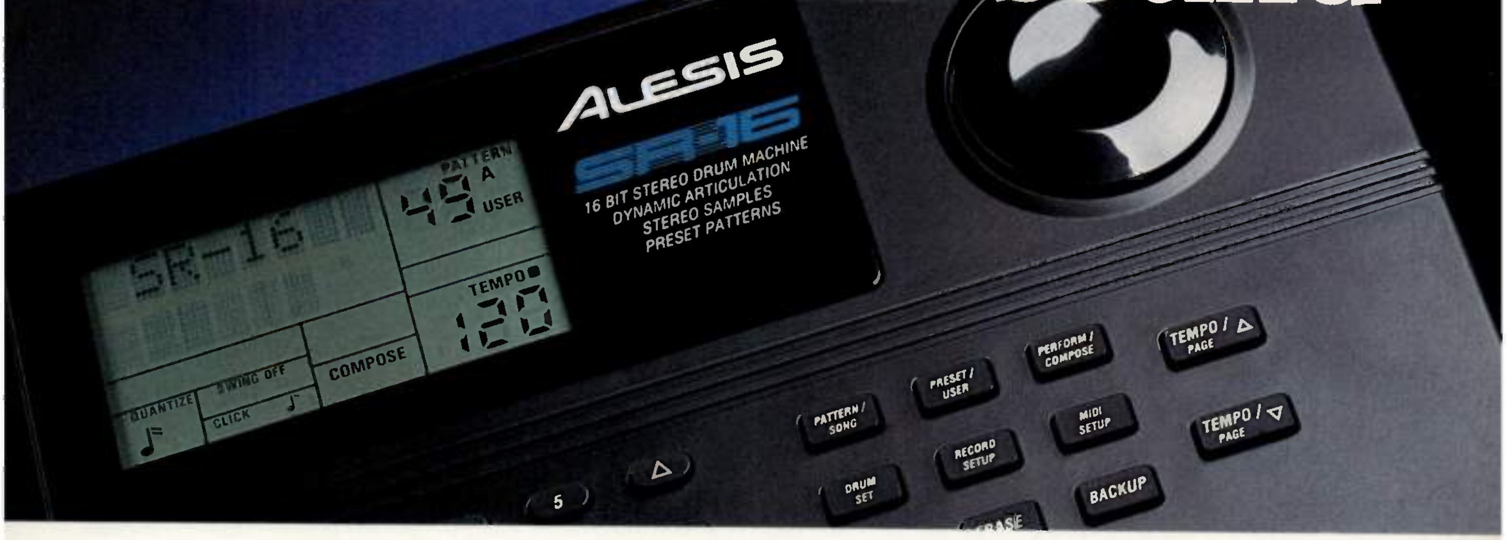
Two ways to get a killer drum sound



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Our readers interrupt us, chide us for our language and attitude, and ask for a transfer. Such is rock 'n' roll.

INTERRUPTS AND INTERFACES

Greg Hudgins' letter in the November 1990 issue of EM ("We Interrupt This Program") had just enough information to cause the neophyte MIDI user to panic. While he is correct about the cascaded interrupts in the AT-class, IBM PC-compatible machines, he appears to be uninformed about the way the newer MPU-401-compatible MIDI interface cards handle these interrupts.

The newer MPU-401 chips have a feature that allows an AT-class machine to use IRQ2 without any danger of disturbance from the hard drive, the built-in clock, or any of the other functions that are routed through IRQ2. The newer coprocessor simply ignores these signals and allows them to pass on through. This is true not only for Roland MIDI interface cards that use the MPU-401 chip, but also for interface cards from other manufacturers that use these chips, such as Voyetra and CMS. The Music Quest MIDI interfaces do not use the MPU-401 chip; instead, they use a firmware emulation of that chip. There are seldom any problems with these interfaces, especially the new ones.

Our MIDI Special Interest Group (SIG) has about 60 members, using every type of IBM PC-compatible computer you could imagine, from 8086s and 8088s to 80486s. We also have people who use Tandy and Leading Edge products. The older Tandy products require that you use IRQ5 if you have a hard drive. The newer Tandy products are completely compatible with IBM standards and usually require no change from the standard IRQ2. Almost all of us who use AT-class machines use IRQ2 without any problems, both in coprocessor (intelligent) mode and in UART (unintelligent) mode. As a point of fact, at present there are no commercially available MIDI interfaces that allow the user to address any interrupt above IRQ7 anyway, so the information about the free interrupts about IRQ7 is of no use to the average user.

One common source of MIDI conflicts in IBM-PC compatible computers is the extended memory board. Sometimes these are configured so they come in at an address that is used by the MIDI interface. This also can occur with some video boards and certain accelerator boards.

Our group has determined empirically that if your system works with IRQ2, you should leave your hardware and software set for that interrupt, even if you have an AT-class machine. If you have problems, check to see that your accessory boards are not giving you an address conflict. If there is nothing else to resolve, then change your IRQ setting on your interface and in your software. But most of all, read your manuals—all of this information is in them.

Bill Palmer
MIDI SIG Coordinator
Houston Area League of PC Users (HAL-PC)

AVERSE TO OUR INFORMAL WAYS

Confusing the meanings of adverse and averse has adverse effects to which I am averse.

I suspect it was just an oversight that you allowed Craig Anderton's misuse of "adverse" to slip through on page 50 of your October issue. Just in case it wasn't, let me point out that I like English because it has lots of words that mean different things. I mourn the loss of a perfectly good word like "averse." I hope that in the future, you will help forestall its demise and that of other endangered words.

I have one other nit to pick while I'm at it: Where I come from, it is a sign of respect to refer to people we've never met by their surnames. I'm sorry you've disposed of this custom in your letters column.

David Dana
California

Mr. Dana—Since it was founded, Electronic Musician *magazine has drawn on readers for much of its writing and information. The editors always considered the readers part of an extensive group of friends who exchanged ideas and information about their common interest, electronic music. Times have changed, and we've grown a lot (thanks to all of you!), but we still get a lot of articles from our readers, try to answer as many letters as we can, regret the calls and letters we've missed, and generally still feel like friends you bring home once a month. That's why we're informal. Incidentally, although you may be averse to the idea, informality of address increasingly is preferred in American society, especially in Northern California (where* EM *is based). I have sophisticated theories about why this is the case, but reading my sociological conceits might have adverse effects on your patience.—Steve O*

DAVID POVILAITIS

TUESDAY, DECEMBER 18, 1984

Price Of Sampling Plummets!

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STUDIO TIMES

SEPTEMBER 1990 Cutting Edge News For the Contemporary Musician VOL. 16 NO. 9

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IBM-TO-ATARI SEQUENCE TRANSFERS

I rent a MIDI recording studio that uses an Atari ST running Steinberg *Pro 24 III*. At home, I plan on using an IBM-compatible machine running Passport's *Master Tracks Pro* sequencing software. Is it possible to convert a standard MIDI file from the IBM format to the Atari format so I can transfer my MIDI information via 3.5-inch disks? Would it be possible to download the sequence off the IBM into a Korg M1 and upload the sequence from the M1 to the Atari? How reliable is this, and how much information would be lost?

Norman B. Taylor
Tennessee

Norman—That's a big enough topic for an article, so we published one. "Sequence Transfers from Studio to Stage," in the May 1990 issue, discusses transfers between software and hardware sequencers, including step-by-step instructions for the M1. The article includes a sidebar (p. 74) that discusses transferring MIDI files between different types of computers. In theory, the transfers seem simple enough (except between the Macintosh and other computers; see the sidebar). But in practice, as you anticipate, there are lots of pitfalls besides format compatibility, many of which are discussed in the article. In your case, there should be few format problems. MIDI files created on Atari, Amiga, or IBM computers are compatible across computers. You're in luck with regard to disk format, too: Atari and IBM share a common disk format, and IBM-formatted, 360K and 720K floppy discs can be read by both machines.

Those whose PCs lack a 3.5-inch drive, or who use Amigas, can upload the MIDI file from one machine to a BBS (see "Going Online" in the November 1990 issue) then download it to the other machine. If you have two modems, you also can transfer files modem-to-modem. Finally, and least satisfactory, you can transfer a sequence in real time by connecting the MIDI interfaces and playing back one machine while recording with the other. Any way you do it, read the article first.—Steve O

OPERATION HELP

Assistant Editor: EM is looking for an assistant editor to be based in the San Francisco Bay Area. Applicant must have knowledge of MIDI and computers. Excellent editing and writing skills and magazine publishing experience also are required. Salary commensurate with experience. Send resume and cover letter to Assistant Editor Position, Electronic Musician, 6400 Hollis St. #12, Emeryville, CA 94608. No phone calls, please.

Manuals, Dinosaurs: I need owners manuals for the ARP Axxe and E-mu SP-12 and service manuals for the E-mu SP-12, E-mu Emulator III, Oberheim OB-1, and Oberheim Xpander. Also, I want faulty, damaged, obsolete analog synths (e.g., ARP, Moog, EMS, etc.).

K. Dulay
89 Fountain Rd.
Edgbaston
Birmingham B17 8NP,
England (UK).

K.—E-mu Systems (tel. [408] 438-1921) is very much alive and well, so you can get SP-12 and E-III information from them. As to support for the dinosaurs, we've published a lot of that information in "Service Clinic"; see the indices on p.84 of this issue and p.93 of the January 1989 issue. For the ARP Axxe manual, contact Music Dealer Service, 4700 West Fullerton, Chicago, IL 60639; tel. (312) 282-8171. There never was an OB-1 service manual, just a schematic; it and other Oberheim manuals and parts can be obtained directly from the Gibson Labs/Oberheim plant in North Hollywood, CA (tel. [818] 503-0631. 0124).

ERROR LOG

November 1990, "Going Online: A Guide to Electronic Bulletin Board Systems": The MIDI-Exchange BBS was mislabeled the "San Francisco MIDI Users Group." The IBM-based BBS is available to all computer users, not only to Mac and Atari users (as stated). Our apologies to MIDI-Exchange system operator Walt Perko.

November 1990, "EM Guide to Keyboard Synthesizers," p.47: The chart should indicate that the Ensoniq VFX and VFX[SD] transmit both channel *and* polyphonic aftertouch.

SAMPLING THE EM MAILBAG

We get a lot of calls and letters asking when we reviewed a particular piece of equipment or discussed a certain topic. To save you (and ourselves) a lot of time, we offer you several ways to find articles and back issues. To begin with, each December EM since 1988 includes a complete index for that year, so make sure you have those three issues. As noted earlier, "Service Clinic" topics are indexed in this and the January 1989 issues. The EM editorial department also offers a back issue listing that we update annually. Just send us a self-addressed stamped envelope marked "Back Issue Listing." (Incidentally, for an SASE, we also offer an Error Log listing.) Back issues are available from the Mix Bookshelf; tel. (800) 233-9604 or (415) 653-3307. There's more, too; please turn to "FYI: For Your Information" on p.112.

To top it off, thanks to EM author and long-time reader Dave (Rudy) Trubitt, the EM Special Interest Group (SIG) on the PAN computer bulletin board includes a simple but useful article database. If you don't know about PAN or the EM SIG, read "Going Online" in the November 1990 issue.—Steve O

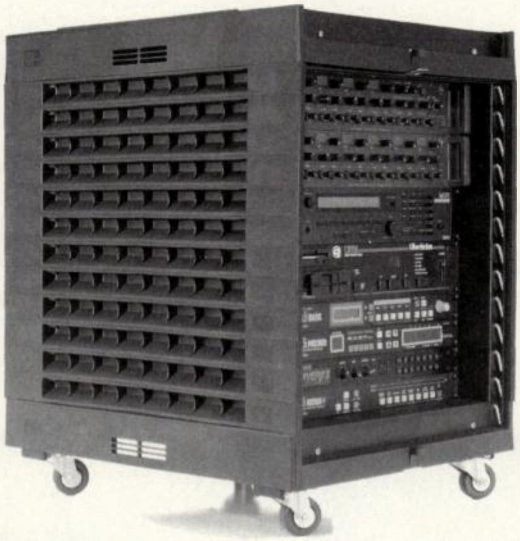
WHAT'S NEW

We start 1991 with more coverage of the 1990 AES convention and discuss ground-breaking software from Opcode, an unusual rack-mount mixer series, and a born-again MIDI guitar controller.

Last month, we spent time looking around the Audio Engineering Society's convention in Los Angeles but ran out of space before we saw everything. As promised, we've come back to finish up and take a look at a couple of new items that were not at the show (hard to believe, but true).

I THINK THEY'VE GOT US SURROUNDED

The surprise product intro of the show came from Roland (tel. [213] 685-5141). Their **RSS** (Roland Sound Space) **Processing System** appears to have leapfrogged the efforts of a whole group of American and Canadian companies to deliver a workable system for "three-dimensional" sound. (The concepts and development of 3-D sound were covered in a two-part series in the February and March 1990 issues of *Mix* magazine. Some of the concepts and technologies involved were described in "Into New Worlds" and "An Ear for Processing" in the July 1990 **EM**.) The Roland system provides four channels of processing, each with a separate control for azimuth (horizontal location) and elevation (vertical location). The processed sound, complete with illusions of location, is reproduced over two loudspeakers and can be recorded on ordinary media, either analog or digital. No decoding is required for playback. Physically, the unit consists of a table- or laptop controller, a rack-mounted digital processing unit, and two 2-in/4-out A/D/A converter units. The processing unit also accepts direct connection of digital audio via optical cable, and sound localization can be controlled via MIDI.



Modulock Total Height Expansion (T.H.E.) Rack

Roland's demonstrations throughout the show created a considerable stir, giving many attendees their first taste of 3-D audio. It also became clear that although the illusions of "behind the head" and laterally placed sounds can be startlingly vivid (even over inexpensive sound systems), there are some notable limitations. For one, the process is very sensitive to the listener's position, with a "sweet spot" along a line exactly equidistant from each loudspeaker. For this reason, demonstrations were conducted with four people at a time, seated one behind the other. The other interesting thing is that some listeners (5 to 10%, according to Roland) do not get the effect at all. This most likely is because the process depends on replicating the changes that take place as sound enters the ear and travels to the ear drum. As you may have noticed, ears come in different shapes, and perhaps some people's ears are too far from the "norm" to respond to the models used in the RSS. In the current version of the process, there is no control of apparent distance, and the elevation controls were not used in the demonstrations. Sounds could not be moved quickly because the system does not incorporate simulation of Doppler pitch shift. To this listener, at least, location of more than one source behind the listener also produced a very strong phasing of the audio.

Roland expects to deliver units in the first quarter of 1990 at a price of "$25,000 to $35,000." The response at the show makes it clear that they should have no problem placing the first units into commercial production studios, even with the limitations mentioned above. After that, it is going to be interesting to see just how deeply this technology affects the recording of music and film sound.

ON THE (MIX) LEVEL

On the more personal scale, some of the nicest products at this show were in the area of mixing and dynamics processing. Mark of the Unicorn was proudly displaying the **MIDI Mixer 7s** ($595; tel. [617] 576-2760), a fully MIDI-controlled audio mixer in a 1U rack-mount unit. The device includes seven stereo inputs with bass and treble boost or cut, two stereo effects sends and returns, stereo auxiliary in, and an overall noise gate. This looks like a cost-

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Steinberg JONES PH: 818-993-4091 FAX: 818-701-7452 and space-effective way for the MIDI artist or engineer to mix audio, and it highlights the evolution of MOTU from a purely software company to one of the more innovative hardware manufacturers, as well.

Roland is moving to rejuvenate and upgrade their series of half-rack signal processors sold under the Boss name. Included in the show introductions were the **GE-21 Graphic Equalizer** ($225), **CL-50 Compressor/Limiter** ($199.50), and **NS-50 Stereo Noise Eliminator** ($199.50). All feature professional audio performance, according to the manufacturer, and a handsome new look. Most interesting of all, however, was the **SE-50 Stereo Effects Processor** ($499). The SE-50 is the first half-rack format effects processor with an alphanumeric LCD, but more important, it is the only device in its price range that separately digitizes each input. This allows the SE-50 to perform "split" processing, with separate effects for each input. It also makes the SE-50 capable of vocoding, where the filtering of one input signal is controlled by the frequency content of the other input.

Alesis continued their quest to provide the cleanest, inexpensive version of everything used in recording and performance with the **3630 RMS/Peak Dual Channel Compressor/Limiter** ($299; tel. [213] 467-8000). The 3630 provides either stereo, or dual mono, dynamics processing with a separate noise gate for each input. The controls are comprehensive, with gate threshold and delay, and compression threshold, ratio, attack time, release time, and output level for each channel. Indicators include a 12-segment display for gain reduction and one for input or output level (switchable). Hard- or soft-knee compression curves may be selected, and there is a side-chain for ducking and de-essing. Alesis was pleased to point out that the 3630 uses dbx VCA chips, generally accepted as a standard in the pro industry.

Not to be outdone, ART unveiled their stereo dynamics processor, dubbed the **MDC 2001** ($499; tel. [716] 436-2720), with even more features, at least on the surface. Besides compression and limiting, the MDC includes an expander, an exciter circuit, a de-esser, and a hard limiter on the output. The manufacturer claims that the VCAs used in the MDC are of a completely new type, with 15 dB greater dynamic range and much less distortion than conventional types.

TAPEWORMS

We usually feel a little bit sorry for the tape manufacturers at these shows. Here they are, making a high-technology product that is absolutely indispensable to the entire recording industry, but they have a heck of a time trying to give their product and presentation any trace of "sex appeal" ("Just look at the oxide on that baby."), especially now, in the seeming dusk of the analog tape era.

Well, 3M managed to do it. Against all odds, they produced a new tape, called **996** ($14 per 7-inch reel of 1/4-inch tape; tel. [800] 245-8332 or [612] 736-5019; for more information, see "40 Great Gift Ideas" in the December 1990 issue), that seems to improve the performance of analog recording quite significantly. It prints hotter than other tape by several dB, while simultaneously reducing print-through. The result is much better transient response and almost undetectable tape hiss, according to engineers and producers who have used the new formulation.

If you're working to bust out into the big time, Yamaha has the right console to take along for the ride.

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Professional Audio Division

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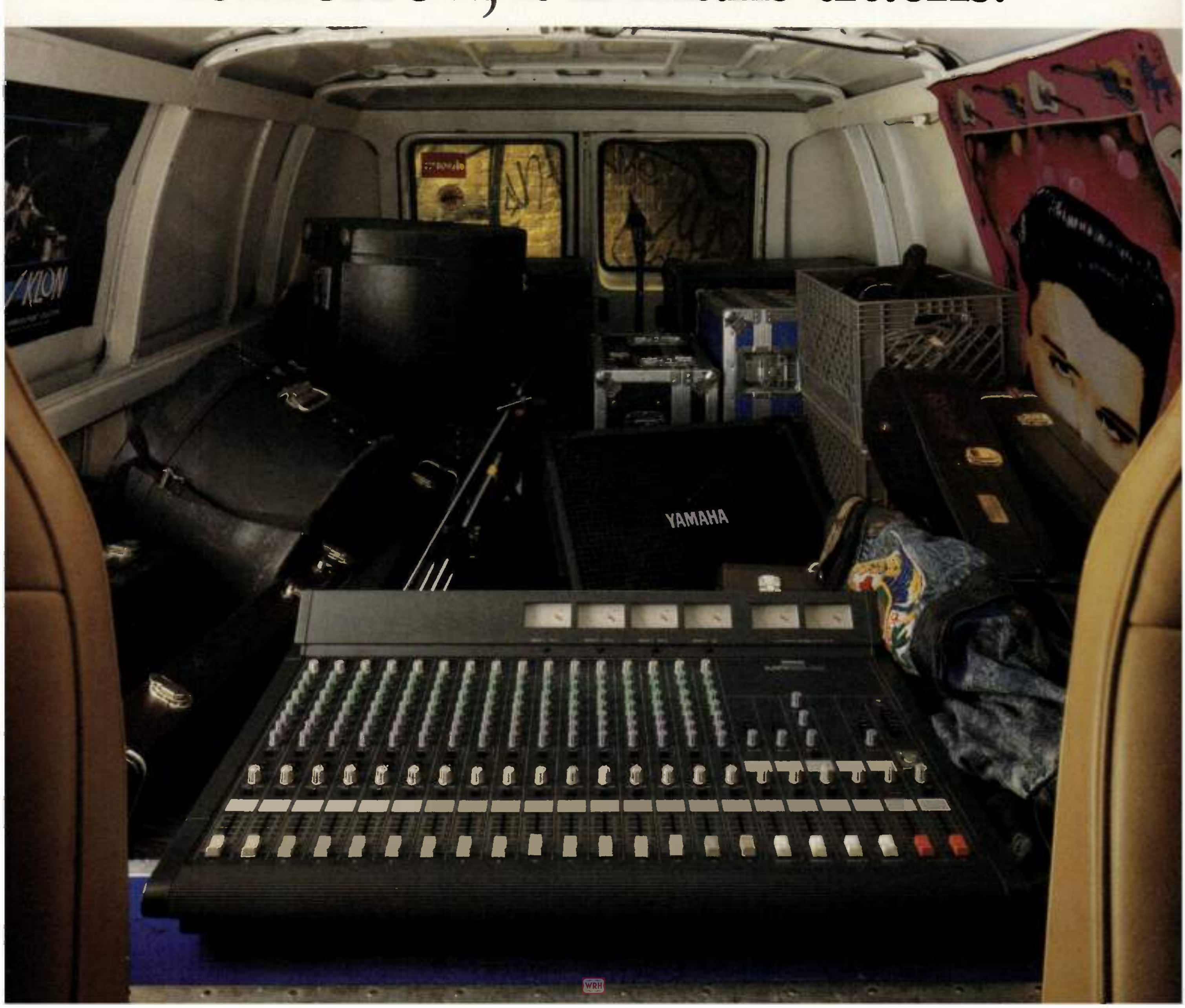


To get that point across, 3M lined up an impressive array of enthusiastic endorsements from nearly a dozen studio luminaries. 3M 996 is to be available on the general market in early 1991, in widths from ¼-inch to 2 inches. (No word on whether it will be made available on cassette.) Hats off, gang. We sure didn't expect this one.

IT'S DAT TIME, FOLKS

With DAT looking more and more like the dominant 2-track format in many contexts, TDK (tel. [800] 752-9835 or [213] 538-5259) is making a move to position themselves as the leading supplier of premium DAT tape. With a clever, can't-miss product name—**TDK DAT**—the company claims their advanced formulation and superior quality control makes their DAT cassettes the most reliable and longest lasting in the industry. People who use DAT a lot know that the quality of tape makes a big difference in the results, and we'll be waiting to see how TDK's claims stand up in the rough, tough world.

Speaking of DAT, Sony's Pro Audio Group (tel. [201] 358-4197) showed the first professional DATs to incorporate the proposed IEC standard for time code. This has been a major issue in the acceptance of DAT for general pro use—the DAT format was conceived for consumer use and originally carried no provision for time code—and Sony's showing clearly signals that time code DAT will be a factor in the future of recording. Three models were shown, together with an editing controller that makes true digital editing possible on DAT for the first time. The **PCM-7050** is the flagship of the line. The more affordable **PCM-7030** has almost as many features as the PCM-7050 and is intended for video and film post-production applications. The **PCM-7010** is the lowest in price and is recommended for general-purpose recording. Pricing of the units is a little involved because there are numerous options, ranging from $4,500 for the most basic version of the 7010 to $14,500 for a fully loaded 7050. A complete editing system (7050, 7030, and RMD7300 editing controller) is available for a cool $25,000. None of these would be described as low-cost from the home-recording perspective, but Sony emphasizes full service and support (including a 24-hour service hotline) in all of their professional products.

Sony PCM-7030 DAT Recorder

NOT THE RACK!

Bo Tomlyn of Modulock (distributed by Key Clique, tel. [818] 905-9136) showed the **Total Height Expansion (T.H.E.) Rack**, the first truly modular design for a standard, 19-inch rack.

Racks of any height can be constructed by stacking interlocking, single-rack-space "sidebars" (SB-2, $25 per pair) between a universal "top/middle/bottom" piece (TMB, $75 apiece). The sidebars, made of 90% polypropylene and 10% glass (for rigidity), provide front- and rear-mount capability and act as handles. The all-polypropylene TMBs have ventilation along the top and provide for optional casters or locking rolltop doors that fit all configurations up to twelve spaces. The Standard model ($389) includes twelve SB-2s, with a capacity of 700 to 800 pounds, and two TMBs without casters or doors. The Deluxe model ($489) adds two doors and four rubber casters. You also can buy the parts to "roll your own."

POST-AES PRODUCT NEWS

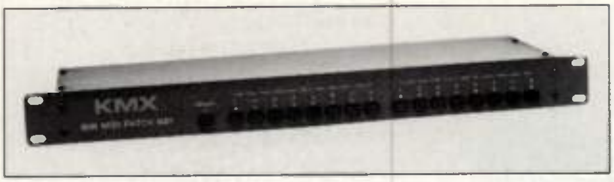
Opcode Systems released its long-awaited *StudioVision* ($995) for the Macintosh, which combines with Digidesign's Sound Tools or Audiomedia digital recording systems to let you record and manipulate audio data within the *Vision* sequencer environment. *Vision* users can upgrade to

Holland FM7202A Submixer

StudioVision for the $500 difference in price. Look for a review in our next issue. In addition, Opcode is shipping Max ($275), an icon-oriented programming language for the Macintosh, to software developers. (The company expects to release Max to consumers early in 1991.) Developed at IRCAM, the Parisian electronic music research institute, and named for electronic music pioneer Max Mathews, Max lets you construct complex applications by using click-and-drag mouse techniques to link software modules. For more on Max, see "Programming for the Rest of Us" in the July 1990 **EM**.

Opcode Systems
3641 Haven Dr., Suite A
Menlo Park, CA 94025-1010
tel. (415) 369-8131

Holland Synthesizer introduced its 2U rack-mount, FM-series line mixers, which are designed for submixing instruments and available in several configurations. The **FM7202A** ($1,500) is a 24-in (twelve stereo channels) by 2-out unit with two stereo auxiliary buses (sends only). Each level knob (for the main and aux buses) is a stereo pot that controls both left and right channels, so the left/right balance on each bus is the same for all channels. A master panpot sets the balance for the bus as a whole, and there are left and right master, but not channel, peak indicators. The **FM7202B** ($1,600) is a 48×2 (24-channel) mixer with one stereo aux bus on twelve of the channels, while the **FM7202C** ($1,700) is a 72×2 (36-channel) unit with no sends. The budget version is the single-rack space, 22×2 (11-channel), **FM2202** ($550), which has no sends or input level controls and is designed for use with MIDI sound sources whose levels can be controlled



KMX 8×8 MIDI Patch Bay

via MIDI volume messages. All inputs and outputs use mono, ¼-inch, unbalanced connectors. Nominal input and output levels are +4 dBV. According to the manufacturer, frequency response is 5 Hz to 100 kHz at ± 1 dB and 20 Hz to 20 kHz at ± 0.1 dB, the S/N is -96 dBV, dynamic range is greater than 110 dB, and THD is .008% at 1 kHz.

Key Clique (distributor)
3960 Laurel Canyon Blvd., #374
Studio City, CA 91604
tel. (818) 905-9136

KMX's 1U rack-mount 8X8 **MIDI Patch Bay** ($249) lets you program MIDI signal paths from the front panel and store up to 30 patch setups in memory. Each of the eight inputs and eight outputs is controlled by its own button. To program a patch, you simply press the button to select the source (input), then assign the outputs by pressing their buttons; there are no menus and no cursor keys. Setups can be recalled from the front panel or via MIDI program changes, and the unit is programmable via sysex. KMX also issued a ROM update for the MIDI Central 15 × 16 MIDI patch bay. With version 1.3, you can use sysex messages to request a complete memory dump from the MIDI Central, or generate a dump from the front panel.

KMX
67 W. Easy St., #134
Simi Valley, CA 93065
tel. (805) 582-0485

Quantar Electronics has returned from the dead and is offering an improved, battery-powered **MIDI fretboard controller** ($1,649). The Quantar (reviewed in the October 1988 **EM**) uses high-frequency, sonar-type signals to scan the strings and frets, determining what note is going to be played even before the string is picked. The manufacturer claims that this technology yields tracking speeds far better than pitch-to-voltage conversion methods. The software upgrade from the original to the improved model is available for $50, and the breath controller hardware upgrade costs $50.

Quantar Electronics Corp.
PO Box 842
Sierra Madre, CA 91025
tel. (818) 445-8380

Bokonon Technologies introduced ***Tiresias*** ($79.95 plus $5 s/h), an EPS editing program for the Macintosh. Unlike programs such as Passport's *Alchemy* and Digidesign's *Sound Designer*, *Tiresias* is not a waveform editor. Instead, the program controls the EPS's parameters, including layering, patch button assignments, envelopes, filters, MIDI settings, etc.

