THE ESSENTIAL GUIDE FOR COMPUTER MUSIC PRODUCTION

Electronic Musician

Desktop Music

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2000 Edition

PRODUCTION GUIDE

HARD-DISK RECORDING

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MP3, Studio Shareware, Links Galore!

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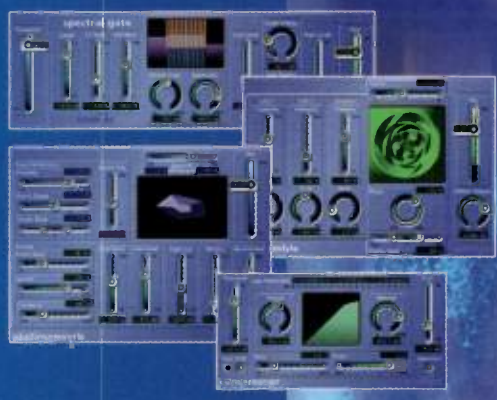

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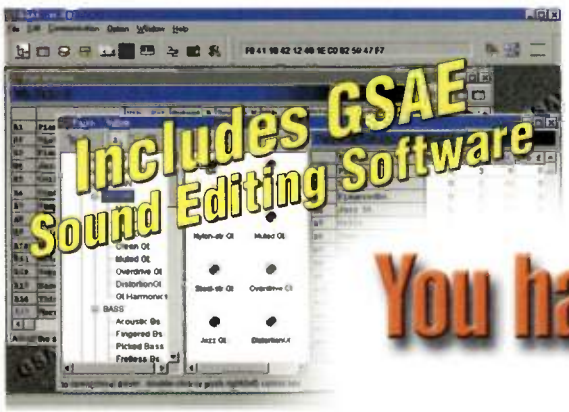

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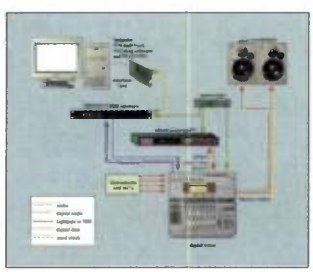

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DMPG 2000

Production NOTES


Hazuki Kataoka

Welcome to *Electronic Musician* magazine's second annual guide to making better music with your computer. Of course, EM covers desktop music every month, but this special issue lets us explain the process from a variety of angles. For this "2.0" version, we have added a number of useful new features. The most exciting enhancement is the way the magazine works alongside EM's Web site. Dial up www.emusician.com, click the DMPG link, and you'll find a mass of relevant multimedia files.

For example, in "MP3 for Musicians" (page 58), author John Krogh describes the effect that preprocessing and various encoder settings have on your sound. You can hear this for yourself online. In "Desktop Video Scoring Explained" (page 74), Don Veca walks you through the process of composing and recording a movie soundtrack. You can check out one of the actual movie clips at the site. And for the adventurous, audio madman Dave O'Neal donated sound files that give you fair warning about what could happen if you attempt his "19 Twisted Sound-Design Projects" (page 90).

You'll also find extensive music-software charts on the EM site. Designed to complement our hard-disk recording and laptop-computer stories, these charts cover audio-processing programs, software synthesizers, recording and editing programs, and DSP plug-in software. We've linked each listing to the manufacturer's Web site, so if you're intrigued by a program, you can easily get more information—and sometimes even a free demo.

Uploading all the charts to the Web gave us space to add mountains of diagrams and graphics to the issue, and my special thanks go to art director Linda Gough and technical illustrator Chuck Dahmer for making the most of the opportunity. Just because desktop music is a technical subject doesn't mean that it has to be presented in a monochromatic way. Another of our goals this year was to give you more tips, basics, and how-to features. While you're visiting www.emusician.com, let us know how we did. After all, magazines can be upgraded, too.

Somehow lost in all this excitement about the Web is something that we musicians may want to think about as we contemplate distributing our creations online. I recently visited an office in which every employee is issued a PC with a fast Internet connection—and horrible-sounding speakers. Advances in data compression and connection speed, which are often touted as the key to making online music really take off, will do very little to enhance the computer-audio experience for these people. And I suspect that the majority of computer users—your potential audience—are similarly limited by poor (or poorly configured) speakers.

Why will people who happily spend $300 or more for a video monitor even consider spending only $10 for audio monitors? And how can we musicians show them the benefits of quality sound? In many ways, computers are bringing artists and listeners closer, but true communication depends on more than technology. I hope you'll find that some of that spirit shines through in this issue.

David Battino
Editor
Desktop Music Production Guide

Electronic Musician Desktop Music PRODUCTION GUIDE 2000 Edition

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A-10 The control amplifier standing on its left ear not only powers the rather handsome monitor pictured in center page, it represents a fairly radical departure in conventional thinking. By bringing the amp outboard, the controls are now where you can get to them, making a snap out of adapting monitor response to listening room acoustics. It also keeps the monitor enclosures themselves from approaching the size of two parked Buicks. Their unusual cabinet shape also improves midrange clarity, stereo imaging and localization. And because its an active monitor, the system response is surprisingly accurate, detailed and has tremendous bass extension. Best of all, considering they are free with the purchase of some pretty solid thinking, the price couldn't be more right.