Bokonon Technologies
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Neural Networks and Computer Music

By Dave (Rudy) Trubitt and Peter Todd

Within the seemingly simple concept of neural networks lies the potential for computer-musician interaction on an unprecedented scale.

MERCEDES McDONALD

I appreciate hearing my music played as I write it, and no one plays more obediently than a computer sequencer. Of course, this is also the computer's greatest weakness, since it can offer none of the vital input other musicians provide. Nevertheless, when I work alone, I've often wished my computer could make some musical decisions, rather than force me to specify every note of its performance. For instance, I'd like to play some bass lines into my system and show it some supportive drum patterns. Ideally, if I then played a bass part that I hadn't shown the system before, it would still be able to come up with something appropriate for the drums.

A new computing technique, called *neural networks,* has this human-like ability to learn by example and deal with unexpected situations. To help me better explain it to you, this month I'm joined by Peter Todd, an electronic musician and researcher in the neural network field. We'll cover the basics and talk about musical applications.

Traditional computers work serially, performing complex operations one step at a time (multitasking systems included). Neural networks, on the other hand, utilize "parallel distributed processing," achieving processing power by having a great number of simple processing units operating simultaneously. There is no "central processing unit" that must accomplish everything itself. Instead, each simple neural unit performs some small aspect of a task. The units then communicate their intermediate results to each other through a set of interconnecting links. This parallel network of cooperating units is analogous to the human brain, whose interconnected neurons also achieve their power through massed efforts.

Here's how neural nets work, in six fairly painless sentences:

- Information, represented by numbers, is passed between units through links connecting outputs of units to inputs of others.
- Each unit can take input from several units, and can send one output value to several other units.
- Each unit's output is a function of the sum of the values of its inputs.
- Values change when passing between units, as the links connecting them are not all equal in strength; some links amplify, while others attenuate or even negate the values they pass.
- The difference in strength, or weight, of each link and the pattern of units they connect make neural networks capable of the particular computation they perform.
- These weights are determined by training the network with examples of what you want it to do.

The pattern of units and links are typically arranged in layers, with data flowing from input layers, through internal or "hidden" layers, and ultimately to output layers. The basic task of

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and here...

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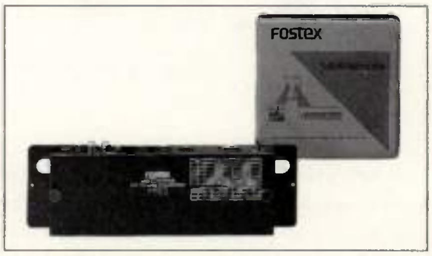
If you own an Atari™ or Macintosh™ computer, you'll make the most of MIDI control with Midi-Remote™ – a Fostex Desk Accessory. In addition to standard tape transport and monitoring control, the software will let you select tracks, locate and loop among ten cue points, automatically punch-in/out, set zone limits, display MIDI time code and generate SMPTE code (all 4 formats).



* The 280/MTC-1 interface does not offer all of the functions available with the open reel interface. • Atari and Macintosh are registered trademarks.

The Macintosh software works with Performer and Master Tracks Pro. The Atari software works with Master Tracks Pro and Dr. T's KCS.

Steinberg's Cuebase sequencer has a device driver for the MTC-1 and 8330 built-in, so you don't need MidiRemote software with it.

As with all computer interfacing certain restrictions apply. So check the details at your local Fostex Dealer or call Fostex.

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any neural network is to take some pattern from its input, modify it by passing it through itself, and output the result.

A MUSICAL EXAMPLE

For instance, let's say you wanted to transform rock rhythms into a reggae feel. First, a structure for representing and processing the data must be devised. Here's one way to do that: A unit with a value of 1.0 could represent a hard drum hit, a value of 0.5 a soft hit, and 0.0 a rest. If we limit the complexity of the rhythms to eighth-note patterns, eight units on the input and output layers would allow the network to hold a whole bar at once (see **Fig. 1**). A layer of hidden links and units will probably be required to perform the rhythmic transformation, but the methods used to pick them are too complex to get into here. Materials for further study will be cited shortly. Note that the weight, or strength, of the links is not set by the user; these will be established during training.

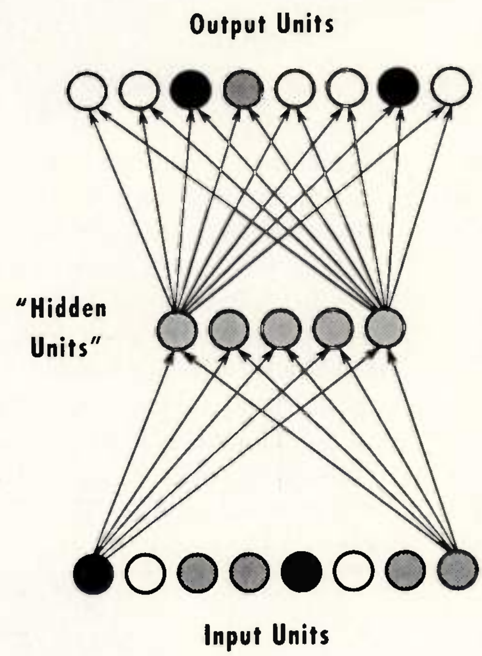

FIG.1: An example network for "reggae-izing" a rock rhythm pattern, using eight input units, five hidden units, and eight output units. Each unit represents one eighth-note. White units are rests, gray means soft hit, and black means accent. A rock rhythm is shown going in at the input units, and a corresponding reggae rhythm is produced at the outputs. Only some of the connections between the units in the three layers are shown here.

We now have a network structured to work with bar-long eighth note rhythmic patterns; but before it can be used, it must be trained. To do so, we must supply some rock rhythms and corresponding examples of the "reggae-ized" version of each. Note that we never have to formulate a set of rules describing the similarities and differences of the two styles. Instead, all we have to do is supply the examples (called a "training set"), and the network will do the rest.

LET THE TRAINING BEGIN!

A neural network trains itself by processing a sample input through itself, and comparing its result to the "correct" example from the training set. The difference between these two is used to calculate an error factor. More examples are processed while monitoring the error factor to see if the network's performance is improving. Errors are reduced by adjusting the weights using a "gradient descent" method, which tries to make the error go down as quickly as possible. This method can be likened to a ball rolling downhill via the steepest slope. When the gradient descent reaches the bottom, the network's output should match those given in the "training set." If not, the gradient descent may be stuck like a ball trapped in a rut on the side of a mountain above the valley floor. Should this happen, the weights of the links can be randomized, and the process started over. After training, the network can process unfamiliar examples in real-time and will produce output in the style of the training set.

ALGORITHMIC COMPOSITION

So what else could be done musically with this? Instead of processing rhythms, we could process melodies. For instance, a network could be trained to embellish plain melodies in a style characteristic of another culture. Another interesting application uses neural networks to combine two different styles into a hybrid containing elements of both. For instance, a network trained to reproduce pieces by Bach and Beethoven could synthesize a new work in the style of both composers.

Neural networks differ from traditional artificial intelligence systems, which are rule based, i.e., their response is based on a set of user-defined rules. Some musical rules can be defined easily, as anyone who has gone through a first-year music theory

A neural network could be trained to embellish plain melodies in a style characteristic of another culture.

class writing "correct" four-part voice leading can attest. However, other aspects of music can be more difficult to specify. In contrast, neural networks teach themselves based on a set of user-supplied inputs and their corresponding desired outputs. You never have to come up with a formal collection of rules, just examples of what you want. Neural networks also differ from "Markov-chain" probability-based algorithmic composition techniques. Neural networks can capture more information from the original music; not just local transitions, but longer contexts and structure, depending on the particular type of network used.

WHAT ABOUT THE HARDWARE?

We've said a lot about neural networks without describing the actual hardware they run on. There are companies building custom digital and analog systems for neural network applications. However, most neural networks are simulated on regular serial computers, as in PCs, Macs, Sun workstations, etc. While it is helpful to be able to run neural networks on computers we already have, all performance advantages of parallel processing are lost. For instance, training can take all night or longer on personal computers.

Other problems? Designing the structure of a network is still something of a black art, and currently, small networks don't scale into big networks very well. Researchers are trying to find ways to move from small example problems to more realistically sized ones, but so far most applications have been fairly small.

If you want to get your hands on a neural network, pick up a copy of *Explorations in Parallel Distributed Processing: A Handbook of Models, Programs, and Exercises*, by James L. McClelland and David E. Rumelhart, MIT Press/Bradford Books, 1988. The book comes in both IBM PC and Mac versions, each containing disks with software that lets you run and experiment with examples discussed in the book. Note that the examples are general, and not specifically musical in nature. You can play with the supplied networks without programming skills, but to adapt them to musical applications you're going to need independence, ambition, and C programming skills.

For reading material specifically on musical applications of this technology, check out two issues of the *Computer Music Journal* that focus on the topic: 13(3) and 13(4), Fall and Winter 1989. Also, a new book called *Music and Connectionism* will be available next spring from MIT press (Cambridge, MA). Edited by Peter Todd and Gareth Loy, the book's sixteen chapters will include introductions to neural networks and computer music research, sections on perception and cognition, and applications including composition and performance, and more. Also included is a discussion of the artistic merits of this type of approach in music.

Which brings us to this: How do we really want to use computers in music? Is it desirable or even appropriate to delegate creative aspects of music making to our tools? What is the role of the computer in this process: collaborator or servant? We'd like to hear your thoughts; it's a topic we'll return to soon.

Peter Todd *has been in school since 1968. When not wiring brains for music, he spends his time evolving simulated creatures to do his bidding and write his thesis.* **Rudy Trubitt** *forgot to get a college degree after his high school graduation. Now he's too crabby to get one, but he enjoys visiting Peter on campus.*

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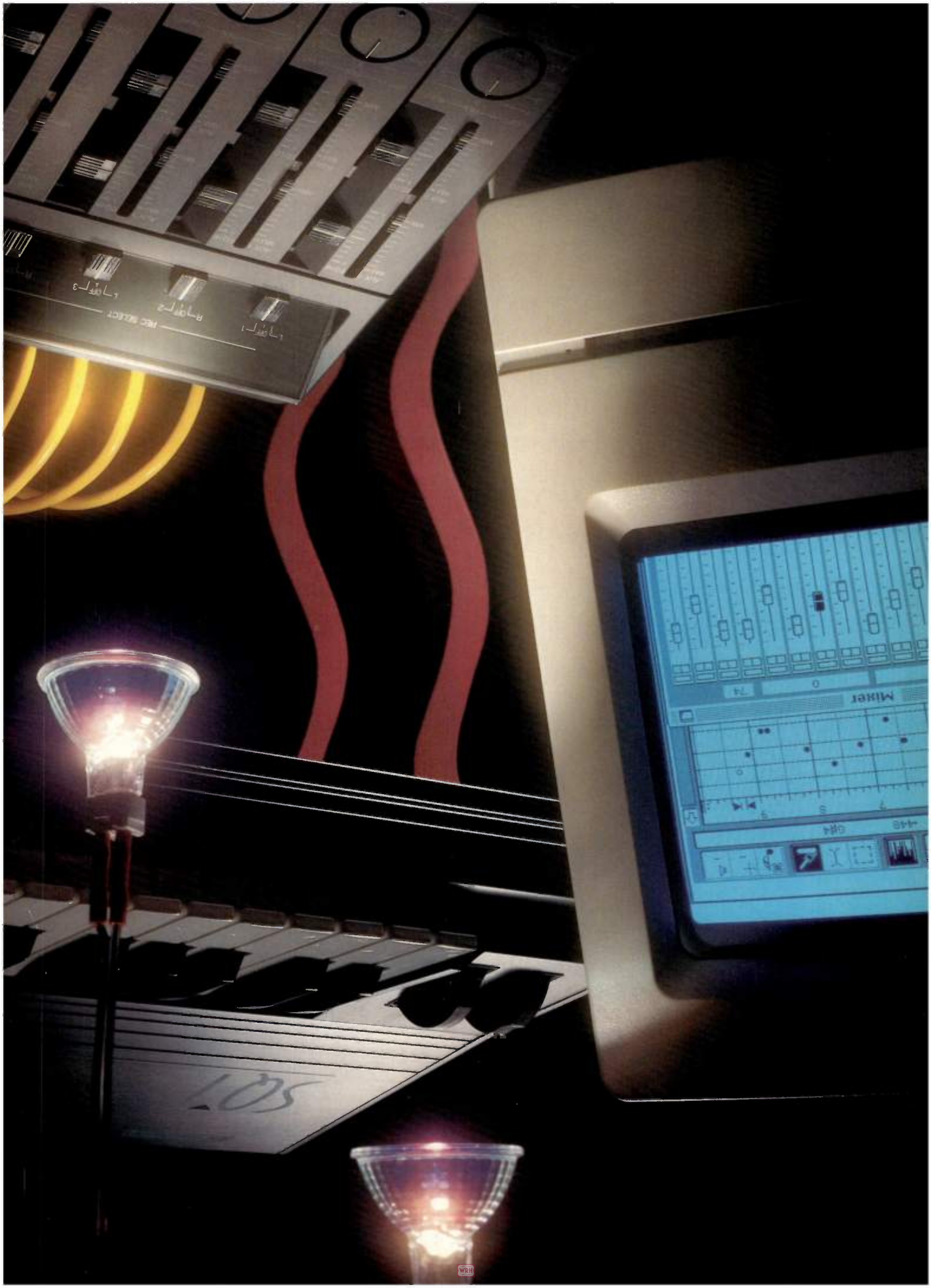

BY DAN PHILLIPS

UNVEILING THE MYSTERY

The Basics of Electronic Music

Don't panic! If you need help with the everyday terminology of electronic musical equipment, here's a Quick Start tutorial.

If you're getting started in electronic music, you may find yourself wading through a morass of buzzwords—multitimbral, polyphony, looping, quantization, graphic editing, etc.—that seem to have little or no connection to music-making. Too often, articles and manufacturers' brochures assume you already understand terms and ideas that aren't obvious. Don't be intimidated; most of the fundamental ideas aren't as difficult as they appear at first. With a little effort and a solid dose of patience, you can learn the basics, start selecting your gear, and get on with making music.

The electronic music-making process can be explained in terms of two broad categories: the equipment used to create and play sounds and the tools used to organize the sounds into complete musical compositions. Electronic music systems of today most often include elements of both.

Electric and amplified acoustic instruments generate sound acoustically, i.e., using strings, reeds, and other devices that directly cause wave vibrations in a medium such as air or water. There are several ways—magnetic pickups and microphones are two common examples—to convert the sonic waves to an analogous electrical signal whose waveform is a copy of the sound wave. Electronic (as distinguished from "electric") musical instruments don't create sound per se; they use a circuit to generate the electrical signals directly. The sound is created when a speaker transforms the electrical signal into sound waves.

The archetypal electronic musical instrument is the synthesizer. Synthesis is a broad term that refers to the creation of sound by any electronic technique. Because their sound is generated "synthetically," rather than "naturally," electronic instruments were dubbed "synthesizers." (For background information on the development of electronic musical instruments, see the December 1990 "From The Top" column.) The structure and sounds of synthesizers vary widely. Some have their own keyboards, some don't.

Synthesizers are characterized by malleability: Because the sound is created from scratch, it can be modified (modulated) drastically, even as the instrument is being played. The

MARK JOHANN

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The 20-pin **synchronizer port** allows interface with all the popular synchronizer systems (ours included) and there's an RS-422 port for control which requires serial communication. There's an external sync input for composite video, plus Word Sync Input and Output capability - all standard on the D-20.

Because of our 4-head recording system the D-20 features **off-the-tape monitoring** so that you'll always know exactly what you have on tape - a very important feature considering the DAT's ability to record for two straight hours (no more multiple reels and alignment hassles).

You'll be able to control all transport functions by remote control—including **punch-in/out**. Built-in cross-fade timing gives you seamless punches. There's even a **pitch control** complete with digital read-out.

Most important of all, the D-20 sounds great. It records and reproduces all the music completely, faithfully, and better than analog alternatives. So plug into the digital master recorder that has the professional features you need now at a price you can afford now.

* The analog recorder referenced is the Studer A-80 1/2" with 3-track head nest; the price comparison is based on option (A) below and an average of published rates of major audio rental companies for the Studer.

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strength of synthesis is that wild, dramatic, and often other-worldly sounds can be created easily, and a variety of techniques can be used to bring a sense of dynamics and "animation" to sound. A weakness (if it can be considered that) is that the sounds are often manifestly electronic, and it can be difficult to realistically simulate the sounds of familiar instruments.

SAMPLING AND SAMPLE PLAYBACK

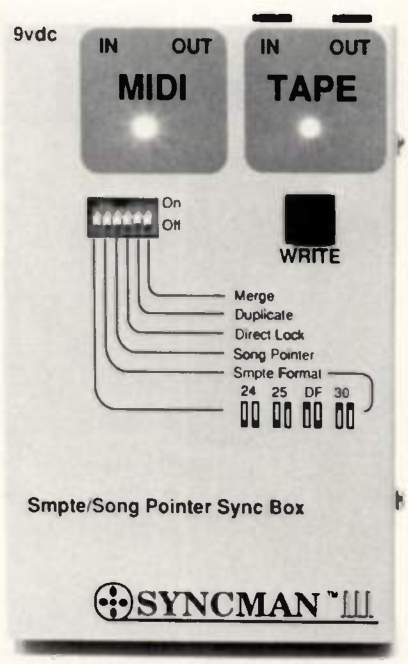
If you wish to use the sounds of acoustic instruments such as piano, guitar, brass, or orchestral strings, sampling technology is the way to go. Instruments of this type can faithfully re-create complex timbres that are difficult or impossible to achieve with current synthesis methods.

A sample is a short recording of sound, just like the recordings on CDs or cassettes. It may be the sound of a single flute playing a quiet B-flat, or the sound of thunder in a downpour. Today's sampler is a microprocessor-based device that records sounds either with a microphone or directly from a line-level sound source, stores them as digital (computer) data, and plays them back each time a sound is triggered. The sample is played back at different rates to transpose the original recording to the desired pitch (just like changing the speed of a record player) so that a single sample can be played across a musical keyboard.

This method works well, but transposing an instrument by too large an interval can seriously distort the nature of the sound. To prevent this effect, several recordings of different pitches are used to cover the full range of the instrument. Most sample-based instruments use this technique, which is known as multisampling.

Samplers allow you to record sounds of your own. This gives you extra flexibility, but sampling is a difficult and time-consuming art, and you should consider whether you have a real need for this capability. Samplers often are considerably more expensive than instruments that only play back pre-recorded sample libraries. The payoff, of course, is that you won't be limited to pre-recorded samples. If you want to fold, spindle, and mutilate recorded sound (after the manner of rap and *musique concréte*), samplers are the way to go. Even if you're not doing your own sampling, there are excellent (and very extensive) sample libraries available. In any case, you should be prepared to spend a lot more time organizing and tweaking your sound materials if you use a "real" sampler.

A popular type of instrument today is the so-called "sample-playback synth," which plays back pre-recorded (sampled) sounds and usually includes many of the sound-processing capabilities of synthesis. On some older instruments (such as the Mellotron, made famous by the Beatles), the sound actually was recorded on a piece of tape that was played each time the particular key was hit. Modern machines generally contain a sizable library of sampled sounds in permanent computer memory so you can start playing music immediately at power-up. Some sample-playback machines let you add more sounds from a computer, or with



memory cards or chips, but they can't record audio. Because sample-playback instruments combine many of the strengths of sampling (real sounds) with those of synthesis (malleability), these instruments often prove to be the best of both worlds and are an excellent choice for the first-time buyer.

Many drum machines and piano modules use sample-playback technology (although some use synthesized sounds). Drum machines usually include their own sequencers (discussed later), which allow them to produce not just sounds, but complete rhythmic grooves. Although general-purpose sample-playback devices usually include drums and piano, you may get higher quality with an instrument dedicated to that purpose, and many of these are attractively priced. If you intend to use piano or drums extensively, it may be worth your while to investigate these dedicated modules.

CONTROLLERS

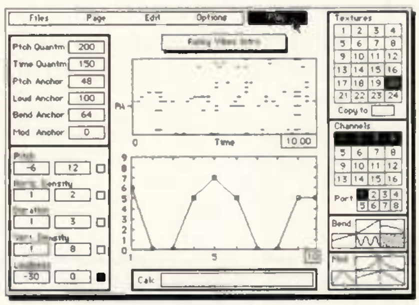
One critical concept in electronic music is that the thing that makes a sound is separate from the thing the performer uses to play the sound. The most common "controller" today is the piano-style keyboard. Many synths and samplers include their own keyboard, but the keyboard is a triggering mechanism, not the part that makes sounds. In other words, a keyboard synthesizer consists of two components combined into one: a keyboard controller and a sound source. Many instruments omit the keyboard entirely and are designed to be played from external controllers (keyboard or otherwise). These "sound modules" often come in the form of rack-mount boxes. The combination of a controller and sound module is functionally equivalent to a keyboard with built-in sounds.

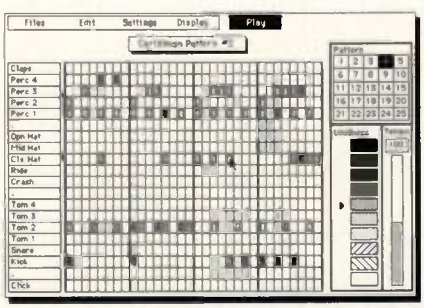
When a key is pressed on a modern keyboard controller, a message is sent to the sound source (whether synth or sampler) that tells the source to play that particular note. When the key is lifted, another message is sent that tells the sound source to stop playing.

Keyboards are by no means the only kind of controller (although they are certainly the most common). Electronic instruments can be played using guitar controllers; wind controllers that resemble saxophones, recorders, or clarinets; percussion controllers; computer controllers (joystick, keyboard, mouse, etc.); and a variety of unconventional instruments (such as Buchla's Thunder, reviewed in the August 1990 **EM**). These devices produce no sound of their own, but generate messages that are used to "play" remote sound modules and control an increasing selection of other devices, including mixers and effects processors.

You can remote-control a fair-sized studio from a keyboard, computer, or other controller by connecting the controller to the sound modules and other gear using MIDI. (MIDI is explained in this month's "From The Top" column, on p.74.) In brief, MIDI is a way for electronic musical equipment of many types (including personal computers) to exchange messages, using standardized cables. MIDI can do far more than just trigger sound modules; as you'll see, it's the source of an enormous amount of musical power.

Non-keyboard ("alternative") controllers often allow the performer a



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The Yamaha WX7 Wind MIDI Controller offers an alternative to keyboards.

good deal of real-time ("live") control over timbre, rivaling the expressive control of conventional acoustic instruments. This control has a huge impact on the character of the sound. I once heard a friend play a MIDI wind controller solo that I would have sworn was played with a real saxophone. When I asked him what sampler he used to create such a realistic effect, I was told he used a very inexpensive synthesizer. His playing, especially his skilled use of the instrument's pitch bend and breath control, made the difference between a cheap imitation and compelling, expressive realism.

MIDI keyboards are not without their own expressive capabilities, however. Many instruments feature velocity sensitivity: The faster a key is pressed down, the greater that note's velocity. Typically, the synth or sampler sound is programmed such that higher velocities make the sound brighter, louder, or both. The velocity is transmitted along with the "note-on" message.

In addition to velocity, many instruments offer aftertouch ("pressure") control. This triggers when you press down on the key after the note has been struck, and often is used for adding effects such as vibrato or orchestral swells. There are two variations: When you trigger channel aftertouch, pressing one key affects all keys; polyphonic aftertouch triggers individually for each key.

Wheels, or joysticks, can be used to bend pitch up or down, or allow other modifications of the sound (depending on how you program the controller and the synth or sampler). They're often used to introduce vibrato, the effect a violinist obtains by wiggling his/her finger on a string. Breath controllers (small, whistle-like devices that the player blows into) are less common, but very effective, especially for emulations of wind and brass instruments.

Pitch bend, modulation, and breath control are standardized messages that can be transmitted over MIDI and are recognized by most sound-producing modules. A number of other controllers, including pedals, sliders, and switches, are supported by various instruments. Since these controls can be changed after a note has been struck, they enable the musician to shape the timbre of a note or

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POLYPHONIC VERSUS MULTITIMBRAL

A standard feature of modern electronic instruments is the ability to play multiple notes at one time. This seems obvious, but not so long ago, synthesizers were limited to single melodic lines. Even today, synths and samplers are limited in the number of polyphonic (simultaneous) notes, or "voices," they can produce. This is an important factor to consider when selecting an instrument for a particular purpose.

Current electronic instruments usually have somewhere between sixteen and 32-voice polyphony. This may seem to be a lot, but multiple voices often are combined to produce thicker, richer, and more interesting sounds. This greatly reduces the number of notes available.

Most instruments today also provide the capability of producing different sounds (timbres) at the same time. In essence, they work as several independent instruments in one. This "multitimbral" capability is especially important when using sequencing (discussed later) to compose music with multiple instrumental parts. Multitimbral use puts much greater demands on the polyphonic capacity of an instrument. Because these separate sounds are produced by a single device, they are known as "virtual instruments," existing in function but not in physical space.

Multitimbral sound generators allow independent control of each of these virtual instruments, as if each one had its own keyboard. MIDI provides this ability by addressing each virtual instrument on any of sixteen separate MIDI "channels." Every MIDI message sent by a controller contains an "address" that defines the MIDI channel. Notes received only are played by an instrument (or instruments) that has been assigned to that channel. Multitimbral sound modules are able to receive on multiple MIDI channels, allowing each virtual instrument to play separately. If you are interested in using a sequencer to create a "band at your fingertips" (see below), multitimbral instruments can be extremely valuable.

Even in "live" performance, many instruments allow you to split and layer different sounds. In layering, two different, complementary sounds are played together whenever a key is depressed. This is useful for creating rich, complex sounds. You might, for instance, layer a bell sound with strings for a ballad, combine strings with brass for an orchestral effect, or blend nameless synth sounds to get a huge, new timbre.

Splitting a keyboard means that, instead of playing all of the sounds on each key, the keyboard is divided into ranges, each of which plays a different sound. The range from the lowest C to B below middle C, for instance, might be assigned to play a bass sound, while middle C to the top of the keyboard might trigger an electric piano.

SIGNAL PROCESSING

Effects and other types of signal processing are an integral part of electronic music production. Most people have found that judicious use of processing greatly enhances the effect that electronic sounds have on the listener. Think of such processing as the icing on the cake, the finishing touch that brings extra life to a sound.

Reverberation is the most commonly

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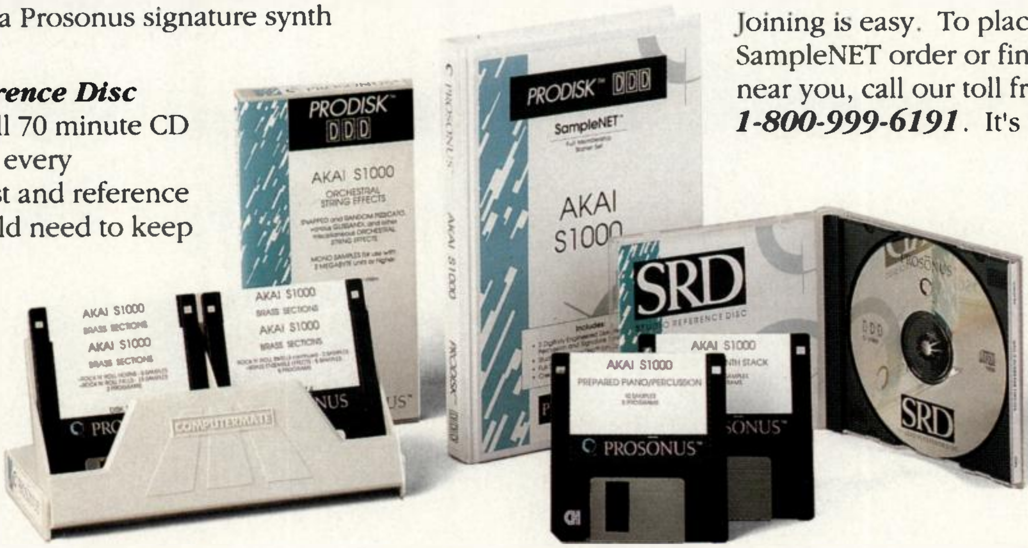

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used form of effects processing. It is frequently used to add realism and a sense of space to electronic sound. Used in large amounts, the effect is the kind of washy decay that you hear after clapping your hands in a large room, or singing in a stairwell. Used more subtly, reverberation simply gives the impression that a sound has been performed in a real space.

Delay is sometimes confused with reverb. Delay consists of one or more discrete repetitions of the original sound. At longer delay times (a half of a second or more), the effect is like hearing echoes across a canyon. At shorter times, delay can enhance the rhythmic qualities of a sound, while still shorter times can be used to "thicken" the sound or increase the listener's sense of space in a stereo listening situation.

Chorusing introduces slight amounts of detuning into a sound, making it thicker and warmer. String sections and choirs, which feature a number (chorus) of sound sources that are slightly out of tune, were the inspiration for this effect.

Distortion, so often coupled with guitars, is an example of signal processing that takes the original sound in a completely new direction. Used judiciously, distortion effects can add an organic sense to synthesized textures. By introducing small amounts of chaos into sound, it can be made to seem more dynamic, full of motion.

There are many excellent and affordable effects modules on the market. Some of these stand-alone effects provide only one type of signal processing, while others can produce any of a number of different effects, from reverb to distortion—or even several different effects at once. Today, many instruments include built-in effects as part of the sound-producing process.

SEQUENCING AND COMPOSITION

Now that you've assembled the means of making sound electronically, you may be interested in arranging those sounds into finished musical compositions. You can use traditional audio recording (as discussed in "Multitrack Recording: The EM Primer," on p.44) to do this, but modern electronic music offers another unique solution: the sequencer.

Sequencing is a process of recording the events and gestures of a musical performance, as opposed to recording the actual sounds of the instruments. This information can be played back to the instruments so they respond exactly as if the physical controllers were being played. You could think of it as the difference between a player-piano roll and a tape of a piano being played. The incredible twist is that once recorded, the performance becomes astonishingly malleable: Sequences can be extensively edited. The parts can be assigned to different "instruments" (try that riff with a flute instead of a trumpet), sections extended or rearranged, wrong notes corrected, rhythms tightened, and tempos changed. The sequencer is to the tape recorder as the word processor is to the typewriter.

In addition to transcribing live performances, sequencers can be used to compose passages that are too rhythmically complex for you to play. Step entry lets you enter each note individually (a step at a time), precisely specifying the timing and dynamics.

Sequencers come as dedicated hardware boxes, or as computer programs. Many operate within the realm of MIDI, recording the messages transmitted by controllers and retransmitting them to a network of sound modules. Some are enclosed in self-contained "workstations" that include sound-generation, sequencing, and sometimes signal-processing in a single package.

INSTRUMENTS AND TRACKS

Sequencers often are are organized to present music as a number of tracks, in a manner similar to a multitrack tape recorder. You can record these tracks one by one, building up a composition until you have an orchestra of virtual musicians blazing away on their virtual instruments. Hardware sequencers usually have a relatively small number of tracks, often eight or twelve; computer-based sequencers frequently feature from 64 to hundreds of tracks.

Sixty-four may seem like a ridiculously large number of tracks (especially since MIDI only has sixteen different channels). However, it can be convenient to assign several tracks to control different aspects of a single instrument. For instance, multiple tracks can be used to place each sound of a drum kit on its own track, so that each may be edited independently. You can keep "performance" data such as patch

changes on separate tracks so that you easily can try out several different combinations of instruments. If you are playing different counterpoint lines on the same synthesizer, or if a synthesizer is playing a split program, it may make sense to hold the data on two separate tracks.

SEQUENCE EDITING

As mentioned before, the great feature of sequencers is their ability to rearrange musical performances at will. Most sequencers today, particularly those that exist as programs for personal computers, allow you to view the recorded data in detail, which makes editing much easier. Currently, there are a number of popular ways to display musical data, including standard musical notation, "piano-rolls," event lists, and phrase blocks. Each of these has its own advantages and disadvantages, and many software-based sequencers allow you to select the form of display that suits your purposes.

Standard notation, with notes, stems, flags, and clefs, may seem like the most elegant way to display musical data—after all, this system has evolved over hundreds of years, and most musicians are at least somewhat familiar with it. As useful as standard notation is for writing down compositions for musicians to play, it turns out it is not such a great way to write down what they *do* play and *how* they play it. For instance, it's easy to show a scale of even eighth-notes in this system, but how do you show the same scale with every other eighth note "swung" by a small amount and a touch of modulation wheel at the top of the octave? It's pretty difficult.

The kind of standard notation available on sequencers is usually limited in sophistication and should not be confused with programs specifically designed to print music. These packages, known as notation programs, may or may not include some sort of sequencing ability. Most of those that do are substantially more limited in capabilities and ease-of-use than are dedicated sequencers.

Piano-roll editing represents musical data as lines on a long sheet of paper, extending from left to right. The vertical position of a note shows its pitch, the horizontal position its rhythmic placement, and the length of the line its duration. Mouse-based software may even allow you to change a note's pitch and rhythm simply by grabbing it and

dragging to the desired position. This technique can be quite intuitive, allowing quick editing for experts in a form that novices can understand.

Sequencers that feature piano-roll editing often include the capability to graphically display—and edit—controller data (such as pitch bend or modulation control). A move on the pitch bend wheel, for instance, will appear as a curve and can be edited by changing its shape or height. Controllers such as pitch bend and modulation wheels send out large amounts of data, so this method can be much more efficient (not to mention pleasant) than having to deal with the raw data itself (unless you enjoy working with lists of hundreds of numbers).

Speaking of raw data, event lists display sequences in the form of (what else?) a list. Each note, controller value, or other event has its own entry. This display ends up being somewhat numbers-intensive, but for precise, nuts-and-bolts kinds of editing, it's hard to beat. This viewing style, for instance, provides a graceful and elegant way to show the exact velocity or start time of each note, so that these values may be quickly compared and edited.

Phrase blocks, instead of showing individual events, show music in terms of measures or other large organizational units, such as verses and choruses. These blocks then may be copied, cut, or rearranged at will. Sequencers that have this feature generally also allow lower-level editing. If you need to do more microscopic work, you can always switch to another view. For composers who tend to think about their music as a series of connected sections, this kind of editing can be extremely useful.

Most sequencers also provide ways to edit musical data in higher-level ways. The most common of these is rhythmic correction, known as quantization. This function aligns a passage of music to specific rhythmic values so that music can be made tight, or swing. Extremes of quantization can result in robotic music, but most sequencers have routines with enough sophistication to produce musical results.

Other kinds of note-processing include the ability to reverse phrases of music, multiply or divide note durations, and split notes into different tracks according to various criteria (pitch, duration, dynamics, etc.). Some

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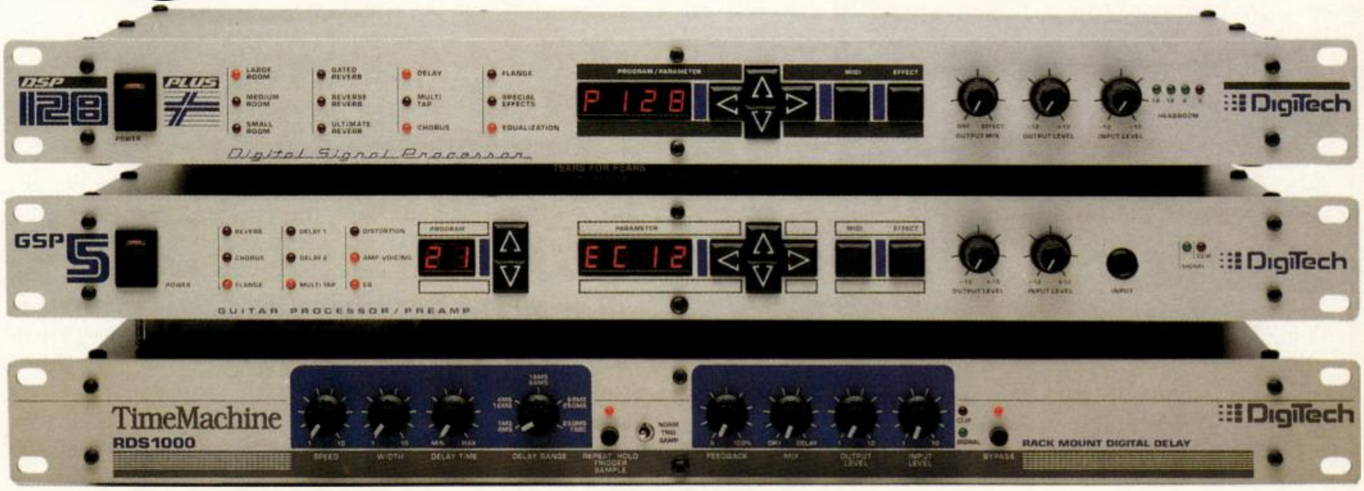

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sequencers even include "algorithmic composition" features that make up new phrases of music by scrambling material already entered in a variety of ways.

COMPUTERS IN ELECTRONIC MUSIC

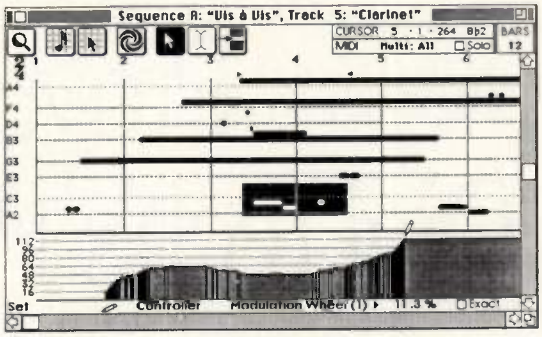
These days, a personal computer forms the center of many an electronic music system. Sequencing programs, alluded to in the previous section, are the most prevalent, but not the only, application. Programs are also available to organize the sound resources of a system (which can be huge, given the capabilities of modern instruments) and to set up the system as a whole. Computers can control nearly as much of the production process—creating and triggering sounds, signal processing, mixing, and recording—as your knowledge and budget permit.

Do you need a computer for your system? It depends on what you want to do. Certainly, the sequencing capabilities of computers far outstrip those of hardware-based sequencers (especially in the editing department). On the other hand, if your interest is live performance, you may prefer to travel light, using a self-contained, "workstation"-type instrument or a small MIDI system.

INTEGRATED INSTRUMENTS

Today, one of the most popular categories of electronic musical instrument is the so-called "workstation." These devices integrate a keyboard controller, a sound-module, effects processing, and a sequencer. In many cases, they provide a convenient and affordable solution for performance and composition. They are easy to move around, and they eliminate the "nest-of-wires" syndrome that often plagues the electronic-music enthusiast. On the other hand, they definitely limit your capabilities in ways that a system of discrete pieces does not.

Another option is to use a workstation as the starting point for a larger system. This is one of the great things that MIDI has brought us. Different pieces of equipment can be combined almost without limit.



The Graphic Editing window of Opcode's *Vision* displays MIDI data in "piano-roll" style.

Although the concepts of modern electronic music are not exceptionally difficult, there are a large number of terms and concepts used to describe them, and this is often the source of confusion. I hope I've clarified a few of the more important parts of the jargon so you're able to get more out of your purchasing dollar and out of your music.

Dan Phillips *is a product specialist for Korg Research and Development.*

B Y   A M Y   Z I F F E R

MULTITRACK RECORDING

An EM Primer

Many thousands of people have sampled the pleasures of home recording. You can, too, once you understand the basic terms and concepts.

Until the mid-1970s, multitrack recording was strictly the province of the professional studio. The only way that an artist could gain access was with major record label support. The equipment available to ordinary musicians was crude, and often designed for dictation or educational use. Today, it seems everyone records their own demo tapes, or even finished albums, and home recording equipment has been the fastest growing area of audio equipment sales for several years.

What is *multitrack* recording, and why would you want to use it? (Definitions of all words in italics appear in the accompanying glossary of terms.) Multitrack equipment lets the artist capture each instrument or group of instruments separately, allowing all of the individual *tracks* to play back together. These tracks are *mixed down* into a final stereo recording. The major benefit of multitrack recording is that it gives you the flexibility to replace, add, and modify the individual parts of a musical composition.

If you play alone, multitracking lets you perform parts one at a time, recording each one individually. At the end, all of the parts are combined to make it seem as if a whole band did the work. A band can be recorded

STEVE LYONS

together, but because the parts are isolated on individual tracks, each player can come back and polish his or her part at leisure. Whether recording a full band, or a one-person act, multitrack recording dramatically expands the available options.

BASIC STUFF

To record, route, mix, and play back sound in the studio, you need certain basic components. First off, you need a means to generate an *audio signal* for recording. In this day and age, this is often an electronic instrument such as a synthesizer, sampler, or drum machine. To record vocals and acoustic instruments requires one or more microphones to convert sound into an electronic signal for recording. The outputs of "electric" instruments (such as electric guitars) are often incompatible with the inputs of mixers and recorders. These may require *direct boxes* to change their output into a form suitable for recording.

To record the resulting signals, you will need some sort of multitrack recorder. Today, there is a remarkable range of equipment available, with four, eight, sixteen, or 24 tracks. Within each category, there are a number of products available at widely varying price points. Be sure to note the *tape format. Open-reel* and *cassette* are the two big divisions in physical formats, and open-reel tape comes in a variety of widths (¼-inch, ½-inch, 1-inch, and 2-inch). Generally speaking, wider tape can accommodate more tracks with better audio quality. Unfortunately, it also costs more (considerably more) for the machines and tape. In recent years, there has been a strong trend towards packing more tracks onto smaller tape formats, including cassette. Technological advances in recording electronics and *tape head* design have yielded equipment that sounds remarkably good even at very high track densities. Presently, machines that record eight tracks on cassette and sixteen tracks on ¼-inch tape are available and proving to be highly viable.

Effective recording requires a *mixing console* to combine and process audio signals during recording and final mixdown. Consoles come in every size, shape, and price point imaginable, and selecting an appropriate mixer for your application is a matter of matching the

continued on page 50

GLOSSARY OF GENERAL RECORDING TERMS

Most of the concepts used in multitrack recording are not difficult to grasp, but the terms used to describe them can seem like a foreign language to the beginner. We hope this list of common terms will help the reader sort things out as he or she gets started in the art of recording. Note that the terms in all the glossaries are not in alphabetical order, but a logical, relational order. We've tried to present them in the order in which you'd need to understand them.

AUDIO SIGNAL: A varying voltage that carries information representing sound. Audio signals may be recorded, transmitted, processed, etc.

SIGNAL PATH: The complete route followed by an audio signal in a recording system.

TRANSDUCER: Any device that converts a sound or signal from one form to another. The most common transducers in recording are microphones, loudspeakers, and tape heads.

MICROPHONE: A device that converts an acoustic sound into an audio signal for recording, processing, or amplification.

CHANNEL: A single audio signal path. Generally, each channel carries a different signal.

TAPE RECORDER: A device that can record and play back an audio signal on magnetic tape.

TRACK: A path on magnetic tape that contains a single channel of audio information.

MONO OR MONOPHONIC: Describes an audio signal which has a single channel of information. Monophonic audio signals may be played over a single loudspeaker.

STEREO OR STEREOPHONIC: An audio signal or recording system in which two audio channels carry correlated information meant to be reproduced over two loudspeakers.

MULTITRACK: Refers to a tape recorder or recording method in which more than two tracks are used to record individual portions of an audio production.

PARTS: The performances of individual instruments or vocalists that make up a musical composition.

MIXING CONSOLE: A device that mixes and routes audio signals while controlling their relative levels. Most mixing consoles include additional processing functions such as equalization.

MIXDOWN: The process of combining the signals on several recorded tracks to create the final mono or stereo version.

MASTERING DECK: A stereo recorder used to record the final mixed version of a multitrack production.

MONITOR: To listen to an audio signal via headphones or loudspeaker. A monitor is a speaker used for monitoring. Generally, monitors are selected for their accuracy of reproduction, or because they resemble some common type of speaker (i.e., a car radio speaker).

DEMO TAPE: A recording that is meant to convey the essential aspects of a song or composition, usually implying that it is not the final recording desired. Demo tapes are commonly used to pitch a song or artist to record companies, or to teach a composition to other musicians.

GLOSSARY OF AUDIO TERMS

LEVEL: The intensity of an audio signal. Depending on the signal type and context, level is expressed as voltage, power, or sound pressure.

continued...

GLOSSARY OF RECORDING TERMS (CONT.)

DECIBEL (dB): The unit of measurement of audio level. The decibel is an expression of the ratio of two levels. In order to be meaningful, a measurement in dB must be made in relation to a fixed reference. Audio signal levels in home recording equipment are most often made in relation to a level of 1 volt. This measurement is referred to as dBV. Professional equipment is more often measured in dBm, which is an expression of audio signal power, as opposed to voltage level. (See "The Decibel Demystified" in the April 1990 issue of EM.)

FREQUENCY: The rate of vibration of a sound or audio signal. Sounds of low pitch have low frequencies, while high-pitched sounds correspond to higher frequencies. Most sounds consist of more than one basic frequency, each of which is referred to as a frequency component. Frequency is expressed in hertz (also known as cycles-per-second, or cps) or kilohertz (thousands of hertz). The range of normal human hearing is from 20 hertz to 20 kilohertz.

NOISE: Any unwanted sound or audio signal. Most often refers to continuous undesired sound, such as a hiss or rumble.

SIGNAL-TO-NOISE RATIO: A measurement of noise introduced by an audio component, expressed as the difference in level (in decibels) between the desired signal and the unwanted noise.

DISTORTION: An unwanted change in tone quality, usually characterized by the appearance of frequency components that were not present in the original signal.

FREQUENCY RESPONSE: The range of frequencies that an audio device can reproduce.

REVERBERATION OR REVERB: The persistence of sound in a physical environment. Reverberation is caused by the sum of acoustic reflections from environmental surfaces. Though mostly ignored in day-to-day life, reverberation is a normal, expected part of sound, and recordings that lack any reverberation seem very unnatural and even unpleasant. Recordists frequently use artificial reverberation (digital reverb being the common form at present) to add reverberation in a controlled fashion.

MICROPHONE TERMS

POLAR PATTERN OR PICKUP PATTERN: The pattern of a microphone's sensitivity to sound coming from different directions.

OMNIDIRECTIONAL: A pickup pattern that shows equal sensitivity to sound in all directions.

CARDIOID: A directional pickup pattern with maximum attenuation at the rear of the mic. The overall pattern, when drawn on paper, has a heart-like shape, hence the name.

BIDIRECTIONAL OR FIGURE-8: A pickup pattern that shows strong sensitivity at the front and rear of the mic, with maximum attenuation of sound arriving from the side.

OFF-AXIS COLORATION: A change in tone color that results when a sound originates from a direction other than that of a mic's greatest sensitivity.

MIXING CONSOLE TERMS

OPERATING LEVEL: In specifying recording equipment, operating level is the level of signal which produces optimum operation. The operating level of most home recording equipment is -10 dBV. So-called "pro" gear usually specifies a level of +4 dBm.

CLIPPING LEVEL: The level at which a given piece of equipment produces unacceptable distortion. Most often, it is the level immediately below clipping that is of interest.

HEADROOM: The difference between the nominal "operating level" and the clipping level. Equipment headroom varies widely, with home equipment typically having less than professional gear.

Headroom is an important concept, because changes in signal level easily can produce unacceptable distortion if the headroom is inadequate. A good deal of the work of recording engineering involves monitoring and controlling signal levels in relation to operating level and headroom to produce the best possible recording without distortion.

COMPRESSOR: An audio signal processor whose function is to reduce the amount of variation in the level of an audio signal. Compression often is used to help manage audio signal level.

LINE LEVEL: Refers to signals that are at or near the nominal operating level of an audio system. It should be noted that terms such as operating level, line level, and mic level refer to overall averages. A real audio signal will normally swing between silence, or minimum level, and maximum, or clipping, level.

LEVEL METER: Any device that provides an indication of the relative level of an audio signal.

MIC LEVEL: The signal level produced by a microphone, typically about 2 millivolts. Mic level signals must be boosted to line level for recording and mixing.

LEVEL-MATCHING: The process of ensuring that the outputs of one

continued...

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capacities of the mixer with the number of tape tracks you use, and the number of individual sound sources you wish to record at one time. We'll elaborate on this subject later.

Today, many home recordists choose an integrated *portable studio*, which combines multitrack recorder (most often 4-track cassette) with a suitable mixer. These units are extremely compact, and more than reasonably priced. They make an excellent choice if your needs are not too elaborate. Singer/songwriters are especially attracted to these units for "rough-and-ready" *demo* recording.

If you want to produce a final tape in a form suitable for playback on the average home stereo, you will need a stereo recorder to serve as a *mastering deck*. This may be a cassette recorder, an open-reel machine, or (increasingly) a digital two-track *DAT* machine.

Of course, you will need a way to hear your production during recording and mixing. Although you can listen on just about anything, the accuracy of your *monitoring system* will have a profound effect on your final results. It is wise to pay careful attention to the speakers and amplifier you select for this purpose.

STARTING AT THE SOURCE

If you are recording electronic instruments, simply connect the device's output to the input of the mixer or recorder. But if you want to record acoustic instruments (including voice), you will need to use a *microphone* or pickup. A dazzling array of microphones are available, and professional engineers have been known to close bars discussing the merits of different mics for various purposes.

To select a microphone, the most essential info you need to know is its *polar pattern* (also known as a *pickup* pattern). This describes the directions from which the mic is sensitive to sounds. An *omnidirectional* mic is sensitive to sounds from all directions and useful when recording several instruments at once (for example, a quartet of singers). A *cardioid* mic (so named for its heart-shaped polar pattern) is sensitive to sounds from one direction and rejects sounds from all others. A *figure-8*, or *bi-directional*, mic picks up sounds from two directions 180° apart but rejects sounds in between. There are plenty of other patterns, too. (For more infor-

GLOSSARY OF RECORDING TERMS (CONT.)

device produce levels appropriate for the inputs of another.

MIC PREAMP: An amplification circuit designed to bring mic level signals up to line level.

SIGNAL PROCESSOR: Any device used to change an audio signal. Common examples of signal processors are equalizers, mixers, compressors, reverberation units.

CONDUCTOR: A piece of material capable of conveying an electrical signal.

AUDIO CABLE: A shielded conductor designed to convey an audio signal from one point to another.

INPUT JACK: The audio connector that brings a signal into an input channel.

DIRECT BOX: A device used to connect an amplified instrument to the mic input of a mixer. The direct box provides level and impedance matching for the output of the instrument.

FADER: A linear or sliding volume control that is used to adjust signal level.

MONITOR MIX: A mix of signals that is used during recording or overdubbing. The monitor mix is used to ensure that the part or parts being recorded are properly related to all of the other parts.

SEND: A separately adjusted mix of signals that may be fed to an external signal processor. Also sometimes used as a monitor mix.

RETURN: A separate input, mono or stereo, that combines the output of an external processor with the main mixer outputs.

PRE-FADER SEND: A send whose level is not affected by the position of the main channel fader. Pre-fader sends are typically used for monitor mixes, since it is often desired to hear a signal that is not intended to appear in the main outputs.

POST-FADER SEND: A send whose level varies in proportion to the position of the main fader for that channel. Post-fader sends are usually used for reverberation and effects, where a proportional mix of direct and processed signal is required.

ROUTING: The process of controlling the path taken by an audio signal. Much recording engineering involves the routing of signals to various tape tracks, monitor mixes, and external signal processors.

PAN POT: Short for "panoramic potentiometer." Two connected volume controls for the left and right channels in a stereo mix, wired such that as the level of the left channel increases, the level of the right channel decreases and vice-versa. Thus, the amount of a signal that appears in the left and right speakers can be adjusted.

EQUALIZATION: The process of adjusting of frequency response to alter the tone of an audio signal.

OUTPUT BUS (OR BUSS): In a mixer, an internal circuit that collects a mix of audio signals and routes them to a selected output connector. Most mixers have more than one output bus, and these are variously referred to by names such as stereo bus, monitor bus, effects bus, etc.

TAPE RECORDER TERMS

TAPE FORMAT: A description of the physical form of tape and the manner in which sound is recorded on it.

continued...

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mation, see "Basic Studio Series, Part 5: A Microphone Primer" in the March 1990 **EM**.)

Electronic instruments produce fairly high-level *(line level)* signals. Microphones, however, produce low-level signals and need greater amplification. (This is why you find separate "line" and "microphone" inputs on mixers.) If you plug a line-level signal into a microphone input, you are likely to overload the input and create massive *distortion*. Conversely, if you plug a mic-level signal into a line input, the signal will get lost in the noise.

You'll probably run into the term *operating level* in reference to mixers, recorders, and signal processors (see "The Decibel Demystified" in the April 1990 **EM** for an explanation). Even more important than the definition, however, is understanding how mismatched operating levels can harm the quality of your recordings. Careful attention to *level-matching* throughout the recording process can mean the difference between a muddy, noisy recording and one that is crisp and full of life.

Careful attention to level-matching throughout the recording process can mean the difference between a muddy, noisy recording and one that is crisp and full of life.

Audio cables are used to connect the various pieces of equipment together. These come in many varieties, differing primarily in the number of conductors and the type of connectors used. Cables are often overlooked as critical links in the recording chain, and many home-studio owners try to save money by buying inexpensive cable. Poor-quality cables can affect tone quality, introduce noise, and generally mess up audio more than you might suspect. It's worthwhile to invest in a few good ones.

THE MIXING LINK

At the other end of the cable is a mixing console. A mixer combines various *channels* of audio (as distinguished from the "tracks" of a tape recorder). Channels on a mixer are also sometimes referred to as *inputs* or *input channels.* The number of channels determines how many audio signals can be combined at once. (See "Basic Studio Series, Part 4: Mixers" in the February 1990 issue, for a more detailed discussion.)

Typically, each channel of a mixer includes an *input jack*, a *fader* (a control to adjust signal level), *equalization* controls, effects or auxiliary *sends*, routing buttons with *pan pots*, a switch labeled "tape/channel" (or with a similar legend), and meters and *monitor-level* controls. There may be other controls, too. You use the input fader to adjust the level of an incoming signal. Equalization lets you alter the tone of the signal by emphasizing or de-emphasizing certain frequencies. Effects and auxiliary sends are used to "split off" a portion of the incoming signal and send it to signal processors such as reverbs or compressors (a *signal processor* is any device that alters the tone or dynamics of a signal); the processed signal from those external devices is *returned* to the mixer to be combined with the other signals.

On a recording mixer, routing buttons let you select the tape track on which you'll record. Tape/channel switches determine whether the mixer "looks" to the line and mic input jacks, or the tape tracks, for a signal. Typically, you select "channel" while recording and select "tape" at the overdubbing or mixing stage when you're ready to listen to what you've recorded. Pan pots control where the signal is located (left/center/right) in the final stereo mix and can be used for routing at the recording stage.

Meters are used to visually determine when the incoming signal is at the optimum level for recording. If the signal is recorded too low, it will be noisy; if it is too high ("hot"), the resulting recording will be distorted. Each manufacturer offers specific recommendations concerning optimal recording levels for their machines; let them be your guide.

When recording multitrack, you usually want each track to be well-separated and recorded at a level that opti-

GLOSSARY OF RECORDING TERMS (CONT.)

OPEN-REEL OR REEL-TO-REEL: A tape format in which tape is stored on a single roll, or reel. In recording or playback, the tape winds off of a source reel and is wound onto a take-up reel.

CASSETTE: A tape format in which tape, source reel, and take-up reel are contained in a single housing. This normally refers to the compact cassette, which has become extremely popular for home, car, and personal listening.

DAT (DIGITAL AUDIO TAPE): A recently developed stereo tape format in which sound is recorded as a digital code. DAT uses a type of cassette which is different from the ordinary compact cassette.

PORTABLE STUDIO: A combination of multitrack tape (usually cassette) with mixer. Often known by the original, trademarked term Portastudio.

TAPE HEAD: An electromagnetic transducer that is responsible for the transfer of an electrical audio signal to and from tape.

TAPE SPEED: The rate at which tape is transported during recording or playback. Tape speed is an important determinant of recording time, with higher speeds yielding better frequency response and signal-to-noise.

TAPE TRANSPORT: The portion of a tape recorder that is responsible for the physical movement of tape past the heads.

TRANSPORT CONTROLS: The part of a tape recorder that the operator uses to control the motion of tape. Most recorders have pushbuttons for forward, stop, fast-forward, and rewind operations.

RECORDING LEVEL: The level at which an audio signal is recorded onto

continued...

mizes sound quality. However, you need to be able to hear the part being recorded in relation to the rest of the music. Recording mixers typically provide for a separate *monitor mix*. Monitor-level controls determine the listening level of each track and have no relationship to the level of signal being recorded to tape.

The mixer combines audio signals together on one or more output *buses*. Usually, there are a variety of buses in a mixer, including the effects sends/returns, the monitor bus, and the main output circuit. (The term "bus" can have other meanings, though: A data bus is a set of wires used for transmission of digital information. A ground bus is where all the grounds in an electrical device connect.)