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DM PG 2000

Laptop Computers

The Ultimate Personal Studio

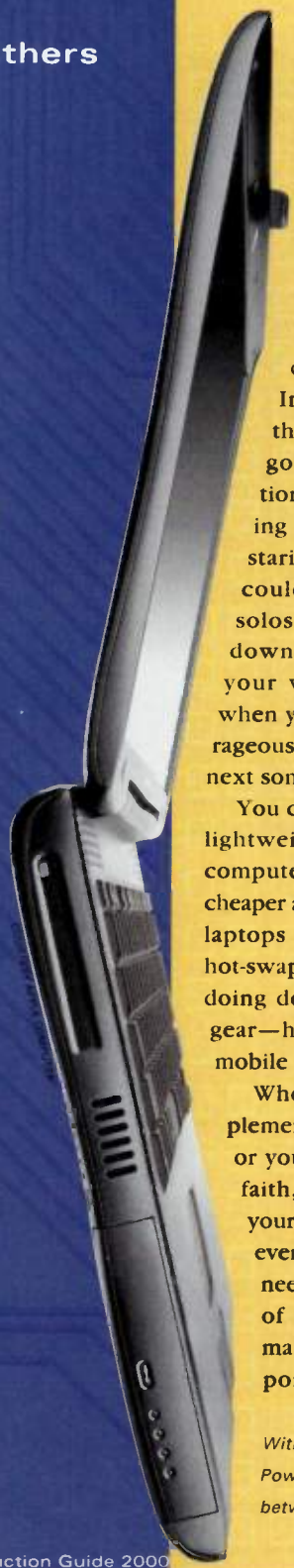
By Brian Smithers

Here's how to set up a mobile music system.

Do you ever wish you had more time to make music? Well, think about all the opportunities you'd have if your studio were always at your side. Instead of thumbing listlessly through that in-flight catalog of golf-club warmers and motivational plaques, you could be trying out new melodies. Instead of staring out the bus window, you could be editing multiple guitar solos into the perfect take. Gulp down that sandwich! Why spend your whole lunch hour chewing when you could be designing an outrageous sound effect to kick off your next song?

You can do all this and more with a lightweight, battery-powered laptop computer, and it's getting easier and cheaper all the time. With well-equipped laptops now selling for $1,000—and hot-swappable USB music peripherals doing double duty as desktop music gear—how can you afford *not* to be mobile at least part of the time?

Whether you're looking to complement your existing desktop setup or you're ready to take that leap of faith, as I did long ago, and carry your musical world with you wherever you go, I'll explain what you'll need. Even better, I'll share plenty of road-tested ideas on how to make the most of your newfound portability. It doesn't matter if you're a walking bag of money or a genuine skinflint like me. You *can* take it with you, and I'll show you how.



With dual batteries, Apple's new PowerBooks can run up to ten hours between charges.

What to Look For

Fully 25 percent of new computers being sold now are laptops, and this increased demand has prompted manufacturers to bring the price/performance ratio ever closer to that of desktop systems. Even today's wafer-thin three-pound subnotebooks are outfitted with PC Card (formerly known as PCMCIA) expansion slots and USB ports, so connecting music gear is easy.

As with desktop systems, almost any off-the-shelf laptop can make a lot of music, but the more processor power and RAM you can afford, the better. You're generally less likely to run into compatibility problems if you buy name-brand products. Ergonomics is another important (and highly subjective) factor to consider. For a breakdown of what you should look for in a laptop, see the sidebar "Buying Your Musical Notebook."

To a large extent, the type of music production you do will dictate what computer you should get and how you should equip it. To illustrate this, I'll delve into five of the top musical applications for a portable computer: sequencing and songwriting, remote recording, audio editing, performing live, and complementing a desktop music system.

Sequencing: Go Where Your Inspiration Takes You

Have you ever thought to yourself, "Quick, Scotty, beam me to the studio before I forget this melody"? You're closer than you realize. With an inexpensive used notebook and a sequencer program, you could not only capture your inspired moments but also work

out entire arrangements at 30,000 feet.

Raw power isn't a major factor in configuring a notebook for MIDI sequencing. Even a 486 with a cheesy FM synth is sufficient for composing and arranging, and these can be had used for under $300. (On the Mac side, you could easily get by with a 68040-based PowerBook and the QuickTime Musical Instruments extension.) If you're willing to sequence in step time, you won't even need a MIDI keyboard or interface. Of course, more money buys you convenience, flexibility, and higher-quality output.

Taste of syn. The first upgrade you might consider is a better-sounding synth. Software-based wavetable synths give you much more realistic sounds than FM without requiring a lot of cash, although you'll want a Pentium or PowerPC processor to run them. For example, Roland's *VSC-88H* offers GM/GS-format sounds on a 166 MHz Pentium or a 133 MHz PowerPC 603e for only $59. (See the DMPG link at www.emusician.com for a complete soft-synth roundup.) It's quite a bit easier to develop an idea when the sounds you're hearing resemble those you'll ultimately use.

FIG. 1: E-mu's EMU8710ps PC Card (Windows) combines analog audio I/O, S/PDIF digital audio output, MIDI I/O, 4 MB of wavetable ROM, and 2 MB of SoundFont-compatible sample RAM.

Another option for getting good sequenced sounds out of a Windows laptop is E-mu's EMU8710ps PC Card sound card (see **Fig. 1**). This little gem features 4 MB of wavetable ROM plus 2 MB of RAM for loading additional sounds in Creative Labs' SoundFont format. That's right: it's a credit-card-size sampler! With its optional breakout box, the EMU8710ps provides stereo analog I/O, MIDI I/O, and S/PDIF digital audio output, making it a powerful and versatile little item.

A company called Ego-Sys expects to release the WaMi Box by the time you read this. Using a PC Card interface, it provides an external wavetable synth with MIDI, S/PDIF, and analog audio I/O. Yamaha's MU15 is a 32-note polyphonic, 16-part multitimbral XG synth that connects directly to your laptop's serial port (see **Fig. 2**).