GET TO KNOW YOUR TAPE RECORDER

The big split in multitrack recorders these days is between reel-to-reel (open reel) and cassette. The open-reel format has the advantage of easy editing and less crosstalk, or interference of the sound on one track with the sound on the next track. Cassette multitrack formats have a sizable cost advantage. Open-reel tape comes in $^1/_4$ or $^1/_2$-inch widths, although professional studios often use wider tape formats, especially for 24-plus tracks. Cassette tape is only $^1/_8$ of an inch wide. Putting eight tracks on cassette tape, with minimal bleed-through, is an impressive technological achievement. Open-reel machines operate at higher tape speeds than cassette machines, yielding better *frequency response*. While budget open-reel decks customarily operate at $7\,^1/_2$ and 15 ips (inches per second), cassette machines operate at $1\,^7/_8$ and/or $3\,^3/_4$ ips. (For more on tape formats, see "Tale of the Tape" in the June 1990 issue. Tape recorders are discussed in detail in the same issue.)

For mixdown, you not only have the same two choices, open-reel and cassette, but an additional option. DAT is a stereo digital format that is becoming increasingly popular in professional and home recording. The advantage of DAT is greatly reduced noise and distortion at the mixdown stage. The major disadvantage is cost: The starting price for DAT machines is around $800. (See "DAT: What You Need to Know" in the April 1989 EM.)

Whether multitrack or stereo, open-reel, cassette, or DAT, all recorders

GLOSSARY OF RECORDING TERMS (CONT.)

tape. For good results, recording levels must be neither too high (distortion) nor too low (noise).

TRACK BOUNCING: A process in which multiple tracks are mixed and re-recorded onto another track, for the purpose of freeing tracks for further recording.

OVERDUBBING: The process of adding additional musical parts to previously recorded tracks.

FOR FURTHER READING

Mix Bookshelf (tel. [800] 233-9604 or [415] 653-3307) offers a huge selection of instructional books, tapes, and videos on both professional and home recording.

Anderton, Craig. *Home Recording for Musicians*. AMSCO Publishing, 1978, pp.182. $15.95.

Bartlett, Bruce. *Introduction to Professional Recording Techniques*. MacMillan Publishing, 1987, pp.397. $24.95.

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Goldfield, Paul. *How to do a Demo Quality Recording in your Bedroom*. Peter Alexander Publishing, 1988, pp.119. $19.95.

Hurtig, Brent. *Multitrack Recording for Musicians*. Alfred Publishing Co., 1988, pp.135. $17.95.

Melan, Peter and Wichman, Larry. *The Musician's Guide to Home Recording*. Linden Press/Fireside, 1988, pp.113. $17.95.

Shaping your Sound with Multitrack Recording, home use edition. First Light Video Pubishing, 1990. VHS or Beta videotape. $59.95.


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Larry Oakes Keyboardist/Guitar for 1988 Foreigner Tour and 1989 Bad Company Tour and Gold Album: "Dangerous Age" Lou Gramm
"Voice Crystal sounds are fat and meaty, just the way I like 'em. Whether duplicating or originating their superior quality is always inspiring."
Marc LeBrun Keyboardist/LA Session Player on Tour with Diane Schuur & Tom Jones
"Whether I'm playing in the studio or live on stage Voice Crystal makes my keyboards sound great!
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"Voice Crystal has the sounds I want to hear, and the sounds I want to create.
Kevin Gilbert Keyboardist for Giraffe
1988 Yamaha Sound Check Winner
"Having a vast library of sounds this good allows me to focus on my songs."
Bobby Lyle Album: "The Journey"
"The new Voice Crystal cartridges give me a whole new array of dynamic sounds to color my music with. I'm looking forward to making them an intergral part of my sound for the 90's."
Bobby Lyle
Steve Reid Producer/CBS Records
The Rippingtons and Super Tramp
"One of the most demanding things about producing is finding the right new sounds for each project. With Voice Crystals I've found an endless variety of fresh sound for my synths and samplers. Keep it up guys!
Mark Stich
Keyboardist for Angela Bofill
Album: "Angela Bofill/Intuition" (Capitol)
"I was given only a few weeks to prepare for the 1989 Good Friends National Tour. With no time for programming my own sounds, I turned to Eye & I Productions and Voice Crystal sounds. From Fat Analog sounds to complex Digital Timbers Voice Crystal really came through for me. Thanks Guys."
Terry Wollman Music Director for The Byron Allen Show Nationally Syndicated, NBC, CBS, ABC TV
"Working with Voice Crystal gives me a spectrum of sounds to choose from and leaves me free to compose and play music."
Terry Wollman
Freddie Ravel
Keyboardists for Sergio Mendez & RAVE'L
Album: "Midnight Passion" (Polydor)
"I use Voice Crystal because they bring new life to my synthesizers and samplers."
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provide essentially the same functions: *transport controls* (play, fast-forward, rewind, pause, stop, record), meters, input-level controls, and some kind of tape location counter. Also note, multitrack decks provide individual switches to "arm" each track for recording.

TAPE'S ROLLING

Let's work through a typical recording session to see how and when each piece of equipment is used. In our example, the orchestration consists of drum machine with mono output, synthesizer with mono output, electric guitar (played through an amplifier), and vocals. We'll record with a 4-track cassette deck with a built-in mixer that has four inputs.

The drum machine and synth are line-level devices, so plug their outputs directly into two line inputs of the 4-track. Place a microphone in front of the guitar amp and plug it into the mic input of a third channel. Then, position a second mic in front of the singer and run it into the mic input of the last channel. Set the tape/channel switch to "channel," and set the routing switches and pan pots so the drum machine routes to track 1, the synth and guitar route to track 2, and the voice routes to track 3, leaving track 4 open for now.

Raise the faders on all four inputs (as in **Fig. 1**) until you see signal registering at the right level on three of the four meters. Next, raise the monitor levels on tracks 1 to 3. (Remember, the level going to tape and the level you hear through the monitors are not the same. Record as much signal as you can without distorting, because it will give the best quality. You can change the level of playback later.) If the guitar doesn't sound quite right, use the equalization on channel 3 to enhance its tone. If the level of the singer's voice is uneven, you can use the auxiliary send to run that signal to a *compressor*. The return from the compressor comes back on the same cable as the send, replacing the unprocessed vocal.

You also can use the *reverb* or echo sends on channels 2 to 4 (synth, guitar, and voice) to give those instruments a fuller sound, bringing the processed signal back into the reverb return jacks on the 4-track, where it is mixed internally into the monitors *but not recorded*. Then we begin recording on tracks 1, 2, and 3, and the band plays through a song.

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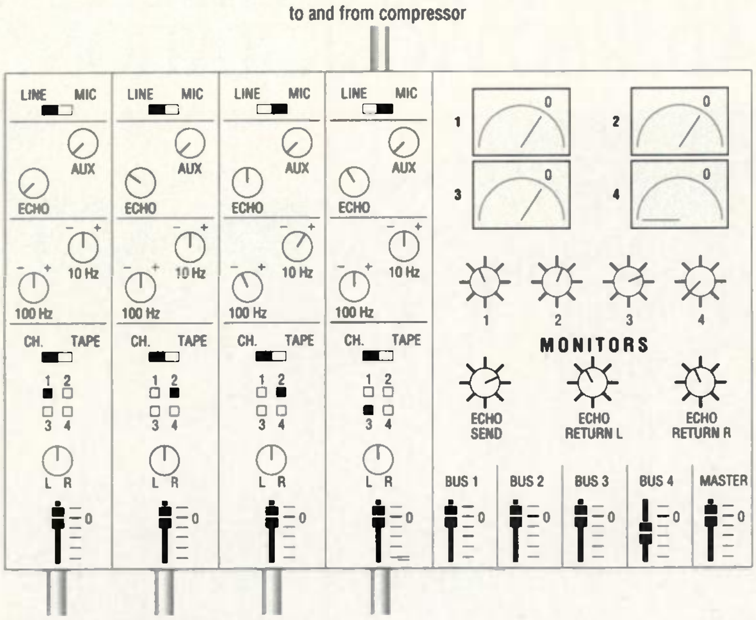

FIG. 1: Mixer configuration for tracking.

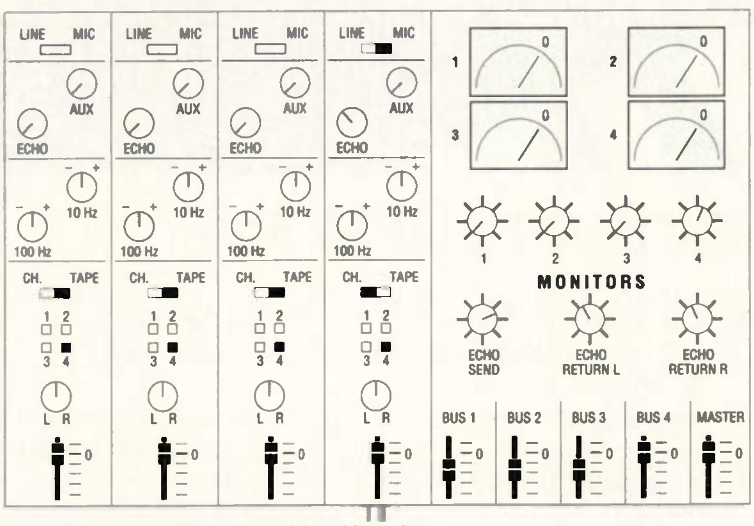

FIG. 2: Mixer configuration for overdub and bouncing.

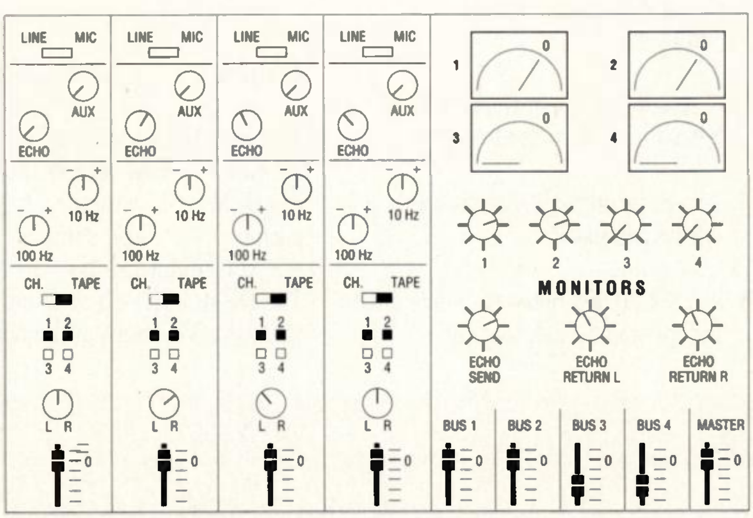

FIG. 3: Mixer configuration for mixdown.

Next, we want to add more vocals. Adding the new vocal part to tracks already on tape is called *overdubbing*. Move the tape/channel switches on channels 1, 2, and 3 to "tape" (as shown in **Fig. 2**) so you can use the routing buttons to *bounce*. The faders on those channels now control the level of the tracks being played back, and this time, you want the levels going to tape to be the same as those you hear in the final mix. So, route channels 1 to 3, as well as the mic in input 4, to track 4. When you roll the tape back to the start of the song and put track 4 into "record" (making sure tracks 1 to 3 are no longer in record), those tracks—along with the new vocal part—will be recorded on track 4, and you need only listen to track 4 on the monitors to hear all the parts.

You now have drum machine, synth, guitar, and two vocal parts on track 4, so you can erase tracks 1, 2, and 3 and use them for more overdubs—additional synth parts, for example. You could continue overdubbing and bouncing indefinitely, but two or three bounces of the same track is the practical limit, since noise builds up each time you do it.

Once you've recorded all the parts, it's time to mix down. First, set all tape/channel switches to "tape" and route the four tracks to the four channels of the mixer (as in **Fig. 3**). Then you can use the equalization and auxiliary and echo sends again, if necessary, just as you did when recording. The only difference is that everything will be routed to buses 1 and 2, which feed the stereo output of the mixer, and this time, everything you hear—including the reverb—will be recorded on the stereo deck. Use the faders to change levels (perhaps making the guitar louder during a solo) while the song plays back on the 4-track deck and is recorded onto the 2-track. Our final product is a stereo mix that can be used to run off cassette or reel-to-reel copies, or even (if the quality is high enough) to master an album.

Amy Ziffer *earned her BM in audio engineering from the Berklee College of Music. Among her accomplishments, she lists two years on the editorial staff of* Home & Studio Recording *magazine and sainthood in the First Pedestrian Church of Boston. She'll consider any job offer that will allow her to reside in Paris, France.*

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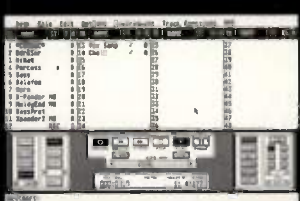
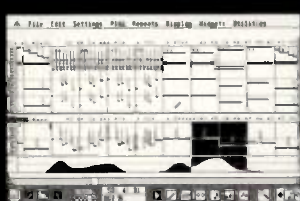


Recording



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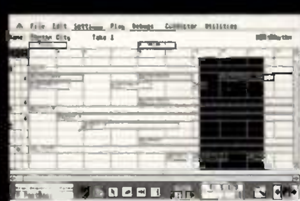

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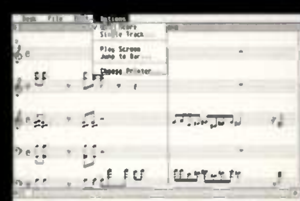

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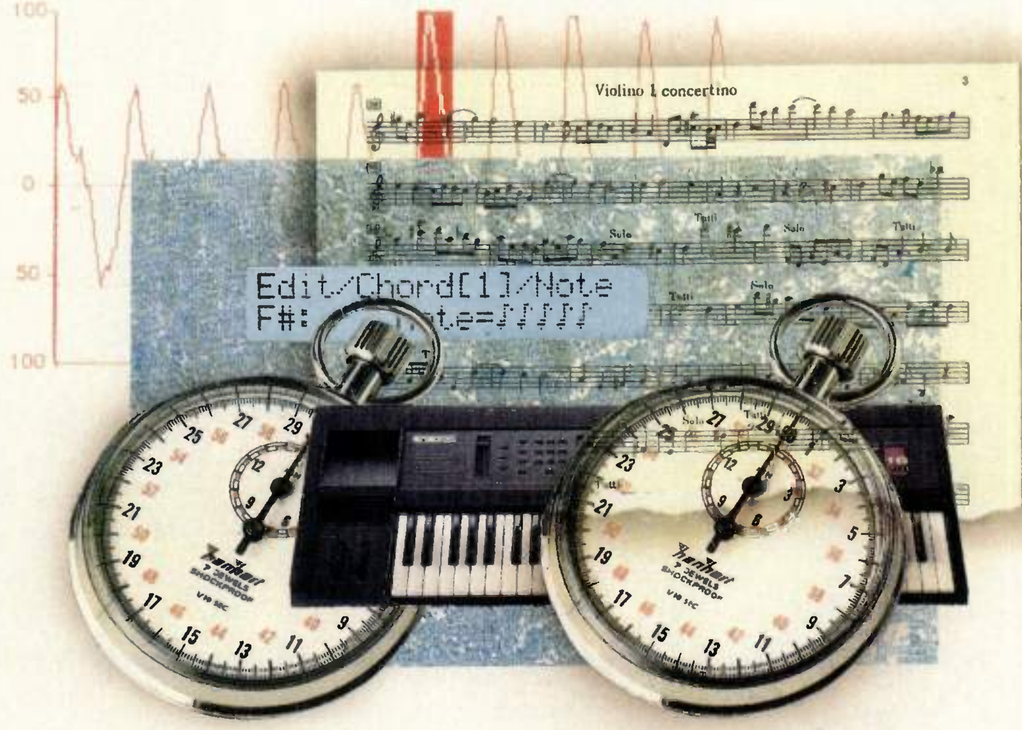

LAURA TARRISH

In using sequencers and tape together, there's nothing more critical —or more misunderstood— than exact synchronization.

Today, music recording and composition are based on two fundamental technologies: sequencers and multitrack tape. Sequencers are used to transcribe performances for electronic instruments as lists of notes and performance nuances (such as key velocity, sustain pedal, etc.). These computer-stored descriptions are used to re-create the performance by retriggering the instruments as though they were being played by invisible hands. The major advantage of sequencing is that these descriptions can be changed easily and extensively, making sequenced electronic music an extremely malleable medium. (See "Unveiling the Mystery: The Basics of Electronic Music" on p.26 of this issue.)

But sequencers record MIDI data, not audio, so they're no good for recording vocals and non-MIDI instruments. (This is changing, though. With Opcode's recent release of *StudioVision*, Macintosh-based recordists with Digidesign's Sound Tools or Audiomedia digital recording systems can work with audio signals within the sequencer environment. Similar products are under development by other software manufacturers.) Tape, especially multitrack tape, is the common medium for recording acoustic and electric (as opposed to electronic) instrument tracks. In addition, tape can be used to take some of the load off of the sequencer by recording parts that "overflow" the number of synths and drum machine voices available to play them. Tape tracks, however, are much more difficult to edit than sequenced music.

For these reasons, the typical electronic music studio of today is a hybrid, with sequencers and tape machines locked together so that one can complement the strengths of the other (see **Fig. 1**). Generally, electronic instrument tracks are composed and arranged on the sequencer; these parts are referred to as *virtual tracks*

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SEND FOR FREE CATALOG • MUSICIANS INSTITUTE • 1655 McCADDEN PLACE • BOX 010 • HOLLYWOOD, CA. 90028 • (213) 462 • 1384 because they are treated as though they were tracks on tape when it comes time for the final mix. A well-integrated tape and sequencer combination is a profoundly powerful system for music composition.

For this approach to work, the tape machines and sequencers must be synchronized to each other in some fashion. The term "*synchronization*" comes from the Greek word for "at the same time." It implies that the tape machine and sequencer will always start from the same precise point in time and maintain exactly the same speed as they play. This sounds like a simple requirement, but some ingenious technology is needed to implement it successfully.

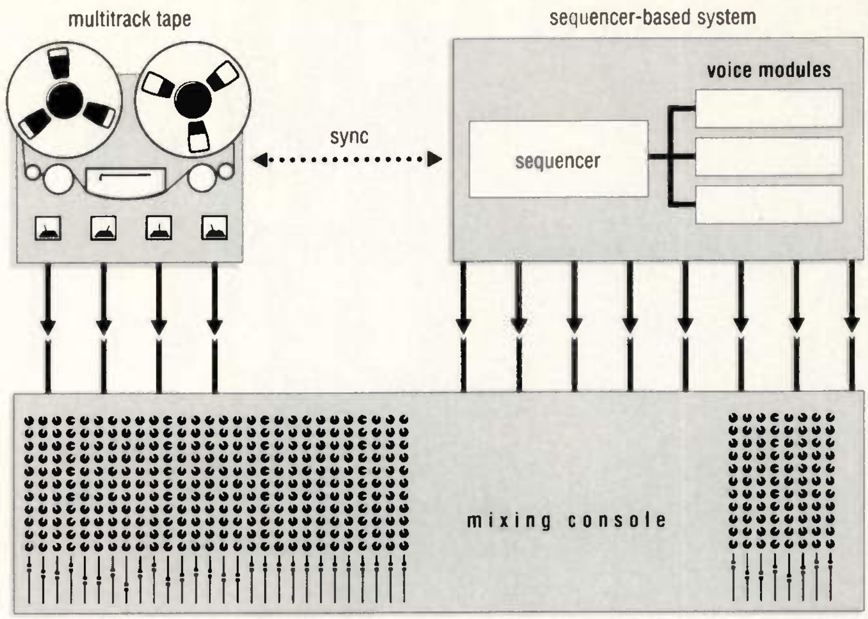

FIG. 1: Sequencers and multitrack tape can be combined into hybrid systems more powerful than either alone.

HOW IT WORKS

For synchronization to work, one machine must follow another. Tape machines can be synchronized to sequencers, but this generally requires a fairly expensive piece of hardware, and even then it's awkward because the tape requires time to chase to the location of the sequence. On the other hand, sequencers are agile by nature, and they only need position information to go immediately to any point in the composition. For this reason, it is almost universal for the sequencer to chase to the tape machine, not the other way around.

To convey the positional information the sequencer needs, a single track of tape is dedicated to recording and reproducing a *sync tone.* This audio track encodes positional information in a form the sequencer can read. The reference for tape position should be established before any tracks are created, so the tone is recorded at the beginning of a session or project. (There are exceptional cases where this doesn't apply, but they are beyond the scope of this article.) A hardware sequencer or MIDI interface may provide all the facilities needed to record and read this tone, or a third box may be required to translate the tone into a form the sequencer can understand (see **Figs. 2** and **3**).

There are two basic types of sync tone: the older, variable-rate *FSK* sync, and time code sync, which is commonly used in today's equipment. Variable-rate sync drives the sequencer directly, just like a clock gear. Each tick of the "clock" is embedded in the tone and increments the sequencer by a single step of predetermined size. If the clock speeds up,

Simple Sync Steps: Time-Based Formats

RECORDING

1. Patch the sync signal's path. For devices with their own sync in/out jacks, patch directly to tape; for systems requiring converters, patch the converter's sync in/out to tape and route the converter's MIDI out to the sequencer's MIDI in. Some MIDI sequencers have a second, merged MIDI in for this purpose.
2. Set the sequencer to the tempo desired for the composition.
3. Set the sequencer (and/or converter) to Internal Sync mode.
4. Set the intended sync track to the optimum record level.
5. Locate the tape to at least five seconds before the point where you wish the song to begin.
6. Enable record mode on the intended sync track and begin recording.
7. After the transport has stabilized for five seconds or more, start the sequencer.
8. Stop the transport after more sync than you need has been recorded.

PLAYBACK

1. Rewind the tape to at least five seconds before the beginning of the song.
2. Patch the sequencer so that its MIDI out is driving the MIDI In of the desired instrument(s).
3. If you intend to commit sequenced tracks to tape, patch the instrument's audio outs to the desired tape tracks and put it into record mode.
4. Place the sequencer (and converter) in External Sync mode.
5. Start the sequencer. The device should be waiting for a sync signal from tape.
6. Start the tape transport. The sequencer should begin playing at the beginning of the sync signal. If not, check your cables and internal/external sync settings. If there is no problem here, the problem is most likely in the record or playback level. Try attenuating the sync playback to find the right level; if this doesn't work, restripe the tape at a different level and repeat the rest of the steps until the optimum level is found.

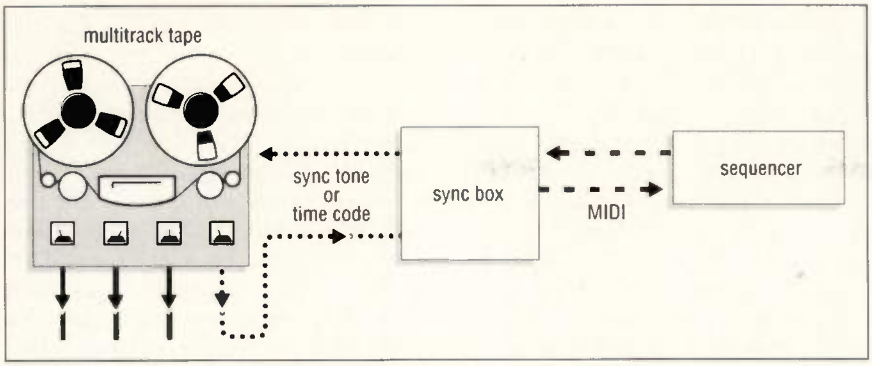

FIG. 2: Sync-to-tape using an external conversion box.

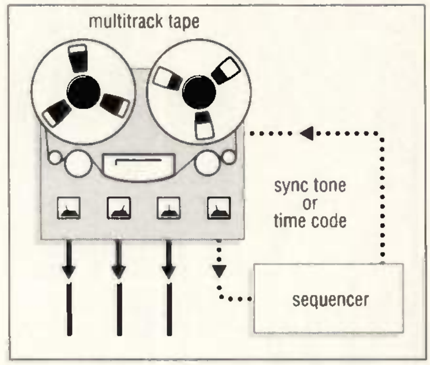

FIG. 3: Sync-to-tape with a sequencer that has facilities to read and write sync directly.

then the sequence speeds up, and likewise if it should slow down. By the same token, the tempo of the sequence cannot be altered once the tone is recorded.

Originally, sync pulses were recorded directly to tape. This works but is very much subject to dropouts. A technique of encoding called *frequency-shift keying* or FSK (responsible for the now-familiar sounds of fax machines and modems) was devised to carry the tempo in a more stable format. These techniques were most commonly used for pre-MIDI systems. The big disadvantage of this type of system is that the sequence must always start from the very beginning, eliminating one of the big advantages of sequencing: random access capability.

A similar approach was used for MIDI sequencers at first, but it was quickly supplanted by "intelligent," or "smart" FSK, which encodes MIDI *song position pointer* information into the sync tone. Using this system, the tape can be started at any point, and the sequencer can chase to that position. Even *intelligent FSK*, however, is inextricably linked to the tempo at which it is originally recorded.

Time code, in contrast, simply records a reference to elapsed time in hours, minutes, seconds, and divisions of seconds. The tempo and starting time of the composition is specified in the sequence itself, and the sequencer is responsible for relating tempo to absolute time. Using time code gives the composer much more flexible control over tempo. It also is appropriate for situations where audio events must be related to fixed moments in time, such as in spotting sound effects to film.

A number of years ago, the Society of Motion Picture and Television Engineers (*SMPTE*), an organization of engineers in the film and video industries, agreed on a standard for a time code that could be recorded on a standard audio track. This is known as SMPTE time code. Today, SMPTE time code is used so universally that if you say "SMPTE," it will most likely be understood that you mean the time code, not the organization. (For more on SMPTE time code, see "Synchronization in the Home Studio: A Time Code Primer" in the August 1988 **EM** and "The Industrial Video" in the December 1989 issue.)

Since early in the history of MIDI, boxes have been available to record SMPTE time code and translate it into MIDI clocks and *song position pointer* messages. Because SMPTE is an absolute time reference, the translation box had to be provided with a *tempo map* to determine the start time, initial tempo, and any changes in tempo within the duration of the composition. For this reason, these *"sync boxes"* were elaborate, microprocessor-driven devices that were anything but simple to use.

The use of SMPTE time code in the average MIDI studio got a huge boost when the specification for *MIDI time code* (MTC) was ratified by the MIDI Manufacturers Association (MMA). This provided a standard way to translate SMPTE time code from tape into a form that the sequencer could read directly. The result is that all of the functions of tempo mapping have been absorbed into the sequencer itself. Today, most sequencers (hardware and software) chase directly to MIDI time code. Many hardware sequencers and MIDI interfaces are equipped to record

Simple Sync Steps: SMPTE Formats

RECORDING

1. Patch the sync signal's path. For devices with their own SMPTE in/out jacks, patch directly to tape; for systems requiring converters, patch the converter's SMPTE in/out to tape and route the converter's MIDI out to the sequencer's MIDI in. Some MIDI sequencers have a second, merged MIDI in for this purpose.
2. Set the time code conversion device to Write mode.
3. Set the intended sync track to the optimum record level.
4. Locate the tape to at least five seconds before the point where you wish the song to begin.
5. Enable record mode on the intended sync track and begin recording.
6. After the transport has stabilized for five seconds or more, start the converter in Write mode.
7. Stop the transport after more sync than you need has been recorded.

PLAYBACK

1. Rewind the tape to at least five seconds before the beginning of the song.
2. Patch the sequencer so that its MIDI out is driving the MIDI in of the desired instrument(s).
3. If you intend to commit sequenced tracks to tape, patch the instruments' audio outs to the desired tape tracks and put them into record mode.
4. Set the tempo and meter in the sequencer; program tempo maps as desired.
5. Place the time code reader in Read mode, if necessary.
6. Place the sequencer in External Sync mode.
7. Start the sequencer. The device should be waiting for a sync signal from tape.
8. Start the tape transport. The sequencer should begin playing at the beginning of the sync signal. If not, check your cables and internal/external sync settings. If there is no problem here, the problem most likely is in the record or playback level. First, try attenuating the sync playback to find the right level. If this doesn't work, go back and restripe the tape at a different level and repeat the rest of the steps until the optimum level is found.

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and read SMPTE time code directly. If you are confused about the difference between SMPTE and MIDI time code, remember that SMPTE is the audio signal recorded onto tape. MIDI time code is a serial stream carried on a MIDI cable and cannot be recorded directly onto tape. (For more on MIDI time code, see "MIDI Reaches Adolescence" in the May 1988 **EM** and "I Want My MTC" in the November 1988 issue.)

GUIDELINES FOR A CLEAN SYNC

The primary problem is getting a good sync tone, or time code, track onto tape. This process is known as *striping* the tape. Sync tones of all kinds are notoriously sensitive to tape dropout. Another source of difficulty is that the sync tracks contain large amounts of energy at the most annoying frequencies, and these have a strong tendency to bleed into other tracks. Regardless of the sync method used, the guidelines

A Glossary of Synchronization Terms

SYNCHRONIZATION: The process of linking recording devices to play in an exact time relationship to one another.

SYNC TONE: An audio tone that encodes clock or time information in a form that can be read by a sequencer or other device.

SYNC-TO-TAPE: The process of locking a sequencer to stereo or multi-track tape.

VIRTUAL TRACKS: Parts that are to be played by the sequencer during final mixdown. The term comes from the idea that the sequencer parts can be treated as though they were tracks on tape.

CHASING: The process that occurs when one device (tape machine or sequencer) changes its location to match that of another device.

CHASE-LOCK: The process of locating to another device's position in time, then maintaining exact lock-step.

FSK (FREQUENCY-SHIFT KEYING): A method of encoding digital information (clocks and other messages) so they can be properly decoded after recording or transmission over audio lines.

MIDI CLOCK: A standard MIDI message that conveys one "click" of a sequencer clock. The MIDI clock is defined as having a rate of 24 times the quarter-note pulse.

SONG POSITION POINTER: A MIDI message that indicates the measure number and quarter-note beat location within a composition.

INTELLIGENT FSK: A form of sync tone that encodes the MIDI song position pointer in the audio track.

SMPTE TIME CODE: A standard method of encoding time in hours, minutes, seconds, and portions of a second into an audio signal.

STRIPING: The process of recording a sync tone, or time code, onto a track of tape.

OFFSET: In the context of synchronizing sequencers with tape, offset generally refers to starting offset, which is the point in time (as represented by the time code) at which the sequencer will be- gin playing.

GUARD TRACK: A tape track that is deliberately left blank in order to provide isolation between audio and time code or sync tone.

SYNC BOX: A device that can generate and read time code while translating time code locations into MIDI clocks and song position pointers to drive a sequencer.

TEMPO MAP: A list of tempo changes used by the sync box or sequencer to determine the correct song position pointer, as well as the correct tempo.

MIDI TIME CODE: A portion of the MIDI standard that allows SMPTE time code to be directly represented as MIDI messages that can be read by a computer or sequencer.

for successful operation are similar.

• Always stripe the tape first. It's virtually impossible to stripe a tape and find the right starting offset and tempo to match previously recorded tracks.

• Always record the sync tone by itself. While it might be tempting to commit a sequenced track to tape while striping, it is safer to wait. This ensures that all sequenced tracks see exactly the same signal.

• Always clean your heads before recording the sync signal. While this is standard operating procedure for recording in general, it is also one less variable in a *sync-to-tape* environment.

• Always give yourself five seconds or more of tape at the head of the reel and between songs. This allows the transport to stabilize before it comes to your start point.

• Always stripe more than you need. You never know when you'll decide to tack on another chorus as you're tracking a tune, and it's better to have too much sync tone than not enough. In the case of SMPTE, stripe the entire tape while you make a pot of coffee. In the case of tempo-based sync formats, you'll want to record sync on a per-song basis (both for the right tempo and a distinct point where the clock starts).

• Always create a sequenced reference track before recording live tracks. If you wish to record live instruments before recording sequenced tracks, you'll want something to serve as a metronome. In other words, since you can't hear the sync track itself, you need to know where the beat is. In the case of time code, locking in the starting offset and laying out the tempo/meter maps is a part of this process.

• Always record the sync signal on an outside track. From the standpoint of crosstalk, having an adjacent track on only one side is preferable to one on either side. (Most engineers put sync on the last track of a given format, e.g., track 8 of an 8-track deck.)

• If possible, provide an empty "guard" track between the sync track and those that contain your music. In our 8-track example, track 7 would remain empty.

• If there are not enough tracks to make a *guard track* feasible, record an instrument in the adjacent track that does not contain critical high-frequency material. This is because the crosstalk will be most noticeable in high-frequencies. A track containing a mellow or flat kick drum can be rolled off on the high-end to eliminate the bleeding sync tone without seriously altering the instrument.

• Use the shortest amount of cable possible, with high-quality wiring and drop-out and signal fluctuations. The more direct the signal path, the better.

• Keep the recording level between -6 VU and 0 VU, and optimally at -3 VU. The bottom line here is experimentation. If crosstalk is a problem on your format, strive for the lowest possible recording level that still provides good sync. If some of your tracks are to be used in other studios, a happy medium close to -3 VU will help insure compatibility.

• Regenerate sync signals during transfers. Generation loss has terrible effects on sync signals. If your equipment allows it, always regenerate the sync during transfers by driving your sync device from the master reel and recording the fresh output of the sync device onto the slave reel.

Jeff Burger *is president of Creative Technologies, a multimedia production company based in Northern California.*

POWER PANIC BUTTON

for the EM IMP

Our MIDI microcomputer finds a new role in the never-ending battle against the forces of evil (or at least, stuck notes).

In November 1990, **EM** *published plans for the Integrated MIDI Processor, or* **IMP**, *using a general-purpose microcontroller (the Intel 8031 or 8051). True to its name, the* **IMP** *is a versatile servant capable of performing a variety of MIDI tasks just by inserting an appropriately programmed IC. This month, we present a "software option" for the* **IMP** *that can be a lifesaver in the studio or in live performance.—GH*

Have you ever experienced the panic of having synth notes stick-on during a session or a live set? This always seems to happen at the worst possible moment, and if you're using a complex setup, it can take a lot of time just to figure out which synth it's coming from. Still more time is lost in eliminating the offending note, perhaps even at the cost of having to reload patches or samples lost while powering the instruments up and down. (All taking place under the pressure of audience, clients, musicians, and deadlines, of course.) If so, then you need a MIDI "panic button."

I've seen several devices labeled "panic buttons." Most send a system reset (HEX FF) message whenever the button is pressed. This works in many situations, but sometimes the job calls for stronger medicine.

AN INDUSTRIAL-STRENGTH MIDI PANIC BUTTON

The Power Panic Button (PPB, for short) is the ultimate panic button. The PPB is a program that runs on a simple microcomputer, the Intel 8031 or 8051. The program lies dormant until it senses that a particular pushbutton,

BY PAUL MESSICK AND JOHN BATTLE

or footswitch, has been pressed. It then sends out a data burst containing every known MIDI neutralizing message on every channel.

First, it sends the all-notes-off message on every channel:

```
All-notes-off
        1011nnnn
        01111011

where: nnnn = channel number
```

This done, the PPB begins sending individual commands to each of the 128 notes on all 16 channels, instructing them to "turn off." In the MIDI protocol, there are actually two ways to turn a note off. The most obvious is the notes-off channel message:

```
Notes off
        1000nnnn
        0kkkkkkk
        0vvvvvvv

where: nnnn = channel number
        kkkkkkk = note number
        vvvvvvv = velocity
```

Due to some misunderstanding in the early days of MIDI, many developers chose an alternate method of turning notes off. This method consists, oddly enough, of sending a note-on status byte for each note number followed by a velocity of zero , i.e.:

```
Note on
        1001nnnn
        0kkkkkkk
        00000000

where: nnnn = channel number
        kkkkkkk = note number
```

That's 128 notes on each of the sixteen MIDI channels, with three bytes per message (more than 3,000 bytes total). A quick calculation shows that sending all these bytes takes a little over two seconds, and twice that if both kinds of message are sent. In order to reduce transmit time, we send only the second, more universal, message in the PPB.

Finally, the program sends commands to center the pitch wheel, set the modulation wheel to zero, and release the sustain pedal. Each command, in keeping with the "power" philosophy, is sent on each of the sixteen MIDI channels. This is virtually guaranteed to stop offending notes.

BUILDING THE IMP

All of the information needed to build the IMP is contained in the article "Merging with the Integrated MIDI Processor." (See p.72 in the November 1990 issue of **EM**.) The IMP is an easy project to build, especially if you use the available printed circuit board (see sidebar: "Sources"). Note that you will want to install a momentary pushbutton (or a jack for a footswitch) for S1, described as an option for future use in the original article. It's also recommended that you socket the 2764 EPROM, IC3, so that it will be easy to change software in the future. For that matter, you really should socket all chips in a project of this kind.

INSTALLING THE PPB SOFTWARE

If you have already built the IMP, all you have do to is secure an EPROM (Erasable Programmable Read-Only

PROGRAMMING THE 8031/8051

Writing and debugging software for the IMP's 8031 microcontroller requires (at minimum) a computer, an EPROM burner, and a piece of software called a cross-assembler. (The PPB program was written using AVMAC Macro Assembler version 2.45 for IBM PC, from Avocet Systems.) A modem and an account on the PAN network is also recommended, so that you can download the code written by EM authors. It's much easier to write a program starting from someone else's code, because a sizable part of the source code is taken up with hardware definitions and initializations that stay the same from program to program.

If you've programmed in higher-level languages, you may find assembly language a little tough at first because assembly code deals with the most basic levels of the computer hardware. Fortunately, the 8031 (and its immediate relative, the 8051) is one of the easiest micros to program, and the programs we are interested in are fairly simple. Assembly language is used for this kind of application because the final code is more compact and faster than that generated by higher-level languages. Speed is especially important for real-time MIDI processing applications, and we need compact code because our EPROM memory space is limited.

Assembly language source code is written as a text file, using mnemonics that represent the instructions used by the microprocessor, and labels that are defined (by the programmer) to correspond to constants and variables. Illustrated is a snippet of 8031 assembly code to show the general format that is used (see Fig. 2).

Once the source code has been written, the assembler program processes the text of the source, converts each instruction and constant into a binary number, and assigns memory locations to hold each of the variables. This process can (and has been) done by hand, but it's incredibly tedious for anything but the smallest programs, and practically impossible for large ones. Computers are perfect for this kind of "look-it-up-and-keep-it-all-straight" operation. This also makes it much more feasible to try out different versions of code, and to fix things that don't work the first time.

The assembler produces an object file from which the final codes are derived in the form of a hex file. This file must then be transferred into a PROM or EPROM, a memory device that the microcomputer can read. This is done using a device attached to a serial or parallel port of the computer. Finally, the programmed PROM or EPROM is inserted into the appropriate socket of the target (in this case the IMP), and the software is run.

At this point, it is not uncommon to discover problems with the program as it is written, and the process of debugging begins. For assembly language coding on a small system such as we describe, most debugging is done by a classic process known as crash-and-burn where: (a) The programmer examines the original source code for the errors; (b) the source code is modified and a new EPROM is generated from the assembled code; (c) the program is run again; and (d) if the new code doesn't work, go back to (a).

More elaborate software and hardware tools (called simulators and emulators) are available that aid the process of debugging by allowing the programmer to run all or part of the program and examine the results in the internal registers and memory locations of the microprocessors. These tools can be costly, however, and are often unnecessary for small programs.

```
label       instruction  operand(s)      comments
;
HITPANIC:   MOV          R4,#0           ; load initial channel #
HP_AN:      MOV          A,#0B0H         ; load status byte
            ORL          A,R4            ; add channel
            CALL         SEND            ; send status byte
            MOV          A,#7BH          ; all notes off
            CALL         SEND            ; send second byte of message
            MOV          A,#0            ; value = 0
            CALL         SEND            ; send third byte
            INC          R4              ; next channel
            CJNE         R4,#16,HP_AN    ; repeat until done
;
; subroutine to transmit one byte
;
SEND:       JB           TE_FLG,SEND     ; wait if xmit buffer not empty
            MOV          SBUF,A          ; send byte
            SETB         TE_FLG          ; set xmit buffer full (reset by
                                         ; hardware)
            RET                          ; return to calling routine
```

FIG.2: A fragment of assembly language source code for the 8031.

THE PPB PROGRAM

The Power Panic Button program is a simple piece of code that only has to do two things: (a) Incoming MIDI data is transferred directly to the outputs, so that the PPB can be placed in-line with other MIDI data sources; and (b) when the button or footswitch is pressed, the PPB transmits a complete block of data containing all of the neutralizing messages.

A flowchart of the program is shown in **Fig. 3**. When the IMP is powered on, the first part of the program initializes the state of all of the ports and memory locations that are used. The program then goes into a loop condition, waiting for a press of the button or the arrival of MIDI data at the Input port. When a MIDI byte is received, the program exits the loop just long enough to transfer the byte directly to the MIDI out. When the button is pressed, the program jumps to a routine that transmits the "panic button" data block. After transmission is completed, the program jumps back to the main loop, where it waits for another event. It should be noted that MIDI data that comes into the unit during a "panic" transmission most likely will be lost.

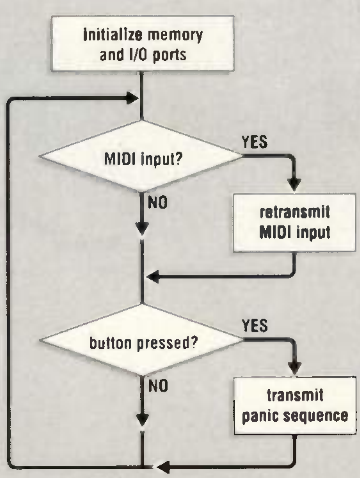

FIG.3: A flowchart of the Power Panic Button program.

SOURCE AND OBJECT CODE

If you want to download the code for the PPB, you will need a computer with modem and an account on the PAN network. If you are not already a member, you can call (800) 336-0149 or (800) 336-0437 and ask for the local access number and instructions for reaching PAN. You then can "log-on" with your modem. At the "Username" prompt, type the letters "PANJOIN." Then, when you see the prompt for "Password," type "EMSIG." The network will prompt you for the remainder of the sign-on procedure. As an EM reader, you will be exempt from the normal sign-on fee (normally $225), but you will still be responsible for the online charges of $24/hour for daytime use, or $12/hour for evenings and weekends.

Memory) that has been programmed with the code for the PPB, and install it at IC3. (It's always advisable to socket EPROMs for this reason.) If you originally built the IMP for MIDI merging, it's a good idea to keep the original EPROM (labeled), in case you ever want to use the IMP as a MIDI merger. If you need a separate merger, you can build a second IMP.

There are two ways to obtain an appropriately programmed part. By far, the easier way is to order it from **EM**'s DIY supply source (see sidebar: "Sources"). The current price of an EPROM containing the PPB program is $12. Just ask for the "PPB EPROM" when ordering.

If you have an EPROM burner and a modem available, then you can obtain the code from the EM SIG on the PAN network. The object code and the hex file (the binary data ready to be written to EPROM) are available there. If you're the kind of person who has an EPROM burner, then you also may be the type who likes to hack code, and you'll be glad to know that the source code (the 8031/8051 assembly language code from which the binary program is derived)also is posted. Illustrated are two ways to obtain the program in EPROM form (see **Fig. 1**).

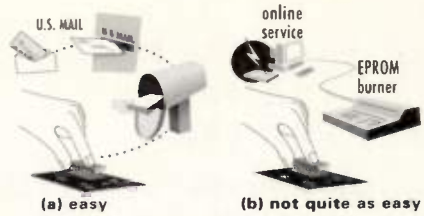

FIG. 1: Two ways to obtain the Power Panic Button software on EPROM.

USING THE POWER PANIC BUTTON

Using the PPB is simplicity in itself. Just hook the unit in the MIDI line from the master controller and sit tight. Whenever you press the button, the light will flash for about two seconds, and everything will be fixed (hopefully).

Paul Messick *hopes someday to invent a Panic Button placebo.* **John Battle** *co-founded Datastream, a MIDI accessory supplier, with Paul Messick.*

SOURCES

PLANS

If you missed the original article describing the IMP, you can obtain a copy by sending $5 to:
Electronic Musician
Back Issues
PO Box 41094
Nashville, TN 37204

Be sure to specify that you want the November 1990 issue.

IMP PARTS

Printed circuit boards for the IMP and pre-programmed EPROMS may be ordered from:
Kent Clark
PO Box 322
Madison, AL 35758

The IMP PC board is $28 (ask for IMP PCB). The EPROM containing the PPB software (PPB EPROM) is $12.

GENERAL PARTS

Unless you live in an area that has good retail electronic component suppliers, your best bet for general parts supply is probably mail order. There are several excellent suppliers, including:

Digi-Key Corporation
701 Brooks Ave S.
PO Box 677
Thief River Falls, MN 56701-0677
tel. (800) 344-4539

Jameco Electronics
1355 Shoreway Rd.
Belmont, CA 94002
tel. (415) 592-2503

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Anyone who builds electronic gear should have catalogs from these four companies.

What is MIDI, Anyway?

By Bob O'Donnell

Before you can make this important tool work for you, you need to learn what it is and how it works.

Have you ever been to a concert where the guitarist seems to be playing trumpet parts and the keyboardist seems to be playing guitar? In today's music-making environment, what you see is not always what you get. Seemingly incongruous combinations of instruments and sounds happen all the time. Similarly, some of the music you hear at a concert or on a recording may actually be "performed" by a personal computer, by itself or along with human performers.

These magical developments are made possible by an important but commonly misunderstood subject: MIDI (pronounced mid-ee), or the Musical Instrument Digital Interface.

MIDI is a standardized protocol that allows electronic musical instruments, peripheral products, and computers to communicate and share information. The information they share concerns musical performance; the notes being played, the strength or loudness with which they're played, a particular sound being used, etc. A MIDI signal is *not* the actual sound of an instrument—that's handled by the audio circuits—it just describes the performance gestures of the performer (see sidebar, "What MIDI Isn't"). MIDI consists of a number of messages, in the form of computer data, that work like a language to specify how and when events (such as a note being played) occur. By itself, MIDI achieves nothing; its sole purpose is to communicate between devices.

MIDI appears as a round, 5-pin connector on the back of products that transmit or receive these messages. There are three types of MIDI connectors or jacks: In, Out, and Thru (see **Fig. 1**). MIDI In jacks receive data from other MIDI instruments, MIDI Out jacks transmit data generated by a MIDI instrument, and MIDI Thru jacks retransmit an exact copy of the data that comes into an instrument's In jack. The MIDI messages are carried by special cables, with the appropriate connectors on each end. MIDI messages can only travel in one direction, so it's important to make the proper connections. Logically, the order of connection is Out to In, or Thru to In. The flow of signal from device to device is sometimes called the MIDI datastream.

WHY MIDI?

By the early 1980s, keyboard synthesizers had become popular, and many people were interested in more effective ways to use them in recording and live performance. For one thing, performers were interested in playing the sounds of one keyboard from another so that they could hear, for instance, the string sound from one instrument and the brass sound from another by playing one keyboard. Synthesizer manufacturers responded to this and other concerns by creating their own "communications" systems for connecting related products. Unfortunately, it was difficult to make synths from different companies work together.

In 1982, Dave Smith (then president of Sequential Circuits and now leader of Korg Research and Development in the U.S.) proposed the Universal Synthesizer Interface, a standard means of connecting together devices from any company. This idea stuck a chord with a number of people, and representatives from American and Japanese manufacturers began working with Smith's ideas. In late 1983, they produced the specification document describing the Musical Instrument Digital Interface (MIDI), and a star was born.

Since then, applications for MIDI have grown beyond its creators' wildest dreams. In addition to allowing easy remote access to any sound imaginable from a MIDI keyboard, numerous other instrument "controllers" have been produced, such as MIDI guitars,

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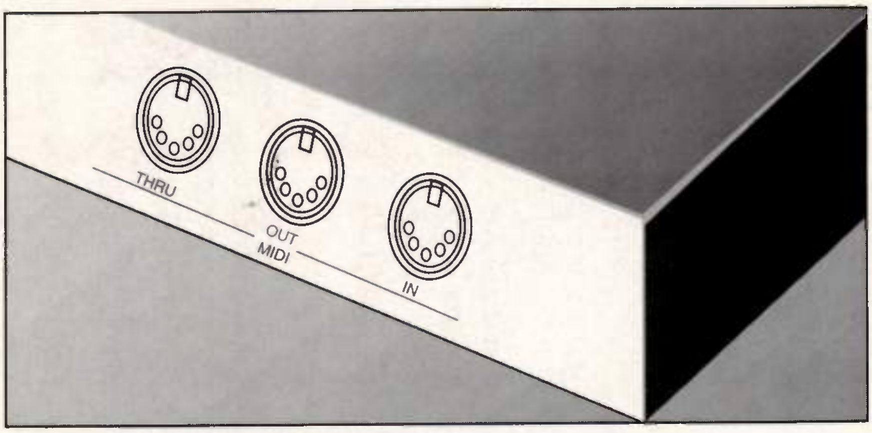


FIG. 1: The three types of MIDI jacks: In, Out, and Thru.

MIDI wind controllers, MIDI violins, etc. While all vary in the manner in which they are played, they share the ability to generate MIDI messages (just like those from a keyboard) that can be used to control other MIDI instruments. Today, if you want to play drums from your guitar, or piano from drum pads, it's no problem. Just connect the MIDI Output from a MIDI guitar controller to a device with drum sounds, or the MIDI Out from drum pads to a MIDI device with a good piano sound, and jam to your heart's content.

Similarly, MIDI messages can be used to control devices that are not musical instruments: You can automatically adjust volume levels of a MIDI-controlled mixer, change settings on a reverb unit, or control a stage lighting system. Because MIDI is simply a command language used to tell receiving devices to respond in a certain way, the possibilities are practically limitless.

MIDI speaks the same digital language used by computers, so the combination of MIDI instruments and computers was obvious. You don't *need* a computer to take advantage of MIDI, but using one in conjunction with MIDI offers many powerful options. If you want to use a computer with MIDI equipment, you'll need a MIDI interface for your type of computer—unless you own an Atari ST computer, which has one built-in. With a computer and the appropriate MIDI software (not all music software supports MIDI, by the way), you can record your music one part at a time using a sequencing program (a piece of software that allows you to record, edit, and play back performance data). If you don't like a particular sound, or the tempo at

which it's being played, you simply change it and then listen to the piece with the new sound or new tempo. You also can create a piece of music in standard music notation and immediately hear what it will sound like on a connected MIDI synthesizer, with the same type of flexibility. No longer do you need to find a group of musicians willing to play your music to hear your compositions.

HOW DOES IT WORK?

MIDI works like an elaborate remote control system. If you play a note on a keyboard, for example, it generates a message that is sent to the MIDI Out connector. That message then travels down a MIDI cable to any other connected piece of MIDI equipment. Upon receiving the message, the connected device identifies the message and responds accordingly. If the receiving device is another synthesizer, for example, it will play the same note—but not necessarily the same sound—as the one played on the transmitting keyboard. If a piece of equipment is not designed to handle a particular type of MIDI message (or is set to receive on a different MIDI channel), it ignores the message and does nothing. A reverb unit, for instance, probably would just ignore the message used in this example. MIDI does not add new features to equipment, it simply provides a way to take advantage of the features already included.

While most MIDI products both send and receive MIDI messages, some (called controllers) are designed primarily to generate MIDI messages while others act as passive targets, responding to the MIDI data they receive. In a basic situation, the main controller (or "master") is often a keyboard synthesizer, but you also can use MIDI guitars, MIDI drum pads, MIDI wind controllers, or any other device that generates MIDI data. Typical receiving (or "slave") devices include "keyboardless" MIDI expander modules (which contain the sound-generating portion of a synthesizer), other keyboards, and drum machines.

MESSAGES

To understand MIDI messages, it helps to think of MIDI as a means of translating musical performance into a digital form. Again, MIDI does not contain nor have anything to do with audio signals; rather, it consists of performance gestures (such as playing a particular note, selecting a particular sound, moving a pitch bend wheel, etc.).

Most messages in the MIDI protocol describe specific performance-oriented actions—though they need not be performed in "real time" (that is, played in tempo), or even be generated by a human player. Among MIDI's messages are Note-On, which tells a connected instrument to play a certain note; Note-Off, which releases the note; Program Change, which tells a connected device to switch to a different sound or patch; and MIDI control-

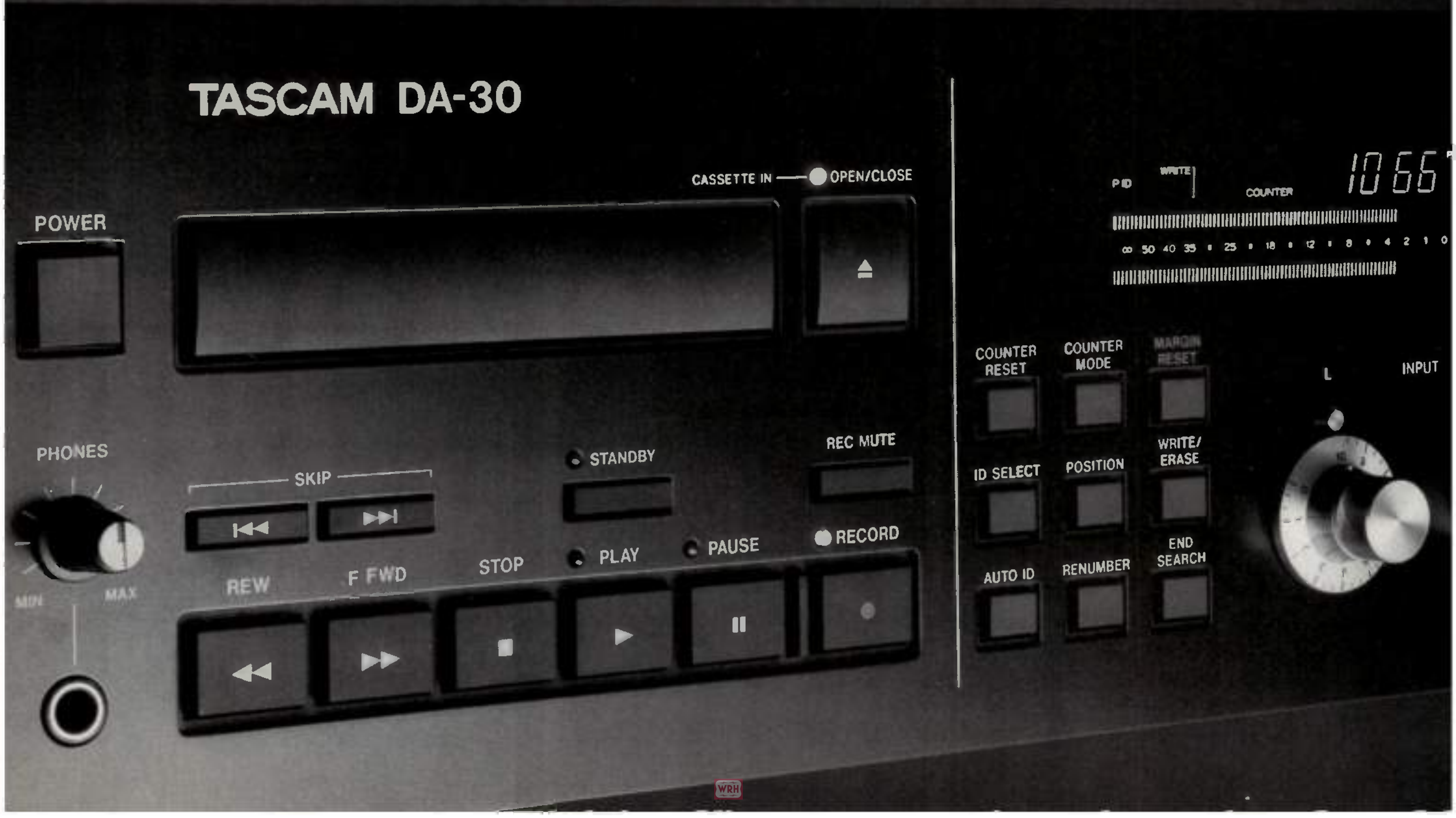
WHAT MIDI ISN'T

As important as it may be to understand what MIDI is, it's even more important that you understand what MIDI is not: MIDI is not audio. No matter how many MIDI cables you have hooked-up, you won't get any sound unless an audio output is connected to an amplifier and speaker. In particular, don't confuse MIDI with the signals used by digital audio recording equipment. Although both MIDI and digital audio consist of digital signals relating to music, the two are very different things.

MIDI messages describe the gestures that make up a performance (e.g., when and how hard keys are played, when the sustain pedal is used, etc.), whereas digital audio actually records the precise sound. It is very much like the difference between a player piano roll and a tape recording of a piano performance.

It's also important to realize that you can't listen to MIDI directly. You might as well try to listen to a piano roll without a player piano. There must always be some kind of sound-generating device to respond to the messages in the MIDI "score." MIDI messages will tell a slaved instrument to play at the appropriate time, but they have no way of knowing if an appropriate slave instrument has been connected to an audio system.

Another common point of confusion involves program changes, a type of MIDI message. People sometimes get the idea that selecting a certain type of sound on a master keyboard will cause any slaved instruments to switch to the same kind of sound. Not true. A program change message—generated when you select a new sound—merely tells receiving devices to select a particularly numbered program. If program 23 on the master controller is selected, the receiving device will call up its own patch 23, without regard for the nature of that sound. It's up to the user to arrange sounds so that desirable combinations can be selected.



lers, such as pitch bend, and volume, which describe continuous changes in the level or position of a particular part of a MIDI device.