Input. To get all those great ideas into your mobile sequencing setup, you may be content to use step entry from your computer keyboard, but there are other options. For example, Cakewalk's Windows sequencers include a handy utility called *Virtual Piano* that shows up as a tiny onscreen piano keyboard. You can play notes on this display with your mouse or use your computer's alphabetic keys (see **Fig. 3**).

Of course, computer keys aren't velocity-sensitive, but the program does offer an onscreen slider to set Velocity, as well as pitch and modulation sliders. *Virtual Piano* isn't going to replace your Kurzweil PC88 master-controller keyboard, but believe me, it fits much better in a backyard hammock. Non-Cakewalkers can find similar shareware applets available. (Speaking of virtual

The Sony VAIO Z505SX offers a software-based MIDI synthesizer. Pentium III versions will feature a dedicated Yamaha XG synthesizer chip.

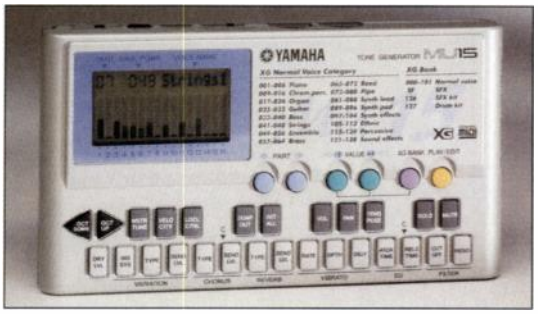


FIG. 2: Yamaha's MU15 synth is made to order for mobile music production. Featuring 32-note polyphony and 16-part multitimbral operation, the MU15 can connect directly to a notebook's serial port.

top is too much to carry, Yamaha has packed an awful lot of possibilities into its QY70. Combining an XG tone module with an 8-track, 32,000-note sequencer, the QY70 includes thousands of drum loops and other phrases. In addition to MIDI I/O, it has a direct computer interface. Roland's PMA-5 packs an 8-track, 20-song, 21,000-note sequencer; a GS synth; and a touch-screen display into a tiny box with a computer interface.

pianos, serious keyboardists may want to check out BitHeadz's *Black & Whites*, a software synthesizer that specializes in piano sounds.)

If you're willing to spend—and lug around—a little more, you can find portable keyboards to expedite and enliven your sequencing. Roland's three-pound, battery-powered PC-160 sports 32 full-size, velocity-sensitive keys. The Yamaha CBXK2 is a bit heavier, weighing in at just under six pounds, but it features 49 keys. With capable portable controllers like these, you may start to blur the line between scratch tracks and final tracks. Compact MIDI interfaces using your laptop's parallel, serial, or USB ports are available for connecting your music keyboard (see **Fig. 4**).

For those times when even a laptop is too much to carry, Yamaha has packed an awful lot of possibilities into its QY70. Combining an XG tone module with an 8-track, 32,000-note sequencer, the QY70 includes thousands of drum loops and other phrases. In addition to MIDI I/O, it has a direct computer interface. Roland's PMA-5 packs an 8-track, 20-song, 21,000-note sequencer; a GS synth; and a touch-screen display into a tiny box with a computer interface.

Recording: Go Where the Clients Are

If you're doing work for hire, convenience to your clients could be your biggest selling point. I once got a call from a vocalist who wanted me to edit together a demo tape from existing recordings. She was flabbergasted when I said I'd come to her.

I set up a cassette deck and my notebook on her coffee table, and as we reviewed the source material, I either recorded it from tape or digitally extracted it from CDs in my drive. I assembled and tweaked the segments she had selected in Syntrillium *Cool Edit* while she warmed up for that night's show, and then I dumped it all back to cassette. You could easily take

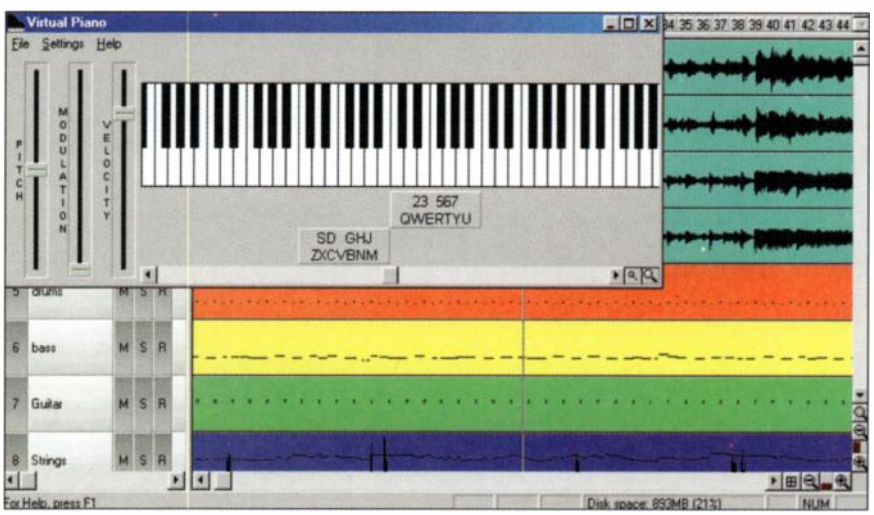


FIG. 3: The Virtual Piano *applet is included with Cakewalk's Windows sequencers to facilitate note entry when no MIDI device is available. The computer keys that trigger the notes are shown beneath the piano keyboard display.*

FIG. 4: Midiman's compact Portman PC/S MIDI interface is powered by the computer's serial port. Parallel-port and Mac versions are also available.

this one step further and show up with an external CD-R drive (and even a pint-size printer to make custom labels) and still not have to make a second trip to your car.