When MIDI's designers created the original specification, they realized the need for separate control of individual devices within a group of connected instruments. For example, for different instruments to play independent musical lines, each one needs to see a different set of MIDI messages. Rather than requiring separate cables and datastreams for each of these, they provided MIDI with the ability to handle up to sixteen independent streams of messages, called "MIDI channels," on a single cable.

Every performance message is assigned to one of these sixteen channels. For a piece of equipment to respond to a message from another MIDI device, the two must be set to receive and send on the same MIDI channel. This is an important point, so it bears further explanation. Merely connecting two MIDI devices properly does not guarantee communication between the two. You need to make sure that each device is set to receive or transmit on the appropriate MIDI channel, or channels in the case of a multitimbral instrument (see "Unveiling the Mystery: The Basics of Electronic Music" on p.26).

OTHER OPTIONS

MIDI is very important in the electronic music-making process, but it's not required to make electronic music. Today's keyboard "workstations"—instruments that combine a keyboard synthesizer with a sequencer—allow you to perform all the major functions of electronic music without involving MIDI at all. The sequencers built into these instruments do not directly use MIDI to record and play back their internal sounds, but they most often adopt the format of MIDI messages for their internal representations. They also allow you to use MIDI to control other instruments from their built-in sequencers, however. In this instance, MIDI is the "expansion port" that lets you go beyond the limits of any particular device. Also, you can use a multitrack tape recorder to record individual instruments, one part at a time (see "Basic Multitrack: The **EM** Primer" on p.44) without using MIDI at all.

In its few years of existence, MIDI has taken on an enormous role in the world of electronic music, bringing the field to a previously unimaginable level of accessibility. Musicians around the world, working in studios of all shapes and sizes, now use MIDI to help bring their musical ideas to life. In the truest sense, it has brought a revolution.

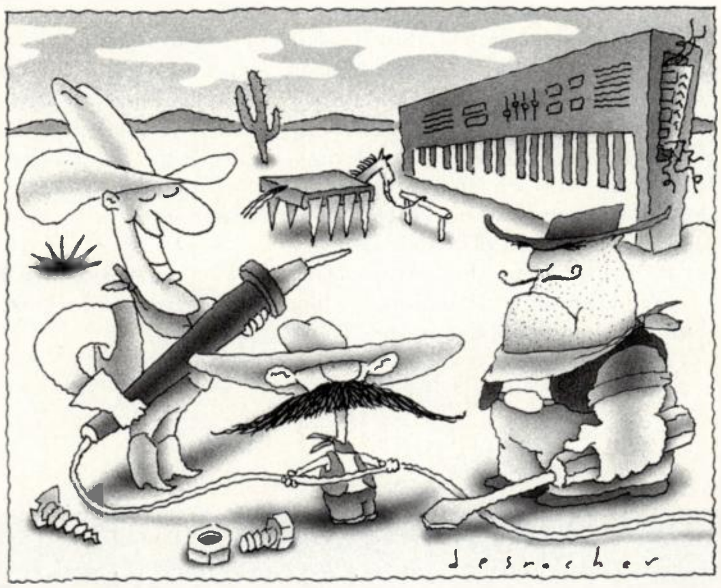
Next month: Synthesizers.

***EM** editor **Bob O'Donnell** clearly remembers what it was like to be very confused about MIDI.*

Questions and Answers

The good, the bad, and the ugly in service documentation, a "Service Clinic" index covering the last two years, and a plea for guidance from our readers.

By Alan Gary Campbell



JACK DESROCHER

Q. I ordered a service manual for my XYZ-brand synthesizer [Manufacturer's name withheld to protect just about everybody—AGC.], and all I got was a schematic and some unintelligible pinouts for terminally obscure ICs. This is a service manual? How the heck are you supposed to service anything without an annotated schematic, board layouts, IC function tables, and timing diagrams? For that matter, some troubleshooting guides would be nice. This stinks.

A. A few manufacturers do emphasize low product pricing and trendy features over quality and service or service documentation. *Caveat emptor.* But there are legitimate reasons that some service manuals are sketchy, at best. (Note that this discussion excludes documentation from manufacturers, such as Ensoniq, who service by board and module exchange, and publish intentionally limited documentation. See the August 1990 "Service Clinic.")

Small, independent companies often do not have the financial or physical resources to produce expansive service manuals or authorize a network of service centers. Therefore, such companies tend to emphasize in-house service. Service documentation from such companies, if available at all, often consists of photocopies of hand-drawn schematics, or even blueprints.

Companies that distribute equipment manufactured overseas may have great difficulty in obtaining service documentation that is complete and translated—or even translatable. Moreover, language barriers muddle technical communication, and enquiries regarding specific device symptoms and defects are problematic.

Nonetheless, it is through the efforts of smaller manufacturing companies and farsighted distributors that many innovative, small-market devices are available. Perhaps putting up with sketchy service documentation is a fair tradeoff.

Three manuals that happen to be on my desk during the preparation of this column offer a telling survey: The Yamaha SPX90 service manual contains full specs, panel layout charts, a block diagram, flowcharts, a room-size chart, a preset list, test routine info, MIDI implementation and data format charts, VLSI pinout/function charts, complete parts lists and board layouts, and a separate, map-fold schematic; but no timing diagrams. The Roland S-50 service notes are in some ways even more expansive, containing timing diagrams and considerable technical data, with perhaps less general information. Both manuals are excellent. In contrast, the complete service documentation for the Siel DK-700 consists of a schematic with notes in Italian.

Q. I have a Yamaha SPX90 digital multi-effects processor that has been updated to the SPX90 II specifications. Since the update installation, the output level is far louder in Bypass mode than in Effect mode. How can this be fixed?

A. The upgrade should not in any way affect the relative Bypass/Effect output levels. If the low effect-mode output level occurs in only one output, then there is probably a defective component in the sample/hold, lowpass filter, de-emphasis, or aperture-correction circuit for that output; if the low output level occurs in both outputs, then the A/D and/or D/A gain adjustments are probably out of calibration. Refer to an SPX90 service manual.

The SPX90 has internal diagnostics, but these do not directly relate to the A/D and D/A gain adjustments, which require a low-distortion audio-frequency sine-wave generator, an AC voltmeter (or DVM with dB function), and an oscilloscope. Because of the accuracy required, it is probably best to refer this job to a Yamaha service center.

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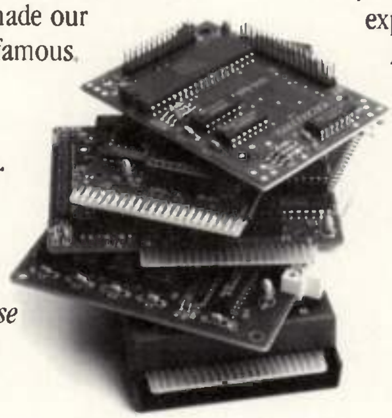

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e. "DIY: Power Panic Button for the EM IMP," p. 68
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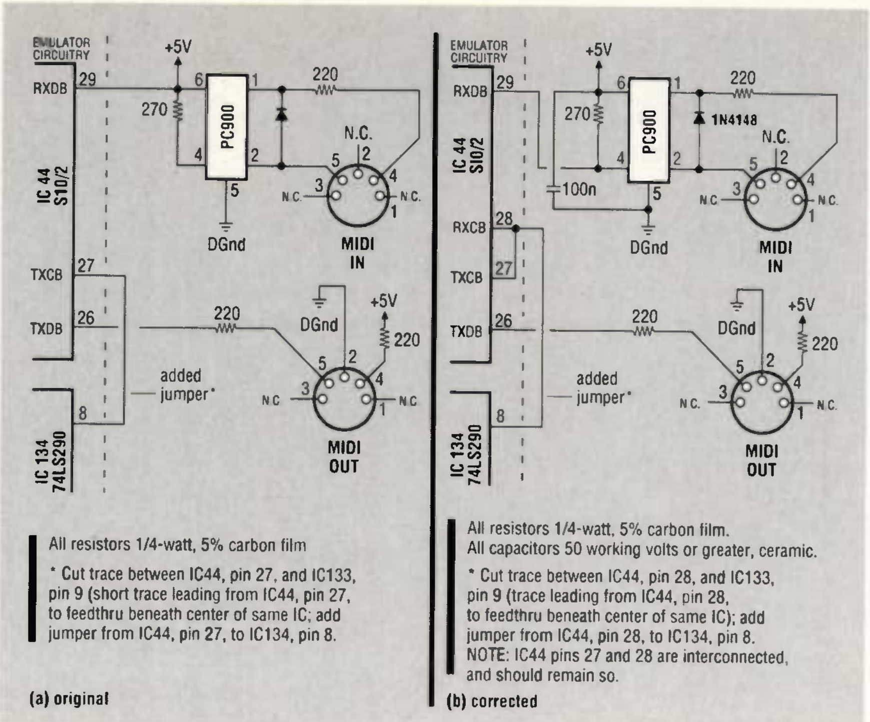

FIG. 1: Original and corrected Emulator I MIDI interface schematic.

Q. Is there any way to test the memory backup battery in my Korg DW-8000 synth? I've had my DW-8000 for several years. Specifically, can I measure the terminal voltage, using a voltmeter, without erasing the program memory?

A. If you use a high-input-impedance digital voltmeter (DVM), and don't screw up (i.e., short something), you should be able to measure the terminal voltage without altering the program memory.

Nevertheless, there is absolutely no excuse for not periodically backing up your DW-8000 programs via MIDI system exclusive or data cassette (the DW-8000 cassette interface is very easy to use). A line-voltage transient or electronic-component failure easily can trash the program memory at any time, even if you don't zap it during testing. Back up your programs frequently, especially when you've created a new program or programs that you don't want to lose.

DW disassembly tips: To access the battery most easily, turn the DW-8000 upside-down on a clean, padded surface (e.g., a bath towel on a table top), with the rear apron toward you. Remove all the Phillips screws around the perimeter of the bottom panel, taking care to note the respective locations of the large and small screws. Also, remove the large screws only from the middle section of the bottom panel. Gently lift the bottom panel just enough that the power supply components clear the rear edge of the instrument case (take care not to strain the connecting cables), then raise the bottom panel to a vertical orientation; note the KLM-z661 mainboard mounted near the center of the bottom panel and the lithium backup battery near the center of the board. With the board propped up in this position, it is fairly easy to access the battery terminals with slim DVM probes. The rated terminal voltage is 3.0 volts; below about 2.7 volts, replace it. Note that the battery is soldered in. If you're not skilled in desoldering techniques and service in general, refer the job to a qualified technician.

Aside: DW-8000 backup batteries generally have a long service life, often five years or more. For more information on backup batteries, see the December 1988 and March 1990 "Service Clinics."

Q. Is it possible to use a cassette interface to transfer program data directly from one instrument to another of the same type?

A. Yes. Moog instruments, e.g., the Source, Memorymoog,and Memorymoog Plus, are particularly amenable. Connect the tape output ("To Tape") of the "sender" instrument to the tape input ("From Tape") of the "receiver," set the sender to "Save to Tape" mode, and the receiver to "Load from Tape." Just make sure that you don't get things backwards. (It also helps if you disable the write protect on the "receiving" instrument.) Back up the programs for both instruments before you try this.

Emulator I MIDI Lives Again

I've had so many recent inquiries about the gremlins that crept into the Emulator I MIDI Interface Schematic in the September 1989 **EM**, p. 42, that I've decided to run a corrected schematic (see **Fig. 1**). (Special thanks to Gary Boggess, who uncovered several of the more subtle stupidities in the original.)

A Really Brief History of "Q & A"

This month's issue marks the fifth anniversary of "Service Clinic"—but not of "Questions and Answers". "Service Clinic" started out, in January 1986, as a mostly monthly feature dealing with topics such as "Obtaining Service," "Product Reliability," "Preventive Maintenance," and "Do-it-Yourself Service." Then, just before the deadline for the January 1987 issue, I realized I couldn't finish my scheduled feature article in time, so I scrambled for a substitute and came up with the first "Q & A." The next month, the article still wasn't ready, so I ran another "Q & A." The thing was so popular it became a department. So much for feature articles.

Over the years, we've tried to maintain a balanced coverage of basic topics, advanced topics, general service topics, old gear, new gear, and detailed descriptions of repairs and modifications that are practical for do-it-yourselfers.

Some readers have commented that the material is too technical, and others, that it's not technical enough. Even fold-out schematics have been requested.

What service topics would you like to see more of, or less of? No, this isn't a solicitation for more questions, but one for information about the kinds of questions—and answers—of interest. Send a postcard to: Service Clinic Survey, c/o **EM**, 6400 Hollis St #12, Emeryville, CA 94608. We'll read all of 'em, but we can't provide personal replies.

EM *Contributing Editor* **Alan Gary Campbell** *is owner of Musitech™, a consulting firm specializing in electronic music product design, service, and modification.*

SERVICE CLINIC INDEX

January 1989—December 1990

January 1989
Cockroach Infestation in Equipment; Computer Viruses; DEP-5 MIDI Implementation Errata/Memory Backup; Destructive Interaction of Vinyl Materials; Infant Failure Mode; Compact Disc Cleaning Devices & Polishing Compounds; Battery Polarity Self-Reversal; Sidebar: "Service Clinic Index, January 1986—December 1988."

February 1989
MIDI Controller/Module Velocity Curve Compatibility; TX1P ROM Upgrade; Poly-800 Top-Octave-Divider Troubleshooting; Obtaining Parts for ARP & Moog Equipment/Moog Spring-loaded Pitch Wheels; Voltage Gate, Switch Trigger, and Voltage Trigger Conversion Circuits; SDR-1000 Turbo I Upgrade; EPS SCSI/Hard Disk Retrofit.

April 1989
Step-Down Transformers; ESQ-1 MIDI Dump to DX7IIFD; C3500 Auxiliary Output Mod; "Identical CDs That Aren't."

May 1989
Keyboard Note-assignment Inversion; S1000 MIDI Volume Controller Assignment; CZ-101 Sticking Panel Buttons; MIDI Y-Cable; NEC Microprocessor Databooks.

June 1989
Tool Magnetization/Demagnetization; K250/250R Diagnostic ROMs; HP-100/MT-32 Sequencer Channel-maps; Poly-800 Memory-Backup Battery Retrofit; Mirage Keyboard Contact Service; CZ-230s Keytop Strips; "Anti-Static Bug Squashers."

August 1989
GM-70 Output Distortion/Cable Strain Relief/Rev 1.03 Upgrade (see September 1989 "Error Log"); ESQ-1 Rev 3.5 ROM Upgrade/Ferrite-Bead Power Supply Mod; Servicing Surface Mount Components; Heat Guns for Heatshrink Tubing; Sidebar: "Gone Fichin'."

December 1989
EPS Disk Drive ID Plate Detachment; ADA MC-1 Phantom Power Mod; K1000 Output Relay Failure/Output Troubleshooting/Keyframe Deformation.

February 1990
MIDI/Audio Snakes; Piezo Transducer Substitution; Fuse Voltage Rating; 3M Hearing Protectors; Omni II Keying Circuit Service.

March 1990
KX5 MIDI-Output Static Damage; Recovering Data from Zapped DX7 RAM Cartridges; DX7/KX76/88 Panel-Switch Troubleshooting; Lithium Backup Batteries; EPS SCSI/Memory Expansion Compatibility; Solder Fume Toxicity/Respirators; "Hammond/Leslie Parts."

June 1990
Obtaining Service on the Road; VFX Button Failure/Version 2.0 Upgrade; Polaris Memory Expansion; Cartridge Contact Cleaning.

July 1990
Obtaining ROMs for DIY Upgrades; MIDI/Oscilloscope Adapter; MIDI Data Tester; Spacers for Potentiometer Bushings; Prophet-10 Cassette-Drive Service.

August 1990

Matrix-6R Memory Glitches/Power-supply-board Flux Residue; RAM Substitution; Ferroresonant Transformers; Modular-exchange Service Programs; "Save the Ozone"; "Save the Oberheims."

October 1990

Optocoupler Theory/MIDI-circuit Applications; Vacuum-tub Mania; Modifying the Keyrange of 76-note Controllers; Anti-ESD Ground Straps; EPS Output-level Mod.

November 1990

Conductive Insulators/Heatsink Compound; MC-500 Service; Omni II Phaser Circuit Service/SAD 512 Substitution/HFO Calibration; Solid-body M'biras.

December 1990

Solder Types, Ratios & Applications; EPS/VFX Keyboard Calibration Problems; Using Microphone Cable in MIDI Applications/MIDI-cable Wiring.

For additional service-oriented topics, see "Resurrecting the Dinosaur," in the September 1989 **EM**.

A Service Clinic Index for the period from January 1986 to December 1988 appeared on p.93 in the January 1989 **EM**.

Direct enquiries to: Service Clinic, c/o Electronic Musician Magazine, 6400 Hollis Street #12, Emeryville, CA 94608.

Sorry, but we cannot provide personal replies to service questions.

First Takes & Quick Picks

We start the new year by admiring an easy-to-use compressor/ limiter; a low-priced music notation program for the Mac; and a handy miniature line mixer.

Symetrix SX208

Symetrix SX208 Stereo Compressor/Limiter ($299)

By George Petersen

Physically, the SX208 is a half-rack box, with the ubiquitous and always-annoying external AC transformer on a cord. (I suppose outboard power supplies are here to stay. On the plus side, these pesky little rascals reduce hum levels within the unit and allow manufacturers to keep production costs down while maintaining a high standard of audio quality.) In the cost department, the SX208 comes in under $300, which is an excellent deal for a decent mono compressor and an impressive price point for a stereo unit.

the EM rating system

EM reviews include 11-step "LED meters" showing a product's performance in specific categories chosen by the reviewer (such as ease of use, construction, etc.) and a "VU meter" indicating an overall rating. The latter is *not* a mathematical average, since some categories are more important than others. For example, if a guitar synth has great documentation and is easy to use, but tracks poorly, it could have several high LED meters and a low overall rating.

The rating system is based on the following values, where "0" means a feature is nonfunctional or doesn't exist, while a value of "11" surpasses the point of mere excellence (a rating of 10) and is indicative of a feature or product that is truly groundbreaking and has never before been executed so well.

Please remember that these are opinions, and, as always, EM welcomes opposing viewpoints. We urge you to contact manufacturers for more information, and, of course, tell them you saw it in EM.

The SX208's layout is straightforward and logical. The back panel has stereo, ¼-inch inputs and outputs that can accept either unbalanced or balanced (TRS) line-level signals. The front panel is equally facile, with controls for bypass, input threshold, compression ratio, output level, and "response," the latter allowing the user to choose between fast or slow attack/release times. LED displays are provided for input threshold (under/over), input/output level clipping, and gain reduction.

Since the SX208 uses circuitry that sets attack and release times depending on the input program material, setup and operation is a breeze, yet I never felt inhibited by the unit's lack of manual attack and release controls. The SX208's program-dependent circuitry had no trouble handling typical studio and live sound applications. Getting the sound you want is merely a matter of setting the threshold, picking an appropriate ratio and response time, adjusting the output gain, and letting the SX208 do the rest.

While the SX208 is a stereo unit, it can also be used as a single-channel device, which is especially useful for recording bass guitar and lead vocals. One point to keep in mind is that the SX208 is a stereo—rather than a dual mono—processor, which means that the device applies similar processing to both channels simultanously. When recording stereo signals, such as synth voices, background vocals or program material, the unit performs flawlessly. However, if you try running dissimilar signals (bass on left channel, lead vocal on right) through the SX208 at the same time, the results can be unusual, to say the least.

Overall, I was impressed with the SX208's performance under a variety of conditions. Vocal limiting was smooth, even with the most unruly, untrained voices screaming into the mic. The "fast/slow" response switch allows the user to tailor the attack/release characteristic with a minimum of fuss, with the fast setting best for strong transient material such as drums and percussive synth patches. The slow setting proved best suited for vocals, bass, and lead guitar.

The SX208 excels in the studio. It really does a wonderful job of improving recorded vocals, especially if the singer has somewhat less-than-perfect technique. It also shines when it comes to handling stereo program material, whether you're making an analog cassette dub of a DAT tape with extreme dynamics, or protecting the speakers in your P.A. system from the early demise caused by feedback overload.

About the only fault I found with the SX208 was the ratio control: Half of the knob's rotation is used for the 1:1 to 2:1 range, while the remainder of the knob's travel covers the all-important 2:1 to 20:1 ratios, which makes it somewhat hard to home in on exact settings in the upper ranges. However, in view of the SX208's $299 bargain price and superb audio performance, I'm sure that most users would be willing to put up with such a hardship.

George Petersen *writes articles, produces records, and enjoys performing live on most non-MIDI instruments.*

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Pygraphics Music Writer 1.1 ($119 to $599)

By Dan Phillips

Music Writer 1.1, from Pygraphics, is a new addition to the ever-growing number of Macintosh music notation programs. Its basic features are consistent with the recent generation of software, featuring real-time MIDI input and publication-quality, PostScript output. (A dot matrix font is provided for bitmapped printer output. For PostScript output, the program uses Adobe's Sonata font, which is not supplied.)

Like other companies in and out of the music market, Pygraphics offers high-, mid-, and low-end versions of its program. In this case, the versions differ only in the maximum number of staves supported. The top and mid-line versions carry pretty standard prices: Level III offers 40 staves for $595, and Level II provides eight staves for $295. The low-end version, however, opens up a new price range for the above-mentioned features: three staves for $119. (Keep in mind, though, that for PostScript output, you'll have to buy Sonata, which adds $95 to the price.) If that sounds intriguing, read on.

CAPTURED LIVE

For many users, the most important aspect of *Music Writer* is real-time MIDI transcription. This is handled by a separate tool, the Mini-Sequencer, that allows you to set a tempo, a quantization amount, and a keyboard split-point (for two-handed input). Although it does not offer such sophisticated features as variable, or manually controlled, tempo, I found its style convenient. The Mini-Sequencer also offers a step-time entry mode for difficult passages. The music scrolls during MIDI playback of notated music, but screen redraws are uncomfortably slow on a Mac Plus.

The program also supports mouse-based note entry, bolstered by a healthy set of keyboard shortcuts. MIDI entry can also be used in conjunction with this technique, with the mouse (or keyboard shortcut) determining the note value and the MIDI controller determining the pitch.

Music Writer carries a full contingent of symbols, boasting most of the standards and much of the gravy, including special note-head shapes, 1- and 3-line staves, bowing markings, and even a set of chord abbreviations and time-marking slashes for use in making rhythm charts. Text entry uses the normal Macintosh fonts and formats, and special provisions are made for working with lyrics. The broad library of symbols is great, but it's also fairly standard. The way in which the program allows you to manipulate these symbols, on the other hand, is special.

Almost any symbol—notes, articulations, text, crescendi—can be moved both vertically and horizontally on the page, using the arrow keys. This is a real boon, responding to that bane of computerized notation known as "collisions," the unfortunate tendency of different symbols (such as slurs, notes, and crescendi) to try to occupy the same space at the same time. The problem is greatly alleviated by the ability to move virtually all of the symbols manually, and this is possible with an ease that exceeds most of the other MIDI-based notation programs.

Unlike some notation programs, *Music Writer* places virtually no limits on the polyphony of a single staff; if you want large tone clusters, you can create them. It also provides easy-to-use utilities for the fugal mainstays of rhythmic augmentation and diminution, as well as melodic inversion.

IT'S NOT FOR EVERYBODY

Despite the fact that *Music Writer* is offered in a 40-stave configuration, it is not an ideal choice for orchestral and/or academic notation. There are just too many little deficiencies that, when added up, are nearly disabling. For instance, although it is possible to print parts out of a score, parts are not automatically transposed at this stage. This makes it inconvenient to edit parts in concert pitch, as every time they are to be printed, they must be manually transposed. It's better than working with pen and parchment, but it isn't up to current standards.

Earlier, it was mentioned that almost all common types of symbols are provided. I wrote "almost" because although grace notes and cue notes are supported, their implementation is inelegant. Usually, these notes are printed somewhere in the range of half the size of their "normal" counterparts, with grace notes having an additional slash running across their stems. *Music Writer* prints both symbols with small note-heads but regular-sized stems and flags (and no slashes on grace notes). The end result looks something like a head-shrinking victim from the *Far Side* comic strip.

Dotted notes also are not well-handled. Unlike some software, *Music Writer* does not alter the positioning of dots to accommodate the constrictions of tight tone clusters, so that collisions occur with other notes, and the dots may become illegible. Unfortunately, dots cannot be moved independently of the notes they refer to.

In the course of reviewing the software, I attempted to notate a number of lieder songs. To my dismay, I discovered that a number of them were almost impossible to accomplish accurately due to a number of deficiencies with regard to notating the subtleties of piano music. In particular, *Music Writer* precludes the grouping of notes on more than one stave, so that a figure that roams between the hands cannot be beamed or phrased together conveniently. Beaming across bar lines is not supported.

While real-time MIDI transcription offered no difficulties, I had a few problems with other aspects of the program's MIDI implementation. For instance, in most cases, the program converted MIDI files with no troubles, but the minor sixth degrees of A-flat and E-flat (the notes F-flat and C-flat, respectively) were consistently and erroneously transcribed as E-flat and B-flat, the fifth degrees. It was easy to crash the program while using the combination mouse/MIDI input feature.

EASY WRITER?

The cover packaging of *Music Writer* boasts a brief description of the software's purpose, giving more than ample space to emphasize that the program is easy-to-use, or at least, more so than most. Its user interface and manual, however, don't quite fulfill this promise. It's a relatively simple program, sparing the user many grimy typographic details and, thus, a certain amount of learning time. Far from being streamlined, however, the program is rife with inconsistencies.

There are, for instance, different methods of deletion for different types of data. These varied procedures include special delete tools, key combinations with mouse actions, the Backspace/Delete key, and the clipboard Clear and Cut commands. As another example, some grouping actions require two or more mouse clicks; some require mouse dragging; some require selection of the data followed by menu commands. None of these procedures is particularly more desirable than another. While it may be necessary to have more than one procedure handle diverse types of data, I'm convinced that consolidating the interface would significantly decrease both the learning curve and frustration level of users.

If you're gearing up for some serious orchestral or avant-garde composing, this is not the program for you. The inconsistencies, and lack of such sophisticated features as automatic part transposition, will take their toll over a long score. On the other hand, there is one use to which I think *Music Writer* is almost uniquely suited: transcribing popular songs. If you want to get your songs down on paper (laser-printer paper, that is) but have been dismayed by the high cost of other programs with real-time MIDI input, the slim price tag of Level I will be hard to beat.

Dan Phillips *is a product specialist at Korg Research and Development and a San Francisco Bay Area-based MIDI consultant, composer, singer, and keyboardist. He is continuing his relationship with pen and paper just in case the power goes out.*

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OVERALL 6

Documentation 5
Features 6
Value (Level I) 9
Ease of Use 6

MIDIMAN Mini-Mixer ($99.95)

By Gary Hall

In my electronic music-making, I find that there are many situations where I need to combine two or more signals together without further EQ or effects processing. With synths and workstations that have built-in processing and stereo outputs, for instance, all I really want to do in many cases is combine the outputs into a stereo signal for monitoring, using the volume control on the instruments themselves to control the relative balance. In these situations, a full-featured audio mixer seems like a serious waste of space and money. The MIDIMAN Mini-Mixer has proven to be the perfect item for occasions such as these. It's a cheap and cheerful utility item that can slide into a pocket of a gig bag or rest unobtrusively amid the wires behind your instrument stands.

The Mini-Mixer provides two groups of four inputs (A and B) on ¼-inch phone jacks. Each group of four is combined to a single output, so the configuration is perfect for up to four stereo signal pairs. At the flick of a switch, the A and B inputs are cascaded, so that the unit becomes an 8 × 1 mixer. Separate 3-position switches let you select input gain to match a wide range of signal levels for each group of inputs. Gain controls remain separate when the cascade mode is selected. The outputs are single-ended, with a nominal level of -10 dBV.

The unit is powered by a single 9-volt battery. The manufacturer claims that one battery will last up to a year of operation. The battery is not particularly easy to change, so it's good that it lasts a long time.

I didn't have the opportunity to measure the noise floor or dynamic range of the unit, but I found it inaudibly quiet in normal use. With the input gains properly set, the device handled all signals without difficulty. In setting up, care is needed to get the gains right because there is absolutely no indication of overload. If in doubt, turn it down.

Is there anything wrong with this product? Well, nothing that more money and size wouldn't fix, but that's the whole point. The Mini-Mixer is sort of the paper-clip of audio: a fast, inexpensive way to tie signals together without the freight associated with a full-size mixer. Put one (or two) in your tool box, just in case.

Overall rating: 9. *MIDIMAN, 30 N. Raymond Ave. Suite 505, Pasadena, CA 91103; tel. (818) 449-8838.*

Gary Hall *is technical editor at* **EM**. *His motto is "Nothing hard was ever easy."*

Roland S-770 Digital Sampler

By Tim Tully

In their new attempt to conquer the high-end sampler market, Roland has created a performance monster.