Do you really enjoy having a garage band drag their gear, munchies, and significant others into your home studio to record a demo? Even if it's your band, it's a nightmare. A notebook studio lets you record them in their natural environment—even if it's literally a garage—without all the disruption. As with any remote recording, you'll have to deal creatively with the acoustics, but the convenience and comfort of recording in familiar surroundings could inspire the band to a much better performance.

Adapt or Die

Craig Negoescu is media director at Frogdesign, architects of the acrobatic Sharp Tri-Pad notebook and several of the early Macs. He points out, "It's part of Murphy's Law that wherever you go you'll find yourself in need of some kind of adapter. Surf the Walkman section in discount electronics stores for weird little stereo eighth-inch-to-anything adapters. I've used an eighth-inch-to-cassette adapter that plugs into a car stereo to listen to MP3s on the road. And the Arkon Sound Feeder short-range FM transmitter has saved my bacon twice. Once in a presentation I beamed the laptop's audio output to a conference-room stereo (a nice room-filling effect), and another time I broadcast to a boom box for a quick P.A."

ADAT or Hard Disk? Yes!

Sometimes you create ideas on the fly. Other times you work deep in the details. Your recording system should allow you to do both. That's the idea behind Alesis digital audio technology. Link your ADAT and computer, and create music exactly the way *you* want to.

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Audio interfaces. Recording high-quality audio into a laptop computer has always been a challenge, to put it politely. Built-in audio systems, while convenient, virtually all suffer to one degree or another from having been crammed in next to hard drives and CPU fans. This usually results in noisy recording and playback. The few PC Card devices that made it off the drawing board tended to be finicky because of manufacturers' less-than-consistent implementation of the PC Card standard.

Fortunately for us, Roland and Opcode have developed USB audio interfaces. Roland's Audio Canvas UA-100 and Opcode's DATport and Sonicport remove the D/A and A/D conversion from the electronically treacherous innards of the computer, resulting in cleaner audio.

FIG. 5: With 24-bit analog I/O on balanced XLRs and coaxial S/PDIF I/O, Digigram's VXpocket is a high-end audio interface the size of a credit card. It works with both Macs and PCs.

The UA-100 provides mic- and line-level audio connections and effects. The DATport is a coaxial S/PDIF interface that requires external converters, while the Sonicport adds 20-bit analog converters and comes in an optical S/PDIF configuration as well. For maximum portability, Opcode's products even draw their power from the USB port. However, as of press time you need a Windows 98 PC to run USB audio; Macs do not yet support it. (For much more on USB gear, check out "A Musician's Guide to USB" on page 24.)

Digigram has introduced a new cross-platform PC Card audio card, the VXpocket, which promises to be a serious contender for premium-quality

Buying Your Musical Notebook

Here's a list of what to look for when buying your ultimate personal studio. Because hardware compatibility is still sometimes a problem, check your vendor's return policy carefully. Also, when your budget forces a compromise, spend your money on the processor—it's the one thing you're least likely to upgrade.

CPU

- PC: 300 MHz or faster Pentium II or Celeron (non-Intel processors may cause problems with some soft synths and plug-ins).
- Mac: 333 MHz or faster G3.
- Slower processors are okay if digital audio isn't a priority.

RAM

- 64 MB minimum; the more the better.
- You'll probably have only one RAM upgrade slot, so fill it as full as you possibly can.

Hard Drive

- 6 GB minimum; the more the better.
- Get a user-swappable hard drive if possible.
- Some models allow a second hard drive in the utility bay, but it may not operate at the same speed as the internal drive.
- Look for a rotational speed of 5,400 rpm or faster. (This is one area where notebooks are still way behind desktops.)

Ports

- Two Type II PC Card/CardBus-compliant slots.
- USB port.
- Firewire/IEEE 1394 port (not essential yet, but offers future potential).
- Fast infrared port for wireless transfer.

Audio System

- Full-duplex 16-bit, 44.1 kHz audio I/O.
- Wavetable synthesis.
- DirectX compatibility (PC).
- Line input, headphone output, and mic input are common; line output is less common but very desirable.
- Speakers (even the best are pretty bad, but they can be convenient).

Design and Ergonomics

- Acoustic noise: Listen for obnoxious whines and whirs from the laptop's hard drive and fan. They could be a problem during acoustic recording.
- Battery life: The longer the better. Some models support dual batteries, which is a plus.
- Docking station: Only certain models support a docking station, so shop for them as a unit. Ideally, a docking station will have two or more full-length PCI slots, at least one drive bay, complete desktop peripheral connections, and complete audio I/O.
- Keyboard/pointing device: This is highly personal, so get your hands on as many different models as possible to find your ideal setup.
- Screen: Shoot for at least a 13.3-inch TFT (active-matrix) display. Newer dual-scan displays are quite good, though. Compare for yourself.
- Weight: The lighter your laptop, the more likely you'll be to take it with you. But be aware of what you sacrifice for low weight. Many ultralights jettison the CD-ROM drive, and some music programs won't launch without a CD-ROM.

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TONMEISTER: The Browser View window integrates audio editing, project file management and play list all at once. No more menu surfing required. Want to burn a CD? Simply export ***SPARK***'s play list into the bundled Adaptec Toast application and you're there!

FX-MEISTER: ***SPARK***'s unique FXmachine is a creative power tool. Comprehensive routings with up to 4 parallel streams and 5 Plug-Ins each give you endless possibilities for creative realtime sound design and mastering processing. ***SPARK*** supports the VST Plug-In format, so you can choose from a wide selection of Plug-Ins by the key players in this field!