Samplers come and samplers go, and Roland has had its share of entries in the field. With the S-770, however, the company seems to be making a bid to produce the definitive, no-holds-barred, sampler for the high-end market. With big features, big specs, big RAM, and big disk, the S-770 comes loaded for bear.

The S-770 samples sounds with 16-bit resolution, at user-selectable rates of 22.05, 24, 44.1 or 48 kHz. Samples are played back using a 20-bit DAC for improved fidelity. The instrument is completely multitimbral and can play a different patch on each of sixteen MIDI channels simultaneously. It recognizes all of the standard MIDI controllers and commands, including polyphonic aftertouch.

The S-770 comes from the factory equipped with two megabytes of RAM, and this can be expanded up to 16 MB for a maximum sampling time of over three minutes (mono) at the 44.1 kHz rate. Of interest to the buyer's wallet, the S-770 uses the same RAM (SIMMS) as the Apple Macintosh. These are readily available and quite inexpensive compared to RAM for other samplers. The unit comes equipped with a 40-megabyte internal hard disk for storage and rapid loading of sounds, and a 3.5-inch floppy disk drive that can use double-density (800K) disks and high-density (1.44 MB) disks, as well as disks formatted on Roland's other samplers (S-50/550, S-330, and W-30).

While memory and storage specs are important, voices are more often the limiting factor in a multitimbral instrument, not RAM. The S-770 addresses the question with substantial 24-voice polyphony. This is quite a bit, more than most of the competition, but it should be borne in mind that stereo samples consume two voices, and the S-770's system of layering samples (described later) can eat up voices in a hurry. It's the same old story: The more we get, the more we need.

There is one stereo output pair and six individual outs. Any voice can be routed to any output, so external processing and mixing can be quite selective. In addition to analog ins and outs, there are digital inputs and outputs that use the coaxial and optical variants of the AES/EBU standard. Digital I/O makes it feasible to sample directly from CD (with a suitably equipped player), or DAT, and lets you record the S-770's output directly to a DAT or other digital recording systems.

There's a standard SCSI port, the same one used by personal computers for data transfer. With this connector, you can move samples, patches, and so forth to and from hard disks, removable-cartridge drives, CD-ROMs, and magneto-optical drives. The SCSI port makes storage expansion a very open-ended affair. If you need to load and


EMAX II

save lots of sounds, this can save you an enormous lot of time.

The S-770 isn't just a "dumb" sample playback unit. It has extraordinarily useful digital filters (especially for a sampler) that can be set to highpass, lowpass, or bandpass mode. These respond to trackable, 4-stage envelopes, and they have controllable resonance, a feature conspicuous by its absence in the bulk of digital instruments, samplers or otherwise. The LFO modulators boast a variety of waveforms and synchronization modes and can be routed to affect pitch, amplitude, and/or timbre automatically or under MIDI control.

With all of these features, the S-770 could seem a little daunting. Fortunately, it's accompanied by an excellent manual (prepared in the U.S. by EM author Paul Lehrman), and that's good: This instrument is complex enough that you'd never learn it all without a good guide. Happily, the manual reads like it was written by someone to whom both English and MIDI are native languages and who understands how to explain complex ideas clearly. Though intricate, the instrument is rational enough that a few hours with the manual will get you up to speed. In addition, the manual is organized in such a way that occasional references and refresher inquiries can be made quickly and easily.

STRUCTURE

In addition to its large, backlit LCD, the S-770 can be attached to a video monitor—color or black-and-white—to increase the sheer size of the readout and let you see a complete page at once. Both screens are navigated via a Macintosh-like mouse. It's amazing how friendly the machine can be with these mechanical elements.

The operating system is arranged in a sensible, hierarchical fashion: Despite its complexity, once learned, it stays with you. There are three general modes: Performance for playing; Sound, for recording, editing, and combining samples; and System mode for setting up operating parameters. A clear and easily accessible menu takes you from mode to mode, and once you're in a mode, a menu pops up that takes you down to the next level, where the mode's various functions are located. Each function, in turn, has up to five pages of commands and settings, and on any page, a list of that function's other pages appears at the bottom of the screen. Click on one of these and you go directly to that page.

Sounds are organized in a similar hierarchy. At the first level, the S-770 records samples (of course), and these can be combined to create a "partial." Don't let familiarity with the D-50, MT-32, or any of Roland's L/A instruments lull you into thinking you know what partials are. S-770 partials are as different from L/A partials as those are from partials in the standard musical sense. Partials in the S-770 consist of as many as four samples, layered so they can all play at the press of a single key. The S-770's internal envelopes and modulators operate on partials. Partials, in turn, are arranged across the keyboard to create a "patch" (a single "instrument" in the standard synthesizer sense). In this case, Roland's "partial" functions like the more standard "multisample," but with much more complexity. In fact, the partial is the heart of the S-770's sonic sophistication.

Between one and 88 partials can be assigned to a pitch range and these are combined to form a "patch," which can have pitch, volume, filter, and vibrato processed by MIDI controllers (such as pitch bend and channel pressure). A patch can have its own tuning and output assignments, as well.

Up to 32 patches (are you still with me?) are grouped into a performance, which is what you typically load into the machine to play. Each of the patches in a performance can be assigned to any of the sixteen MIDI channels to give the S-770 its full, 16-part multitimbral capabilities. Patches can also be layered, so you can play them simultaneously or assign them to different key ranges.

To help keep all these groupings organized, you can also assign bunches of performances and the elements that comprise them into a "volume," which can be loaded up with one operation; a welcome simplification.

Since patches, partials, and performances simply are ways that the sampler accesses samples, they effectively take up no room in RAM. Depending on the size and number of samples (which are the entities that do take up memory), you can load up to 64 performances, 128 patches and 255 partials into a S-770 with the stock 2 MB of RAM.

PARTIALS

Out of this hierarchy, the elements that have the most initial impact on the user, and that need the most explanation, are partials and patches.

Samplers are usually designed so that individual samples—often stacked in velocity-sensitive layers—are arranged across a keyboard to make up a multisampled patch. Roland, however, has graced the S-770 with another organizational level: the partial. Despite the initial suspicion of the techno-weary, the partial is not just a device to confuse you. Partials help when you're playing the S-770, as well as when you're programming it. For the player, they provide unprecedented musical expression and subtlety, something that samplers in general have lacked. When you're programming the next top-of-the-charts sound, you'll be happy to find that most of the S-770's programming functions exist in this single structural level. This considerably reduces wear and tear on the central nervous system. Further, moving among the five partial-editing screens is fast and easy, so it doesn't take the concentration of a yogi to put together a playable sound.

Once you sample, edit, truncate, and loop your sounds, the next step is to assign up to four samples to any number of partials. Once you've put samples into a partial, you can coarse- (±4 octaves) and fine-tune (± a quarter-tone, in increments of one cent) each of the samples, assign the output to which it's sent, and set its pan position, velocity range, and velocity crossfade between samples.

For the partial as a whole, you can set level and filter cutoff and resonance. Each partial has its own 4-stage filter and volume envelopes, which can be tracked by key number, MIDI controller, or velocity. This gives a number of nice effects: for example, sustaining the envelope longer the harder you hit the key. You can assign the low-frequency oscillator to modulate pitch, filter cutoff, or volume of the partial. You can also select which of eight waveforms the LFO will use and how it will be delayed or synchronized.

A high point of programming partials is the sample mix table (SMT). Occupying a full partial-editing screen, the SMT is a joy to use. A table at the top lists all the samples that make up the partial and follows each sample name with the sample's pan position, from full right to full left. To the right of this is the sample's volume level, from zero to 127. You can scroll through any of these quickly by holding a mouse button, or by spinning the S-770's front panel value dial. Below this table, there appears another one for setting the samples' velocity switch points and crossfade values. The latter sets a range of velocities over which the sample fades in or out with velocity.

Below that, a set of four green, horizontal

● ROLAND S-770

bars represents the four slots the partial has for samples. If a slot is empty, the bar is thin; if there's a sample in a slot, the bar turns fat. Whenever you put the cursor over a sample's parameter in the tables above, the sample's bar turns red. If you put the cursor on the bar itself, it turns yellow. If you click the mouse on the left or right end of a bar (representing the sample's low and high velocity-switch points), you can drag the end point left or right to set the velocity-switch points. This convention gives you a sense of the four samples' relative positions in the velocity layer in a remarkably fast and intuitive fashion.

Even better, all of the assignments of velocity switches and crossfades can be modified in real time (as you play) by any MIDI continuous controller. This is highly unusual and a boon for anyone who uses a MIDI guitar or wind controller.

Among samplers, this is a lot of programming punch, although it still doesn't rival the programming power of the most sophisticated synths. (For example, all four samples in a partial share just one filter envelope and one amplitude envelope.) It goes a long way to ameliorate the once-it's-sampled-it-plays-back-the-same-each-time situation that has limited expressive power in samplers since the beginning. When you go to build an S-770 patch, you use a group of partials that already have a good deal of character, nuance, and expression built in.

By the way, partials don't monopolize the samples they use: A sample can be used in any number of partials, limited only by the S-770's polyphony. The same relationship applies between partials and patches, so a single partial can be assigned to a number of patches.

PATCHES

Once you've programmed a bunch of partials, you can assign one to 88 of them to the next organizational level: the patch. The engineers at Roland were paying attention when they built this thing, because the patch-programming parameters let you modify enough of the individual partials' parameters to make your patch coherent and easier to work with. This includes level, pan position , and "offsets" for the filter and velocity settings. These don't simply override the partials' settings, but interact with them in a variety of ways. In addition, you can assign the whole patch to the stereo outputs, to one of the six individual outs, or let the individual partials' output assignments stay in force. You can also set the patch's priority for the "voice-stealing" that occurs when the unit's polyphony is max'd out, and set key range for each partial.

It's not simple, but it makes sense, and it makes the S-770 one of the easier samplers to program.

SAMPLING, EDITING, AND PROGRAMMING

Sampling with the S-770 can be done in mono or stereo, and both channels of a stereo sample can be edited simultaneously. The instrument receives sound through any of four sets of inputs: balanced (XLR) or unbalanced (¼-inch) analog jacks (for mic- or line-level signals) and either coaxial, or optical, digital lines.

The digital inputs (as well as the outputs) are AES/EBU standard and allow

Product Summary

PRODUCT:
S-770
TYPE:
Digital sampler
MAIN FEATURES:
16-bit stereo sampler; 2 MB of RAM expandable to 16 MB; 40 MB hard disk; high-, low-, and bandpass digital filters with variable resonance, SCSI port; analog and AES/EBU digital in and outs; compatible with video monitor; 24-voice polyphony
PRICE:
$7,995
MANUFACTURER:
Roland Corp US
7200 Dominion Circle
Los Angeles CA 90040
tel. (213) 685-5141

Ease of Use 10
Audio Quality 10
Features 10
Value 8
10 OVERALL

you to take samples directly from any CD player, digital tape player, or digital processors equipped with compatible digital outputs, without degrading the sound with unnecessary analog/digital conversions.

You can start the sampling process in any of the usual ways: manual; footswitch; or automatic, level-sensitive triggering (including a Previous Sampling feature that ensures you don't cut off a sample's attack). Just to keep things clean, the sampler even will automatically turn its fan off when you're about to sample.

Once taken, a sample can be edited in many ways. You can combine two mono samples so they act as one stereo sample, and vice versa. Loops in the S-770 can proceed in several different ways, including forward, forward and backward, two reverse loops, and not only sustain, but release loops—another welcome inclusion.

Loops are set using a graphic display of the waveform and the same parameter adjustments found in the SMT (including the click-and-drag bar convention for changing loop and sample points). There are also smoothing and normalization algorithms not usually found in samplers.

You can sample and edit in true stereo and "stereo-ize" samples with a number of algorithms. You can combine and resample any sample—either as single events, or as entire musical phrases played from a MIDI keyboard—and the operation is handled completely internally so that there is no degradation of the signal.

While the unit's sample-editing features are powerful, easy to use, and in some cases, unique among samplers, there are still limitations. Indeed, the S-770 has no auto-loop or zero-crossing functions, nor any waveform cut-and-paste abilities. Nice as it is compared to other samplers, the size of the waveform display cannot compare with a full-sized computer monitor.

If you're interested in using the S-770 for serious sound designing, you'll want a computer-based sample-editing program such as *Alchemy*, from Passport Designs or Digidesign's *Sound Designer*. But even with this help, there's a problem. At this time, the S-770 can move sounds to and from these programs (with minor glitching) via the MIDI sample dump. You can only move one sample at a time, and this can be numbingly tedious. The S-770 can communicate with external storage devices via the SCSI port, but unfortunately, it cannot use SCSI to talk to a computer. In my opinion, the implementation needs to be fleshed out so that the S-770 can function in a SCSI network with other master devices. A machine with the RAM and disk capabilities of the S-770 definitely needs this full implementation. Roland says it plans to release a system software upgrade in the near future that will include this capability. Until then, MIDI transfers, one sample at a time, are the order of the day.

SONIC PERFORMANCE

The question to end all questions is: How does the instrument sound? Would it be too obscure to say that it sounds like an $8,000, 16-bit, 48 kHz sampler with three kinds of filters, programmable resonance, a flexible LFO, and real-time modulation among four samples via MIDI, mod wheel, or pitch bend?

The unit sounds very good. The filters, and the adjustable resonance in particular, are pleasant-sounding and musical. At low resonance settings, the filters are transparent and natural-sounding. Increasing resonance can add anything from a little unobtrusive bite to a full, 1978 electro-disco "wow." While not all the samples included on the hard disk were of first quality (the acoustic guitars and voices are terrific), the machine itself sampled very well. I sampled a number of string, brass, and percussion sounds from Prosonus compact discs, and even sampling through the analog domain rendered crisp, natural-sounding samples with often spectacular presence. Purely digital samples (again, courtesy of Prosonus) ported directly from *Alchemy* via the MIDI sample dump standard, while slow getting there, sounded spectacular.

Roland has shot for the top with the S-770, and while the instrument won't hit every item on every wish list, it's an exceptional sampler for high-end applications.

Tim Tully *engages in multimedia behavior with polyphonic overtones, producing sound and light from an incredibly small studio in Oakland.*

Passport's Sound Apprentice

By Nick Batzdorf

Finally, affordable sample-editing software with a respectable set of features is available for the Macintosh.

Let's say you own several samplers, some from different manufacturers. You know that precision sample-editing, looping, and related procedures are much easier to accomplish if you use a computer rather than a sampler, no matter how fine the sampler's display. (Admittedly, some samplers, such as E-mu's Emulator III, offer features not available in computer software.) Also, you probably want to have one universal program and a central sample library that all your samplers can share, as opposed to a dedicated program and library for each machine. If your studio is Macintosh-based, your main sample-editing options are Digidesign's *Sound Designer* and Passport's *Alchemy.*

Neither of these programs is inexpensive, but one of them—*Alchemy*—is now available in a more affordable, slimmed-down version, *Sound Apprentice.* When *Alchemy* debuted a couple of years ago, it was one of the first sample-editing packages to feature networking, i.e., the ability to exchange sounds among multiple samplers. It also was considerably more advanced than other sample-editing programs. *Alchemy,* now distributed by Passport Designs, is still one of the best music software programs, but with its $700 retail price (probably more than what you have left after purchasing all those samplers), it may be somewhat more sophisticated than necessary. Enter *Sound Apprentice.*

Because multimedia is le môt du jour, and because the program loads and saves sounds in *HyperCard, SuperCard,* MacroMind *Director,* and Apple SND Resource formats (which is supported by Farallon's MacRecorder), *Sound Apprentice* is billed as "multimedia and sample-editing software." It really is *Alchemy* in lamb's clothing, a sort of *Alchemy Junior.* The new program is based on *Alchemy 1.0,* with some instrument updates and bug fixes. You almost certainly will find this a useful piece of software; it is solid, easy to learn and use, and extremely well-conceived.

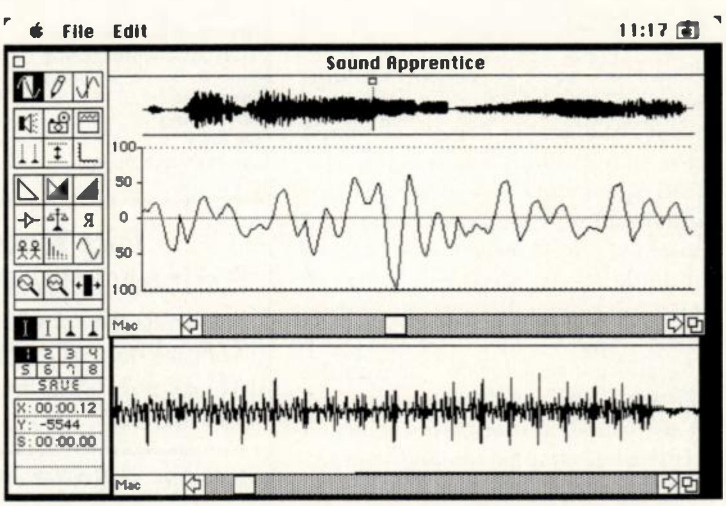


FIG. 1: The main screen of Sound Apprentice.

NETWORKING

Before discussing *Sound Apprentice's* sample-manipulation abilities, let's talk about real-world sample networking; what the manual calls a "Distributed Audio Network" (or "DAN"). While it is no fault of the program, transferring samples over MIDI is frustratingly slow. There is no way around this, a fact of life readily acknowledged in the manual. SCSI support, one of *Alchemy's* features, has been disabled (yet it is still tantalizingly visible, albeit "grayed out," in the network set-up menu). SCSI is a fast communications protocol that permits (among other things) changes made in *Alchemy* to be reflected immediately in the supported sampler in a manner similar to many synthesizer patch-editing programs. For samplers that support SCSI (such as the Ensoniq EPS, Akai S1000, E-mu Emulator III, and

E-mu Emax II), this is a significant drawback, but *Sound Apprentice* does support RS-422 (another fast communications standard that is used by the E-mu Emax sampler).

Different samplers allow varying degrees of adjustment by external controls. In addition, each machine has its particular quirks. For example, most samplers do not let the computer allocate sample memory; this must be done manually. The worst case is when a device must rely on MIDI sample dumps to interface with *Sound Apprentice;* in other words, when the sampler is not among those supported specifically. MIDI sample dumps carry only sample data, sample rate, and loop points. Almost all major samplers now in production are supported directly, but this means, for instance, that owners of Prophet 2000s or Yamaha TX16Ws are out of luck (except for MIDI sample dump). Interestingly, the long-discontinued, and relatively primitive, Ensoniq Mirage is supported.

Nonetheless, the benefits of working with *Sound Apprentice* outweigh the hassles. The program freely converts between many machines and file formats, which alone makes it valuable. Sounds are stored in 16-bit resolution in stereo, and you can audition them from disk through the Mac speaker (with the Mac sound chip's 8-bit resolution) without opening them. (I did experience a crash while doing this under MultiFinder, but it didn't repeat. I assume it was due to MultiFinder's memory-management quirks.) Both stereo and mono sounds can be edited and converted from one to the other. Digidesign's Sound Accelerator and Audiomedia cards are supported for high-quality playback, both from disk and within the program. The program can talk to a MIDI patch bay to centralize as much of the networking process as possible. To convert samples from one machine to another, an included resampling algorithm lets you change sample rates. The two samplers between which I exchanged sounds had different sound qualities (no surprise), but there was no loss of quality in the translation.

SAMPLE EDITING

When you open a sound file, it appears in a window that displays the entire waveform. The only limit to the number of opened sounds is the amount of computer memory. You can choose how the windows are arranged on the screen by selecting "stack," "tile," etc., from the Windows menu. The axes can be calibrated in seconds, number of decimal or hexidecimal samples, or 30 non-drop frame SMPTE. Using the mouse, you choose a tool to select a region of the sound for editing or playback, while a numeric display indicates the position of the mouse. You can zoom in or out, then instantly store or recall up to eight different views, along with the regions selected, for each sound.

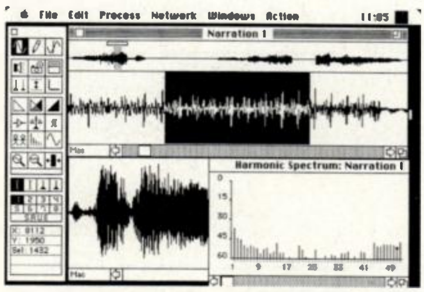


FIG. 2: The highlighted section of the waveform is ready for editing.

Clicking on an icon automatically zooms in on the selected range. The overview above the sound's window can be toggled on and off. This overview shows a reduced-size view of the entire waveform. A toggled auto-zero option automatically moves the selection cursor to the nearest zero crossing. The blending option automatically performs a crossfade at edit points. The detail about options gives you an idea of how slick the program is. It is extremely comfortable to navigate; you find convenient pathways every step of the way.

Once you select a region for editing (and playback), standard Macintosh editing functions (cut, copy, paste, clear) apply, as do mix, insert, and extract (the latter lets you select a section and delete the remainder). During spectrum analysis, commands for Cut Above and Cut Below (a frequency) behave like lowpass and highpass filters. You can perform fade ins and outs and crossfade loops simply by selecting a region and clicking on appropriate icons on the tool palette. Other icons select Invert (make all positive values negative, and vice versa, to help create good edit points), Scale (raise or lower amplitudes for the selected region by a prescribed percentage), Reverse, and

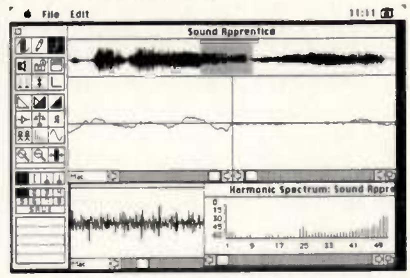


FIG. 3: View of two sounds with harmonic analysis of the top sound.

Equalize. The Replicate command copies a selected area and repeats it to fill in a defined region. The pencil tool lets you draw waveforms. I was surprised that this pencil works only on an existing sample; you can't start from scratch, but you can load in a bogus sample and draw over it, or send an empty sample size using the Info dialog.

By clicking on the threshold icon in the tool palette and dragging the re-

Product Summary

PRODUCT:
Sound Apprentice
TYPE:
Sample-editing software
MAIN FEATURES:
Sample networking; variety of visual editing tools; support for most currently available samplers and sound formats such as Apple SND Resources, *HyperCard*, MacroMind *Director*, and more; ability to audition samples from disk using Mac sound chip or Digidesign Sound Tools; stores with 16-bit resolution
HARDWARE REQUIREMENTS:
Macintosh Plus or better, with System 6.0.2 or later; hard disk strongly recommended; 2 MB RAM required
PRICE:
$295
MANUFACTURER:
Passport Designs
625 Miramontes St.
Half Moon Bay, CA 94019
tel. (415) 726-0280

sulting dotted threshold lines, you can scale the amplitude of a region by a prescribed percentage. I encountered a minor problem with this function: According to the manual, the scaling percentage appears in the numerical display. Although the scaling function worked fine, this display didn't happen.

In addition to what the manual calls "time-domain editing," the program can perform an analysis of a sound's harmonic spectrum. Once the sound is analyzed, you can select individual harmonics, or a group of harmonics, change their amplitude, and cut, copy, paste, mix, or delete them. After editing, the sound is resynthesized. It requires a fair amount of experimentation and practice, but the payoff is extremely precise control over the sound.

CONCLUSIONS

Perhaps the only features this program is missing are those removed from *Alchemy:* SCSI support; time compression/expansion, which lets you change a sound's length without changing its pitch; and amplitude envelopes and frequency envelopes, both of which can be modulated by a soundwave that has been cut-and-pasted. Many samplers have amplitude and frequency envelopes, so this may not be badly missed. Apart from the above, the only other feature that would be nice is a MIDI echo feature. Whether it is worth spending the extra $400 for these features depends on your needs. Looking at it another way, $300 is a good deal for 98% of a $700 program.

The manual really offers a mini-course on sampling and the physics of sound. It begins with an interesting theoretical section about sound in general, takes the reader through guided tours of the program, provides an in-depth explanation of its features (including a helpful section on looping), and ends with a reference section. The only thing missing is an index.

Above all, Sound Apprentice is thoroughly enjoyable to use, letting you perform almost all the sample manipulations you're likely to want in a manner that is both intuitive and convenient. It does its absolute best to make sample networking as easy as possible in a less-than-perfect world.

Nick Batzdorf *is a freelance film composer, music editor, and professional charlatan who lives in Los Angeles, California.*

Digidesign Sound Tools for the Atari

By Gary Hall

It took a while, but Digidesign now offers their popular hard disk recording and editing system for the Atari ST.

When Digidesign began shipping Sound Tools in the spring of 1989, it started a revolution. By concentrating on the essentials of stereo recording and editing, and by using a standard computer as the platform, Digidesign created a hard disk-based audio production system that was streamlined, effective, and incredibly inexpensive in comparison to previous random-access systems. (The Macintosh Sound Tools was reviewed in the November 1989 issue of **EM**.)

Today, as the company proudly advertises, Sound Tools is far and away the most widely used of all hard-disk audio systems. Still, Digidesign could see that new worlds remained to be conquered. For one, although cheaper than any previous alternative, a Mac II Sound Tools system still runs $10,000 and up, once you add in the costs of the computer, the hard disks, and tape backup systems. For another, the Apple Macintosh has had nowhere near the penetration in Europe that it has enjoyed in the United States. Responding to demand, from dealers and end users, Digidesign implemented their system for the Atari Mega ST computer.

The Atari Sound Tools is described by the manufacturer as being identical to the Macintosh version, but because the computer hardware is so much less expensive, a basic, digital, random-access recording and editing system can now be put together for about half the cost of the equivalent Mac-based system. (For larger systems, the differential becomes less because the costs of hard disks dominates. Large capacity disks for the Atari cost as much or more than disks for the Mac.)

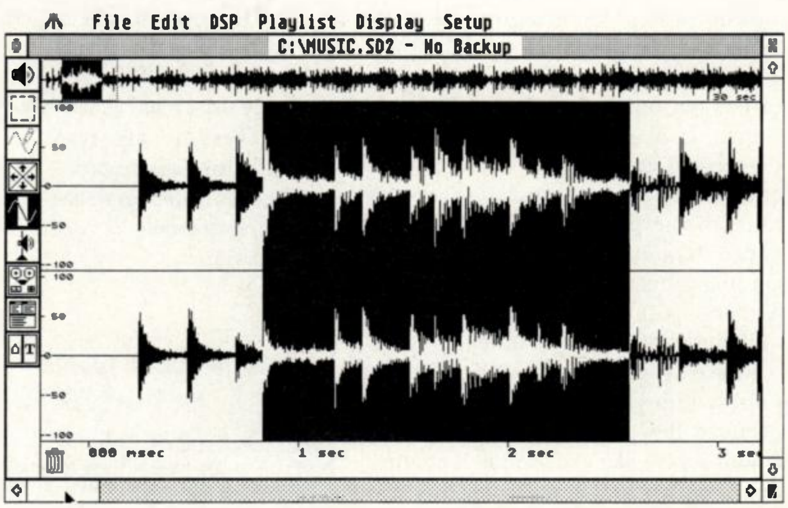


FIG. 1: The basic display and editing screen for Atari Sound Tools. The highlighted region may be processed, destructively edited, or defined as a region to be used in a playlist.

BASIC HARDWARE

Because of specific hardware requirements and the RAM demands of the software, Atari Sound Tools requires the Mega 2 or 4 version of the ST. You're also going to need a nice, big, hard disk drive (or two, or three). I would recommend 60 MB as a minimum. This corresponds to about six minutes of stereo; not very much, but enough to do individual tunes. If you intend to do CD premastering, you're going to need at least 600 MB. (I told you this stuff uses up disk memory.) I used a 60 MB Megafile drive from Atari, and also an 80 MB drive from Supra (tel. [503] 967-9075). The Atari drive was wicked noisy and seemed to have trouble with access time on occasion. (Access time is a critical parameter for drives that are to be used for random access recording.) By contrast, the Supra drive was much quieter—though hardly silent—and worked consistently well. Supra makes a complete line of drives for the Atari (as well as for the Amiga), including rack-mount versions. I can heartily recommend them as a source.

The Sound Tools hardware itself consists of two pieces: a DSP processing board (called the Sound Accelerator) that installs inside the Mega ST, and an external box to handle A/D and D/A conversion. As in the Macintosh version, the processing board is based on Motorola's DSP56001 chip. It's straightforward, cleanly laid out, and ingenious in the way it takes advantage of the Mega's construction.

The Analog Interface box is simple and rugged. Stereo inputs and outputs are provided on ¼-inch phone jacks, and the front panel carries input level trims with two LEDs to indicate signal level. A green led lights at 20 dB below clipping and a red lamp indicates hard clip. The standard interface box for Sound Tools (Mac *or* Atari) is designed to operate at -10 dbV nominal level. If you want to use it with +4 dBm equipment, you'll need a level conversion box.

The audio performance is fine, consistent with most 16-bit conversion systems. (For the ultimate in tweak-quality audio, Digidesign has a high-end converter, Pro-I/O, for $2,995.) When I opened the interface up, I found it very clean and straightforward, but I was just a little disappointed to note that the A/D and the D/A time-share the same DACs and filters. Some of my friends and I are interested in using hard-disk systems for tape-loop-style music, but it doesn't look like we'll be able to use this particular interface. (Oh well.) Also, there is a bit of a transient on power-up or power-down. I attributed this to Digidesign's relative inexperience in designing audio hardware.

The first step in setting up the Atari Sound Tools is to install the Sound Accelerator board inside the computer. It is apparent that Atari is not enthusiastic about people going inside their CPU. The process is not especially straightforward, and there is not a word about

Product Summary

PRODUCT:
Atari Sound Tools

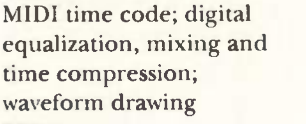
TYPE:
Hard-disk, computer-based digital recording and editing system

HARDWARE REQUIREMENTS:
Atari Mega ST computer with hard disk; DAT or other digital tape recorder

MAIN FEATURES:
Stereo and output; selectable sampling rate; destructive and non-destructive (playlist) editing; continuous "scrubbing" for edit points; variable crossfade; triggering of playlists via MIDI time code; digital equalization, mixing and time compression; waveform drawing

PRICE:
$2,995

MANUFACTURER:
Digidesign
1360 Willow Rd., Suite 101
Menlo Park, CA 94025
tel. (415) 327-8811



it in any of the Atari documentation. The instructions in the Digidesign manual are also a little vague, but a bit of perseverance and creativity did the job. Persons who are nervous about going inside their computer may want to find a good tech to help them out. With

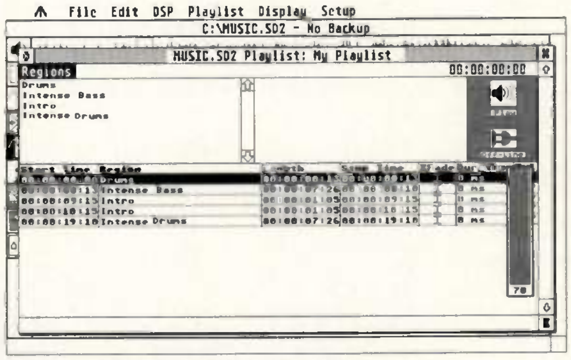


FIG. 2: An example of a Sound Tools playlist. The playlist is often the most effective way to approach editing because it is entirely non-destructive.

the board installed, a 25-pin DIN connector protrudes from an opening on the Mega ST's rear panel. This is used to tie the analog I/O box to the internal hardware.

SYSTEM SOFTWARE

Up and running, *Sound Designer II*, the system software for Sound Tools, does indeed bear a marked resemblance to its Macintosh counterpart. Because the Mac version was covered thoroughly in our November 1989 review, however, I'm only going to highlight differences, or updates from the system as it existed at that time.

Digidesign has been carefully collecting the feedback from users of the original system, and they identified a few features that were so little used as to be superfluous. For one, the Atari Sound Tools provides no support for keyboard samplers. Apparently, those who use *Sound Designer II* for stereo hard-disk recording and editing do not use it for sample editing, and vice versa. Likewise, the frequency analysis plotting feature that has been with Sound Tools from the beginning, was left out.

Both the Mac and Atari versions have a DSP section in the menus. The Mac version has both graphic and parametric EQ selections, but the Atari version has only graphic EQ. It seems a shame.

Some other differences from the Macintosh program are a little more subtle, but perhaps more significant in the end. Atari Sound Tools is noticeably slower than the Mac version, particularly in redrawing the screen when it has been scrolled to a new position in the waveform. This is one of those less-appreciated aspects of hard-disk recording technology that can have a profound effect on productivity.

Another aspect of the system that could affect a purchase decision is upgradeability. With the Sound Accelerator installed, there are no slots remaining for present or future additions to Sound Tools' hardware. Some important software options, such as Digidesign's superb *Q-Sheet A/V*, are simply not available for the Atari. Other utility programs, such as *Master List* (a program that is almost a necessity for preparing a CD master with Sound Tools), were not available on the Atari at the time of this review, although expected soon. On the whole, it is clear that Digidesign's first commitment is to the Macintosh. It's not that the Atari crowd will not get support, they just won't get as much support, and in some cases, they may have to stand in line behind Mac owners.

All is not bleak, however. For one thing, C-Lab is hard at work on a version of their *Notator* sequencing software that incorporates digital audio. Digidesign is also preparing an update to the Atari version of *Turbosynth* (one

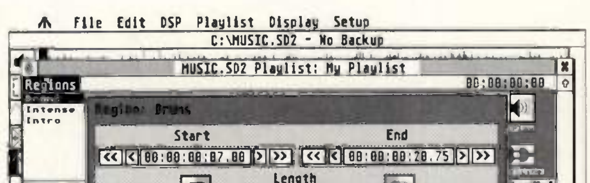


FIG. 3: The start and end points of any region can be easily adjusted, with any desired degree of precision.

of the hottest DSP-based programs around) to use the Sound Accelerator. In some cases, Atari Sound Tools benefits from being the more recent product. There are more options for crossfading, and some effective short-cuts for selecting regions to edit.

In passing, I need to mention that the Atari operating system was not designed to support large, contiguous partitions on hard disks. You'll need to use a formatting utility to create partitions large enough for your digital audio files. Digidesign recommends the utility provided by Supra for this purpose.

CONCLUSION

Reviewing the Atari Sound Tools, I feel like a bit of a curmudgeon. It seems like all I've done is complain. But the fact is that Sound Tools, in either Mac or Atari version, is one of the big innovations of the last several years. It's a tremendous product that's blazing new paths in audio production. It's just that we said all that in reviewing the original product, and this review is really a comparison between the system running on two different platforms.

On that basis, Atari Sound Tools does not fare so well. It's distinctly slower, and not quite as robust as its Mac cousin. More accurately, the ST is not quite up to the job of digital audio. (Note that the same can be said of the Macintosh in its lesser versions.) It also appears that the Atari product is not going to be as open-ended as the Mac version. When you get down to it, I can think of three good reasons to select the Atari version over the Mac: It's a lot cheaper for a basic system; it's a lot cheaper for a basic system; and it's a lot cheaper for a basic system.

Who, if anyone, would benefit by choosing the Atari version? Well, a person who was committed to the Atari culture, for one, and I understand that there are many such people, especially in Europe. The other category would be persons with specific application for a basic system, who do not expect to expand greatly, and who would like to pocket a few thousand dollars in up-front savings.

But if you are considering the purchase of a random-access, digital audio system, I think you owe it to yourself to consider that an investment of that size should offer you a path for growth. On that basis, Macintosh Sound Tools clearly wins out. ■

DAT-I/O: Direct Digital Input and Output for Sound Tools

Not a part of Atari Sound Tools as such, but an optional part of either the Mac or the Atari versions, DAT-I/O ($995) provides direct digital interfacing with DAT recorders, as well as with professional digital recording equipment that implements the AES/EBU interface. Housed in a black box identical to that used for the analog interface, DAT-I/O is so straightforward to use that there is little to say about its operation. Five slide switches on the front panel select receive or transmit; analog or digital input; S/PDIF (DAT) or AES/EBU interface; sampling rate (32, 44.1, or 48 kHz); and emphasis on or off.

DAT-I/O provides a critical link in bringing Sound Tools into the realm of a true professional tool. Together with a good DAT recorder, Sound Tools can maintain audio in the digital domain from recording the final transfer to CD. Digidesign has also created a program, *DATa*, that allows one to back up Sound Tools files, edits and all, onto DAT tape.

Going inside the DAT-I/O, I found an elegant circuit design but not a very lean one. I'd say there were about fifty chips, including several custom-programmed logic arrays. This is a tribute to the excess baggage that has been written into the AES/EBU specification (see "Keeping it Digital" in the October 1990 issue of EM).

The only thing I miss in the DAT-I/O is a word clock input. Again, Digidesign can't really be blamed. The AES/EBU spec does not call for a master sync source. But any digital audio system more elaborate than a straight stereo chain needs such an input. It's not a limit for Sound Tools at this point, but I suspect that when Digidesign introduces systems with more tracks, they will find it necessary to do a redesign.

Dr. T's X-oR Universal Editor/Librarian

By Dennis Miller

System organization and synth voicing just got a lot easier for IBM-based musicians.

Whenever I consider buying a new piece of music hardware, the first question I ask is, "Can I get a visual editor program for it?" There's nothing I like less than straining to read a front panel LED display and pushing buttons like crazy to get to the parameter page I need. With the recent appearance of universal editor/librarians (generic software programs that support numerous hardware devices; see "Complete Control: Universal Editor/Librarians" in the June 1990 EM), the answer to my question is more often than not, "Yes, you can." *X-oR*, from Dr. T's Music Software, is one such program that provides you with comprehensive editing capabilities for a wide range of synths, effects boxes, and MIDI patch bays. After working with this program, it seems to me that stand-alone, single-instrument editors may soon become a thing of the past.

X-oR (which stands for syseX oRchestrator) is currently available for the IBM PC and Atari ST, and its release is imminent for the Amiga and Macintosh. I reviewed the version for the IBM and compatibles, running under Microsoft *Windows* (a run-time version of which is included).

At this writing, the program provides editing and librarian capabilities for over 85 instruments. It's especially suited for use with a MIDI patch bay, but even without a patcher you can get lots of mileage out of the program. With sophisticated file-management features, extensive editing capabilities, an online MIDI file player, and a clear and logical user interface, *X-oR* is everything you want in an editor, and its $329 price tag seems more than reasonable if (as I suspect) it is indeed the "last editor you'll ever have to buy." To top it off, the program isn't copy-protected.

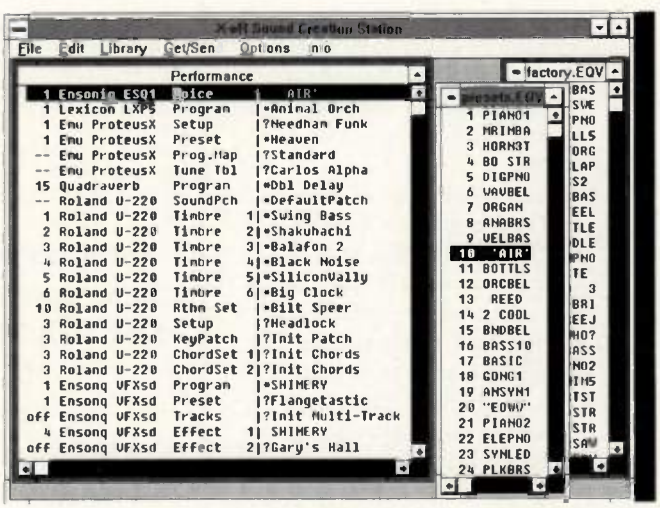


FIG. 1: X-oR's Performance window displays a list of all data types for every instrument in your system.

THE PROFILE

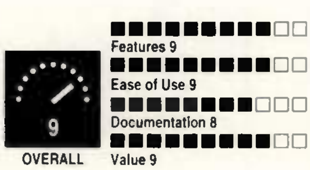
Every device supported by *X-oR* is represented by a template, or Profile, containing all that the program needs to know about a particular instrument. The Profile consists of a number of Patches (or sub-modules) representing the various types of data your hardware uses. The Roland D-110 profile, for example, includes patches for each individual D-110 part, the drum set, and Roland's own patch settings, while the Yamaha TX81Z profile consists of patches for Performance, Single, Microtonal, System and other data types. Because every *X-oR* patch can be edited and stored individually, you'll find that your data stays remarkably well-organized. Any sound in your system (no matter how complex it is) can be accessed with just a few mouse clicks.

Before running, *X-oR* needs to be configured to your hardware. Using a setup program, you can load instrument profiles, one at a time, and set global defaults for each (such as MIDI channel and the selection of directory for data files storage). If you have a programmable MIDI patch bay, you can tell *X-oR* how to establish two-way communication between each instrument and the computer. The whole process is very easy to understand and virtually painless.

After completing the setup procedure, run *X-oR*, and you'll be brought to the Performance window, which contains a complete list of the Patches for every instrument installed (see **Fig.1**). A menu line across the top of this screen lets you access the program's features, including file management, editing, communication to and from your hardware, and help. (Keyboard shortcuts are available for nearly every major operation.) Since *X-oR's* Patches are empty on startup, you need to retrieve all the current settings in your system. You can do this either one device at a time (*X-oR* prompts you to reconnect your MIDI cables each time it wants to talk with a different device) or globally,

Product Summary

PRODUCT:
Dr. T's *X-oR*
TYPE:
Universal Editor/Librarian
HARDWARE REQUIREMENTS:
IBM PC and compatibles; 640K RAM; hard disk; mouse; Microsoft *Windows* (run-time version included)
FEATURES:
Editing and librarian capabilities for over 85 instruments; intelligent patch randomization; standard MIDI file playback; graphic envelope editing
PRICE:
$329
MANUFACTURER:
Dr. T's Music Software
100 Crescent Rd., Suite 1B
Needham, MA 02194
tel. (617) 455-1454



if you've properly configured your programmable patch bay.

Once you've captured your settings, the fun really begins. Each Performance is like a "snapshot" of your entire rig at a particular point in time, containing all tones, timbres, combinations, programs, and whatever else goes to define your system. You can save these snapshots to disk, then recall them for later use. After a while, you could end up with Performances for every piece of music you're working on. Before each work session, simply have *X-oR* send out the Performance, then sit back as your synths get reset one by one. These "global patch changes" can be a real time saver, especially if you have a lot of gear.

EDITING

Like any stand-alone editor, *X-oR* has extensive capabilities for sound manipulation. Open up one of the Patch Edit windows, and you'll find an appropriately layed-out collection of sliders, buttons, and graphs (see **Fig. 2**). Each of these icons responds well to the mouse, making it simple to change values in small increments or in broad strokes. In most cases, the target device is continuously updated as you change settings. The envelope graphs are especially easy-to-manipulate—just grab the "handle" of any breakpoint and move it around—but it would be even nicer if you could zoom in and out and see the exact values you're working with. There's a handy Copy command that can be used to duplicate values within a patch. You can use it, for example, to copy the values of one envelope to another. The Transplant option allows you to move values between different patches. It's simple to pull together bits and pieces from various sources as you search for that perfect sound.

In addition to tweaking existing programs, *X-oR* provides a variety of ways to create new patches. You can call up a blank template with the Init Patch command and simply build your own sound from scratch. There's a Blend/Mingle feature that can be used to create an entire bank of new patches by combining parameter settings from two selected source patches. How these parameters are merged is up to you: average their values using Blend, or have *X-oR* select randomly from the two sources using Mingle. Fancier still is a stand-alone Randomize option that also creates a whole bank of patches. I've never been a big fan of patch randomizing, but *X-oR* lets you determine exactly which parameters will be affected, giving you total control over the process. I was able to create many useful sounds with this feature and learned an awful lot about the architecture of my synths in the process.

SNEAK PREVIEW

X-oR has two ways to audition your work from within the program. The first is a Mouse Playback feature that lets you send MIDI note-on commands by clicking on the mouse. There are a lot of options here: You can play a single note each time the mouse is clicked, or play glissando (with selectable scale). The mouse is moved up the screen to raise velocity, and down to lower it, and the left mouse button is used to access any continuous controller. Holding down the "Alt" key and moving the mouse creates a pitch bend. The only thing missing is an onscreen keyboard or some other icon to give you a frame of reference, but the program does have a MIDI echo feature so you can use it with a master controller. When you're fine-tuning a sound, you need to be able to repeat the exact pitch

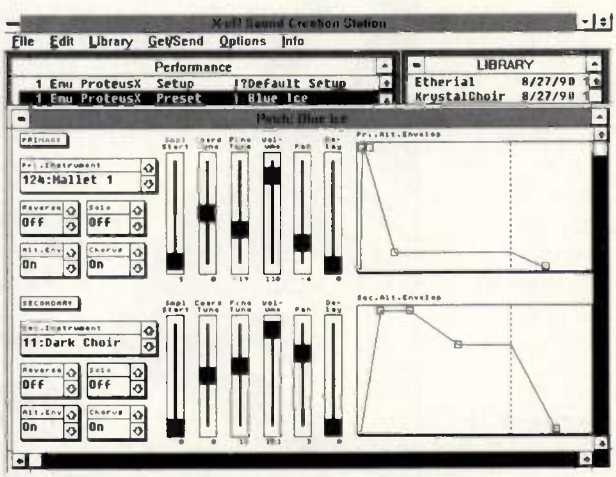


FIG. 2: The Patch Edit window provides appropriate controls for the user-adjustable parameters of each MIDI instrument.

and velocity after each edit for comparison. The mouse could become a useful performance controller if you could tell what notes you were playing.

The SMF (Standard MIDI File) playback feature is well implemented and easy to use. It's a powerful tool for playing back a multitrack sequence after, or even while, you're editing. You can load a standard MIDI file from anywhere on your disk and change tempo, play range, looping, and more, while you fine-tune your patches.

X-oR equals the abilities of my other editor/librarians in every case. In most instances, it's far better-equipped to do the job.

AT THE LIBRARY

When you've finished tweaking, you can send the edited Patch back to the bank it came from, or save it directly to disk. The best place to store patches and complete banks, though, is in one of *X-oR's* Libraries. If you've worked with editors before, you know how easy it is to build up huge stockpiles of sounds, and you may even have considered purchasing a database to keep track of them all. *X-oR's* Libraries have sophisticated capabilities for organizing and managing your sounds that help you find things quickly. You can add comments to Libraries, Banks, Performances, and single sounds.

At the heart of the Library functions are "keywords" that can be assigned to individual sounds, or to entire banks. *X-oR* provides you with a number of categories to use: lists of Effects, Materials, Instruments, and more appear as choices, but you can add your own. You can assign up to eight keywords for a sound. When you need to locate that sound, you simply tell *X-oR* to search using one or more keywords. Conditional expressions such as "and" and "or" provide even more selectivity. The time and date of creation are stamped on every sound as it is saved, so you can sort (but not search) by time and date, too. An Internal Bank feature lets *X-oR* know what banks have been sent, and the program automatically updates the bank in your synth when you tweak it in the Internal Bank. When you boot *X-oR*, it remembers what bank is in your instrument and doesn't resend the same bank.

Around the time that this review appears in print, Dr. T's expects to release *E-oR*, a program that can edit existing *X-oR* Profiles and create new ones. This type of extensibility is rare in a commercial program (although it may be the coming thing; see the review of Twelve Tone Systems' *Cakewalk Professional 3.0* in the December 1990 EM) and is to be commended. I haven't seen *E-oR*, but Dr. T's assures me that the user interface will be familiar to anyone who has programming experience in BASIC or C and will involve entering data into pre-existing "boiler plates," linking visual objects with parameter types, and some actual writing of code. (Of course, a thorough knowledge of system exclusive programming also will come in handy.) For your efforts, you'll be rewarded with custom-designed screen layouts, new profiles for your "dinosaur" synths, robust MIDI monitoring capabilities, and more. It sounds like the extensibility offered by *E-oR* will be well worth the wait.

AT THE CLOSE

One of my concerns about using a universal editor was that I might have to give up some of the control of a dedicated single-instrument editor for the convenience of a more generic program. Comparing *X-oR* to the editors I have for my instruments, it's clear that there's no compromise whatsoever. *X-oR* equals the abilities of my other software in every case. In most instances, it's far better-equipped to do the job. The file-management features are more sophisticated than any I've seen, and the editing features are second to none. There's even an electronic bulletin board you can call for updates and support. Now I've only got one little problem: Who will buy all my standalone editors?

Dennis Miller *is on the music faculty of Northeastern University in Boston. Any resemblance to a comedian on national television who shares his name is strictly coincidental.*

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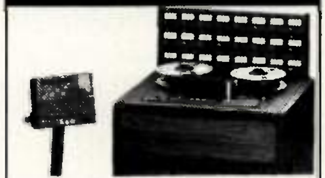

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If you detect an error in a schematic or listing, *let us know*. If a project doesn't work for you, contact us to see if anyone has reported any errors (wait at least a month for **EM** to be in circulation).

Electronic Musician makes no warranties and assumes no responsibility or liability for errors in these projects, for the consequences of such errors, or for the safe and proper function of reader-assembled projects based on plans, descriptions, or information published in **EM**.

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Please reference **EM** when asking manufacturers for product information, returning warranty cards, etc. Advertising provides our financial base, and ad purchases are based on your feedback to manufacturers about which magazines you like.

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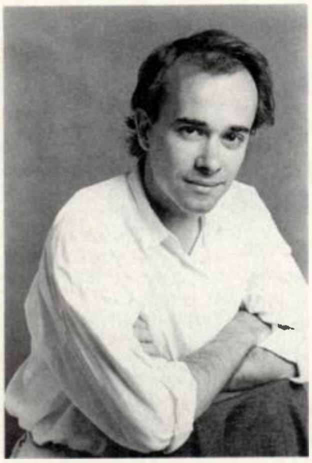
- If you suspect mail order fraud or false representations, notify your local postmaster or the nearest postal inspector.

* Special thanks to MACWORLD for permission to print their research on this topic.

The Recording Industry's Quiet Revolution

A distressing number of "professionals" remain ignorant of musicians' needs. But that's okay—their days may be numbered.

By Brent Hurtig



Last autumn's Audio Engineering Society convention in Los Angeles was a happy clarification of change. For the first time, I saw scads of professional recording products designed with musicians, rather than technicians, in mind. Perhaps this doesn't seem so remarkable to you; after all, hasn't the recording industry always been responsive to musicians? Hardly.

The first multitrack recorders were actually built for the military (surprise!) by Ampex in the early 1950s. These 4- and 7-track recorders were used to log data such as a rocket's air speed and range. Fortunately for us, guitarist Les Paul envisioned a different use for multitrack recording. By 1952 he had developed, in conjunction with Ampex, an 8-track, 1-inch tape recorder. (The deck is still in use today in his home studio.) Only four were built, and it wasn't until 1967 that you could buy a tape recorder with more than four tracks. For some reason (maybe because he was a musician?), it took years for Ampex and other manufacturers to see a commercial market for Les Paul's creation.

Throughout the 1960s and early 1970s, few musicians were involved with the details of recording. True, musician/producers like George Martin and Quincy Jones trail-blazed new technical and creative ground, but the average musician was considered studio-wise if he or she just knew how to "work" a microphone. Such ignorance wasn't the fault of musicians. Studio time was expensive, and the equipment itself was costly, complicated, and in need of frequent maintenance. Perhaps these are the reasons recording engineers, historically, have come from technical, rather than creative, backgrounds. But these reasons don't justify the fact that an astonishing amount of studio gear has been built without the input of musicians.

I'll give you a blatant example. When tracking, a musician should be able to listen to a cue (or monitor) mix of his or her choice. A drummer may want to hear a lot of bass and guitar, whereas a keyboardist might want a lot of vocal and no guitar. Even most ministudios let you create a stereo cue mix for yourself. So it must be easy to create separate cue mixes for multiple musicians with a big-time, $100,000-plus mixing console, right? Believe that, and I've got a seaside resort in Saskatchewan I'd like to sell you.

The fact is, I have yet to find a high-end console equipped to provide multiple musicians with flexible, easy-as-push-button cue mixes. After you've done all the necessary patching, few boards will provide more than two to three independent stereo cue sends (unless you're willing to perform some ridiculous patching, or give up all effects sends). Even The Who could use four independent stereo cues! If console designers would stop to evaluate the needs of musicians, comprehensive and easy cue mixing would be *de rigueur* (or at least an option) on every professional board designed for music tracking.

There are many other examples of how the needs of musicians routinely are ignored. I recently used a new multitrack deck that wouldn't allow musicians to monitor their instruments unless the deck was running and in record! I've heard countless products that sound unmusical. I regularly encounter user-hostile owner's manuals, books, and magazine articles. Isn't it about time musicians were taken seriously by the recording industry?

It is about time. And that's why this last AES confirmed my feelings. The techniques and approaches of today's MIDI-ized, parameter-manipulating, techno-savvy musician are finally "trickling up" to the pro studio. A flock of new, 24-track tape recorders feature punch-in footswitches. Over 40 hard disk recording systems are on the market, and suddenly everyone's talking about digital crossfades, variable sample rates, looping—features that sampling musicians have understood for several years now. Many large mixing consoles now sport MIDI facilities (although I'm still waiting to see better cue mix provisions).

No longer must musicians fight for power in the professional studio. We have it. Those manufacturers, designers, engineers, producers, and publishing executives who are responding to the needs of musicians are enjoying success, and they deserve it. Those unwilling—or unable—to respond to this new order will enjoy difficulties and deserve to go the way of the dodo.

Brent Hurtig, *founding editor of* EQ *magazine and author of* Multi-Track Recording for Musicians, *has worked in the recording industry since the dark ages of 1977.*

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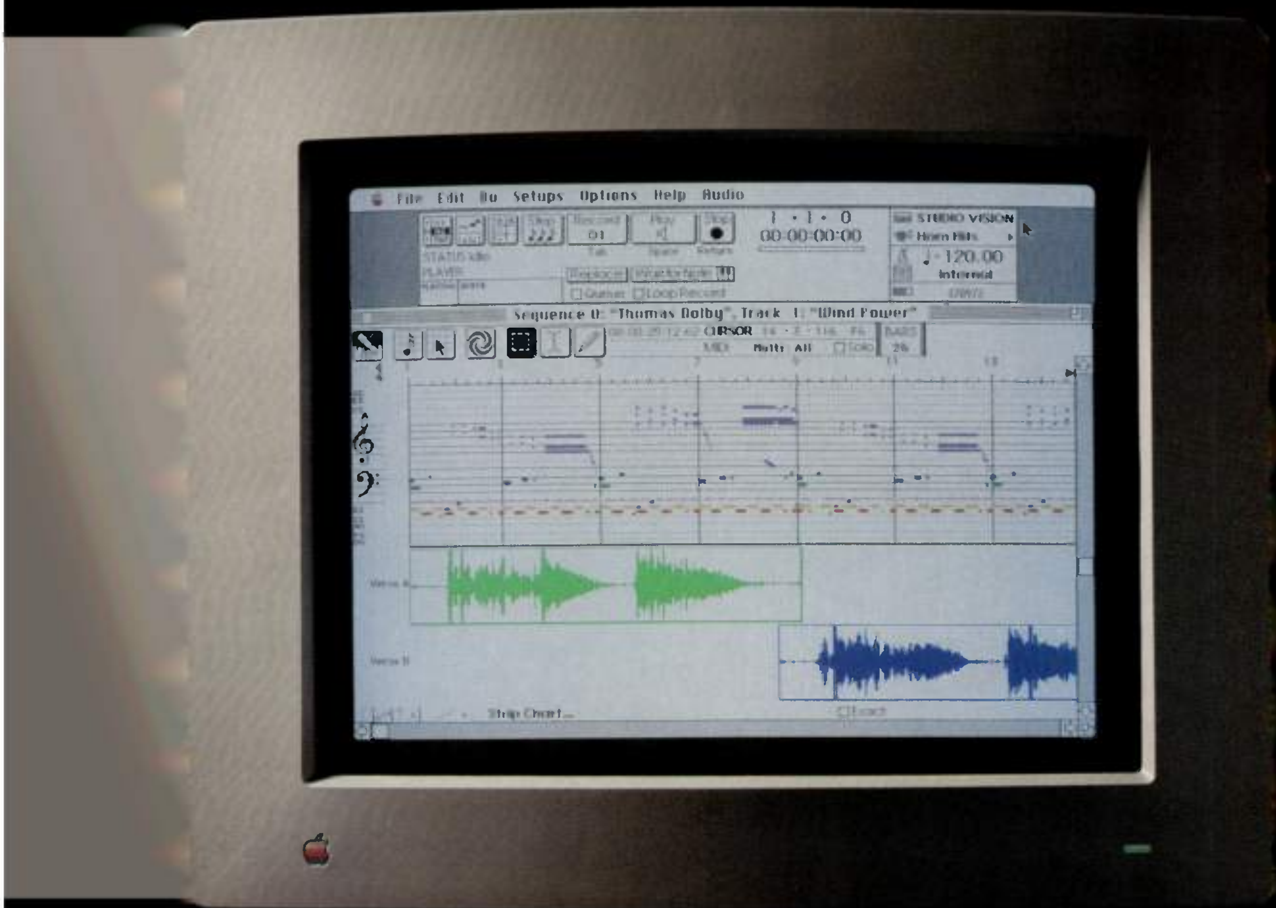

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