SOUNDMEISTER: Realtime Time Stretch is just one of the nice surprises in ***SPARK***. Directly accessible from the Jog-Shuttle wheel of course. But there's a lot more – the key signal processing tools are included and then some: Reverb, Parametric EQ, Notch Filter, Hi/Low Cut EQ, Bandpass EQ, 3 Band EQ, Resonance Filter, FuzzSat, Delay – and the powerful TC Native CL Compressor/Limiter. 24 Bit/96kHz goes without saying. All Plug-Ins are VST compatible, ready for use in any application which supports VST!

AUDIOMEISTER: Steinberg's VST Plug-In support, ASIO sound card support and Digidesign Direct I/O make sure you are compatible with the leading software and hardware solutions! AIFF, SD2, QuickTime and WAV file formats guarantee optimal flexibility. Oh, we almost forgot: ***SPARK*** comes with support for all the major sampler models (MIDI/SCSI): AKAI, Kurzweil, EMU, ...

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Apple's new Power Macintosh® G3 systems are tailored to provide you the best experience in digital audio production. They come with the fastest PowerPC G3 processors, enhanced I/O capabilities like USB and FireWire®, and a stunning new enclosure that radically simplifies system access and expansion. The minimum system requirement for ***SPARK*** is a PCI Mac with PowerPC 604 processor and 64 MB RAM.

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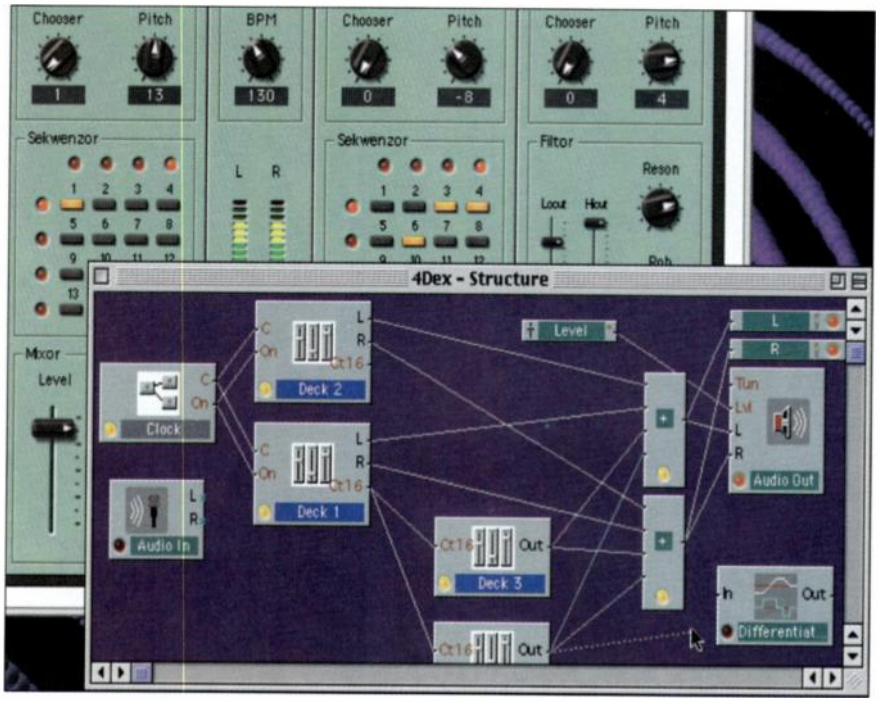

FIG. 6: With nearly 200 sound-shaping modules, Native Instruments Reaktor *(Mac/Win) would fill an entire room if it were implemented as a hardware synth. But it adds no weight to a computer.*

notebook audio (see **Fig. 5**). This is not Digigram's first PC Card audio interface, but it is the company's first designed for music applications. With 24-bit converters and S/PDIF I/O, it represents a serious upgrade for any PowerBook or Windows notebook.

Processing. Of course, your portability factor dwindles quickly if you start lugging around your 16-channel mixer with your notebook, so keep it compact with space-efficient items like A.R.T.'s Tube MP mic preamp and dbx's MC-3 minicompressor. Along with the NanoCompressor and NanoVerb from Alesis, these are just the sort of great-sounding but ultraportable goodies that will let you fit your entire recording kit in a backpack or camera bag. Shop around and you'll find headphone amps, folding headphones, and lots of other items that will work as well in the studio as on location.

Even Soundscape's venerable SSHDR-1 high-end external digital audio workstation (DAW) is now available with a parallel-port interface, allowing you to harness its power from your laptop. At $4,500 for a basic system, it requires deeper pockets than the other options we've discussed, but when you consider that you can use it as your desktop DAW as well, it's practically a buy-one-get-one-free proposition.

Editing: Go Where You're Comfortable

Whether you're editing music tracks, sound effects, samples, scores, or synth patches, a notebook lets you choose your locale. With the exception of the tweakiest balance and equalization adjustments, even a mediocre built-in audio system will serve you well for this kind of work. With studio-caliber headphones and a VXpocket or Sonicport, you've got the world on a string, or at least tucked away conveniently in a padded briefcase.

This is the real beauty of the ultimate personal studio: you can go wherever you want to work, and you can work wherever you have to go. I've taken my notebook into the woods to be comfortable, secluded, and even inspired while I work; I've also taken it to the airport and the garage to be productive when I otherwise would have been killing time. There's no magic to it, and often no additional cost beyond a spare battery, as most audio-editing software and soft synths work with Sound Manager (Mac) or standard wave devices (PC), even if you use sophisticated hardware at home.

Inveterate synth tweakers will find the combination of a notebook and a software synth irresistible. A modular synth such as Native Instruments *Reaktor* (see **Fig. 6**), with its nearly 200 sound-shaping modules, just dares you to spend an entire train ride exploring its sonic possibilities. Seer Systems *Reality*'s ability to mix FM synthesis, physical modeling, sampling, and more

Satellite Studio

LOREN HAMMER

Fusion pioneer

Jeff Lorber uses his Apple G3 PowerBook to be prepared wherever and whenever inspiration strikes. With his Roland PC-200 portable MIDI keyboard and a Yamaha MU128 synth module loaded with the optional VL and DX cards, Jeff has a powerful portable composing setup that's completely compatible with his home studio.

"The PowerBook has a large folder of loops that I can use with [Opcode] *Studio Vision*, and the extra cards and sounds in the MU128 give me a couple of different options as far as synthesis goes," he reports. "When I get home after a trip, I upload the files through Ethernet into the [Macintosh] 9600 in my studio and expand on the writing and do additional production from there."

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will surely lead you to some new and interesting sounds to work with when you return to your studio.

Notation. Copying parts is the sort of tedious work best done in a lawn chair. Fortunately, even a doorstop of a computer can handle music notation. (For more on doorstops, see the sidebar "Dirt Cheap and Ready to Rock.") You may not even need an audio system if you aren't concerned with playback. A good screen is recommended, though, because you'll be staring at it for long periods.

Performing: Go on Stage

The auditorium goes dark as three musicians take the stage. Each glides into place near a sophisticated musical arsenal loaded with more megabytes of samples than you can count. Only these arsenals aren't the massive racks of expensive gear we've come to expect—they're PowerBooks. And those aren't MIDI controllers the musicians have slung over their shoulders like guitars—they're computer keyboards.

Welcome to the world of Operation Re-Information (ORI). These PowerBook-playing pioneers record and perform using their notebooks as their sole musical instruments. They claim to be the only band born out of a piece of software, and unless you count artists whose careers wouldn't have been possible without pitch-correction plug-ins, they're probably safe in making that claim.

AGENT ELSIE DEE

The Operation Re-Information musicians use laptops as their only instruments in concert.

The software in question is *BackToBasics*, a performance-oriented sample-playing program ORI wrote for their own use. (See "Studio-Tested Shareware" on page 64.) It can fire off up to 47 simultaneous 16-bit, 44.1 kHz samples while the player bends pitch through five octaves. *BackToBasics* is available for both Mac and Windows at www.reinformation.com.

Maybe you aren't ready to give up your main axe in favor of your laptop yet, but there are a lot of ways to use laptops in performance. Musicians have been using sequenced tracks to enhance live shows for years. Samplers or even taped tracks are regularly used on stage to fill out vocal harmonies. Your notebook can do all this and more, and it's a lot easier to carry than a rack-mount computer or a rack full of dedicated hardware. And with the latest PowerBooks boasting five hours of battery life, you won't even need to run a power cable to it.

Mix it up. Some computer tools just beg to be taken on stage, and a notebook is the natural vehicle. *Mixman Studio Pro* lets you assign samples to your computer's keys, sync them all to a common tempo, and layer them in real time to build grooves as deep as you want. Revealing its DJ inspiration, its interface is built around a pair of virtual turntables (see **Fig. 7**), but it would take way more than two turntables to equal *Mixman*'s power. Steinberg's *ReBirth* takes a different approach, emulating classic Roland analog synths right down to their appearance. With its pattern-based dance grooves and MIDI-controllable onscreen knobs, your notebook is ready to rock the house.

When soft synths first came on the

Managing Power Management

Add this to your list of one-size-doesn't-fit-all design decisions. To maximize battery life for the average user, notebook manufacturers build instructions into the hardware and operating system to slow the CPU, shut down the hard drive, dim the display, and do whatever else they can to conserve power. These things can wreak havoc with resource-intensive operations such as hard-disk recording. To make matters worse, the power-management standards are constantly "improving," so it's difficult to make specific recommendations on how to defeat them.

Get to know your notebook's power-management controls. Under Windows 98, look for Power Management in Control Panels. Set up a profile called Audio and choose Never for Standby, Monitor Sleep, and Hard-Disk Sleep. Next, look under every tab and disable anything that might interfere with your system's performance. Look carefully—on my notebook, hidden under Toshiba Power Extensions/Power Scheme Extensions/Advanced/Troubleshooting is a checkbox labeled "Disable auto CPU speed control relative to remaining battery capacity." This gibberish means that by default my notebook is set to process more slowly as its battery runs down!

Likewise, telling the computer to quiet its fan will cause it to manage heat buildup by slowing the CPU instead. Also, be sure to set all low-battery alarms to "text only" so you won't have any surprise beeps in the middle of tracking.

You could spend years putting together a powerful, fully equipped MIDI/Audio project studio.

Powerful, Integrated Music Software

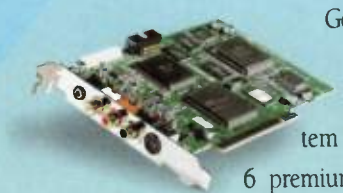
XG Works, included with the SW1000XG, is a complete suite of music software applications

integrated into a single package, featuring sequencing, sound editing, notation, built-in style libraries of music data and full mix control over effects processing, digital audio and MIDI tracks. The SW1000XG is also supported by most major sequencing packages.

Expand Your System With Amazing Plug-Ins

Add to the SW1000XG's powerful synthesizer with three amazing plug-in boards: PLG100-VL lets you solo with the unparalleled realism of Yamaha's exclusive virtual acoustic synthesis; PLG100-DX gives you that vintage FM vibe; and PLG100-VH adds dynamic 1-, 2- and 3-part harmonies to your vocals!*

Or, you can spend about five minutes.



Get a fully decked-out, integrated, professional MIDI/audio project studio without spending a lot of time or money. The Yamaha SW1000XG PCI card is a complete turnkey system that features a 1,267 voice tone generator with 20MB of waveROM; 6 premium digital effects processors plus 5-band EQ; a 12-channel digital audio recording system; and a complete suite of music software. All for just $699 MSRP. And all in the time it takes you to install a computer card and software. The Yamaha SW1000XG: the best and fastest way to create a computer-based recording studio. Check it out today.

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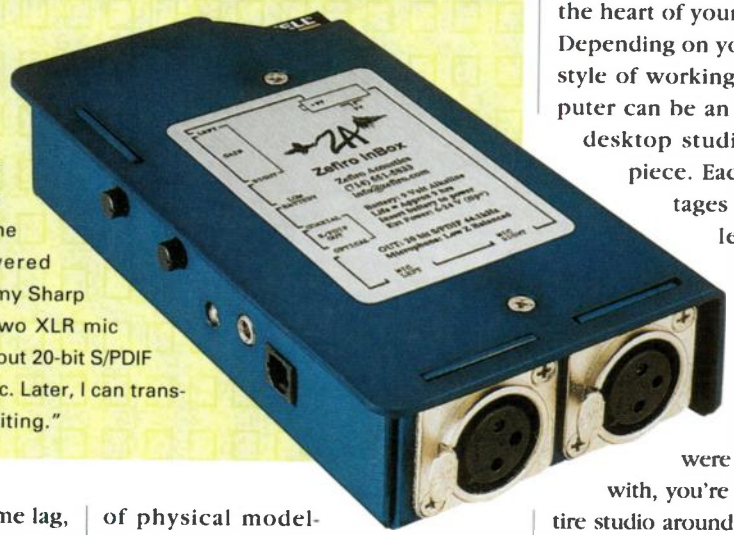
Field Trip, Anyone?

A MiniDisc recorder and a laptop make a great combination for field recording, Frogdesign's Craig Negoescu reveals. "All portable MiniDisc recorders have digital connections," he points out. "I'm currently using the Zefiro InBox [a battery-powered analog-to-digital converter] with my Sharp 702 recorder. The Zefiro takes two XLR mic inputs with gain control and puts out 20-bit S/PDIF at 44.1 kHz on coax and fiber-optic. Later, I can transfer the tracks to the laptop for editing."



scene, there was a *latency*, or time lag, of up to a half second between the time you hit the key and the time the sound emerged. With newer processors and designs, however, latency is so low that real-time performance is feasible. And as computing power continues to grow, so will the synthesis possibilities. For example, Yamaha's new *Poly VL* soft synth takes advantage of the Pentium III's new instructions to provide 8 voices of physical modeling synthesis in addition to 128 voices of XG synthesis.

Follow me. Intelligent-accompaniment software is another natural partner for a performing laptop. While PG Music's *Band-in-a-Box* might be frowned upon in a snooty big-city jazz club, it sure can make a solo gig in a hotel lobby more interesting. For more flexibility, programs such as Cakewalk's *In Concert* or Coda's *Vivace* will follow your tempos, even through your most inspired rubatos.

Portable Pro Tools

"I was asked to participate in Apple's booth at the January '98 NAMM show in L.A.," Frogdesign's Craig Negoescu recalls. "I had to fly in from Texas, and the thought of carting all my equipment made my head spin, so I decided to take a shot at [building] a mobile Pro Tools editor rig. Apple's Mark Gavini connected me with the folks at Magma, who had just produced a rack-mount PCI expansion chassis that plugged into the media bay on the side of the PowerBook. I dropped the Pro Tools cards into the chassis, racked it up into a small six-space case, and hit the road. At the show, I set up my tiny rig and proceeded to demo my Pro Tools sessions. Much to my surprise, people freaked out. It seems my laziness had apparently spawned the first public display of Pro Tools hardware working with a laptop."

In the Studio: Go Home!

Mobility is great, but home is where the heart of your musical adventure is. Depending on your needs, budget, and style of working, your notebook computer can be an enhancement to your desktop studio or even its centerpiece. Each scenario has advantages and disadvantages, so let's close our discussion of the ultimate personal studio with a little cost/benefit analysis.

If you've been paying attention, or if you were off your rocker to begin with, you're ready to build your entire studio around a notebook computer. Notebooks do have a couple of drawbacks, however. First, they cost more than comparable desktops. Second, they're not upgradable. Technically you can install processor upgrades in many notebooks, but you won't, believe me. You may install additional RAM or a larger hard drive, but that's it.

Software is no sweat—anything that isn't dependent on particular hardware will work as well on a notebook as it does on a desktop. More and more MIDI interfaces connect via a serial or USB

FIG. 7: Mixman Studio Pro *turns your laptop into a stand-alone performance instrument. You can trigger up to 16 sample loops by pressing keys; the turntables light up to show the loop status.*

Introducing
WaveCenter/PCI

OK, you see what's happening: digital mixers are looking pretty cool. After all, they've got incredible sonics, built-in effects, and the automation capabilities you could only dream about before. But if you hook that puppy up to the NoiseRacket analog soundcard that came with your computer, you're right back in ****ville. (Rhymes with "Snapville.")

Here's a better idea: keep it digital with our new **WaveCenter/PCI** card. It has all the connections you need to integrate your digital mixer into your computer-based studio. Transfer up to 10 channels of digital audio simultaneously using ADAT lightpipe and S/PDIF, with 24-bit resolution on all channels. Use one of the built-in MIDI ports for mixer automation, and the other to connect your synthesizers.

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port, making them suitable for notebook use. A lot of synthesizer modules come with built-in serial interfaces, so no matter whether your MIDI setup is simple or complex, you'll be able to link it to your laptop.

Audio interfaces. At first glance, your audio I/O options seem to be limited to the PC Card and USB devices we've discussed. They're pretty impressive, though, and the choices are much better than they were even a year ago. But if you're head over heels in love with some new PCI audio card designed for those desktop dinosaurs, there's a way for you to have your cake and eat it too.

For Windows notebooks there are two ways, in fact. The first is to buy a notebook that comes with a docking station. A docking station provides PCI slots and sometimes drive bays in addition to reproducing the notebook's ports for convenient hookup to peripherals like external monitors and printers. That makes it easy to integrate hardware intended for desktop computers into your notebook system.

Compaq and Toshiba, among others, make docking stations for some models. Be warned, though: docking stations can be resource hogs and leave you with no available IRQs. You may need to use Windows Hardware Profiles to disable some nonessential devices when you're docked (see **Fig. 8**).

The second solution, only recently available to Windows users, is Magma's PCI expansion chassis. This fairly expensive ($1,100 to $1,700) but powerful device connects a notebook's PC Card slot or a PowerBook's expansion bay to an external case containing two to seven PCI slots. Performance is said to be almost identical to that of internal PCI slots, so any desktop hardware should work just fine. Now notebook users don't have to pine for such desktop-studio devices as MOTU's 2408 or even Digidesign Pro Tools hardware.

Drive on. Because you can't just keep adding gigantic hard drives to your laptop, you may want to consider an external SCSI drive. Adaptec's 1480 adapter will convert a PC Card port to an Ultra SCSI one, giving you better drive performance than your internal

Dirt Cheap and Ready to Rock

Nervous about throwing your $4,000 notebook in the trunk? Even a tired old model can make music. Sequencing and notation applications demand very little processor power, particularly if you use an external hardware synth module. These programs will run adequately on a 486 or 68040 machine, although screen redraws and printing may test your patience. For really old computers, you may need to use an older version of your favorite sequencer or one of the many inexpensive commercial and shareware alternatives.

Digital audio puts more of a strain on the computer's resources, but even my "old" Pentium 120 can overdub a 16-bit, 44.1 kHz mono track while playing back five additional ones. You can submix tracks, process reverb offline, or lower your audio resolution to manage CPU strain.

Palmtop Studios: Not Quite Ready for Prime Time

An interesting product previewed at the Winter '99 NAMM show got me wondering just how small the ultimate personal studio could get. AET's prototype NanoStudio is a 200 MHz Windows 98 computer with a touch screen, a keyboard, a 1.6 GB hard drive, and an E-mu 8710ps PC Card sound card for MIDI synthesis and audio I/O. It also includes a USB port—all in a two-pound, eight-inch-wide package. But it still wasn't shipping at press time.

Microsoft's palmtop operating system, Windows CE, is slated to support both wave playback and DirectSound by the time you read this. By early 2000, Windows CE will also support MIDI playback through DirectMusic. There are already some shareware MIDI players, MP3 players, and other music utilities available at Web sites such as CEMonster (www.cemonster.com), but for the foreseeable future, Windows CE music support will remain playback-only.

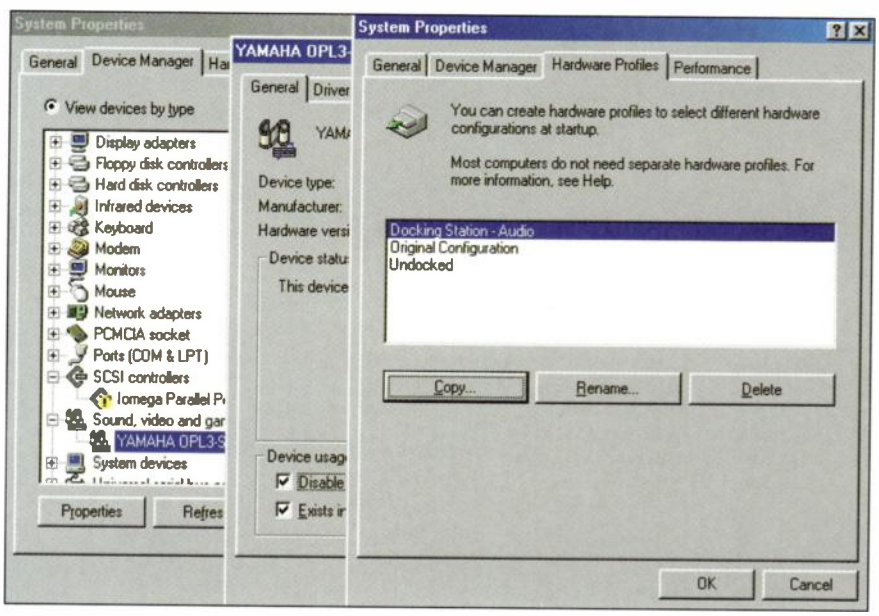

FIG. 8: Using the Windows Device Manager to disable his laptop's built-in audio, author Brian Smithers frees up an IRQ and two DMAs for use by the audio hardware attached to his docking station. This configuration can be saved as a Windows Hardware Profile.

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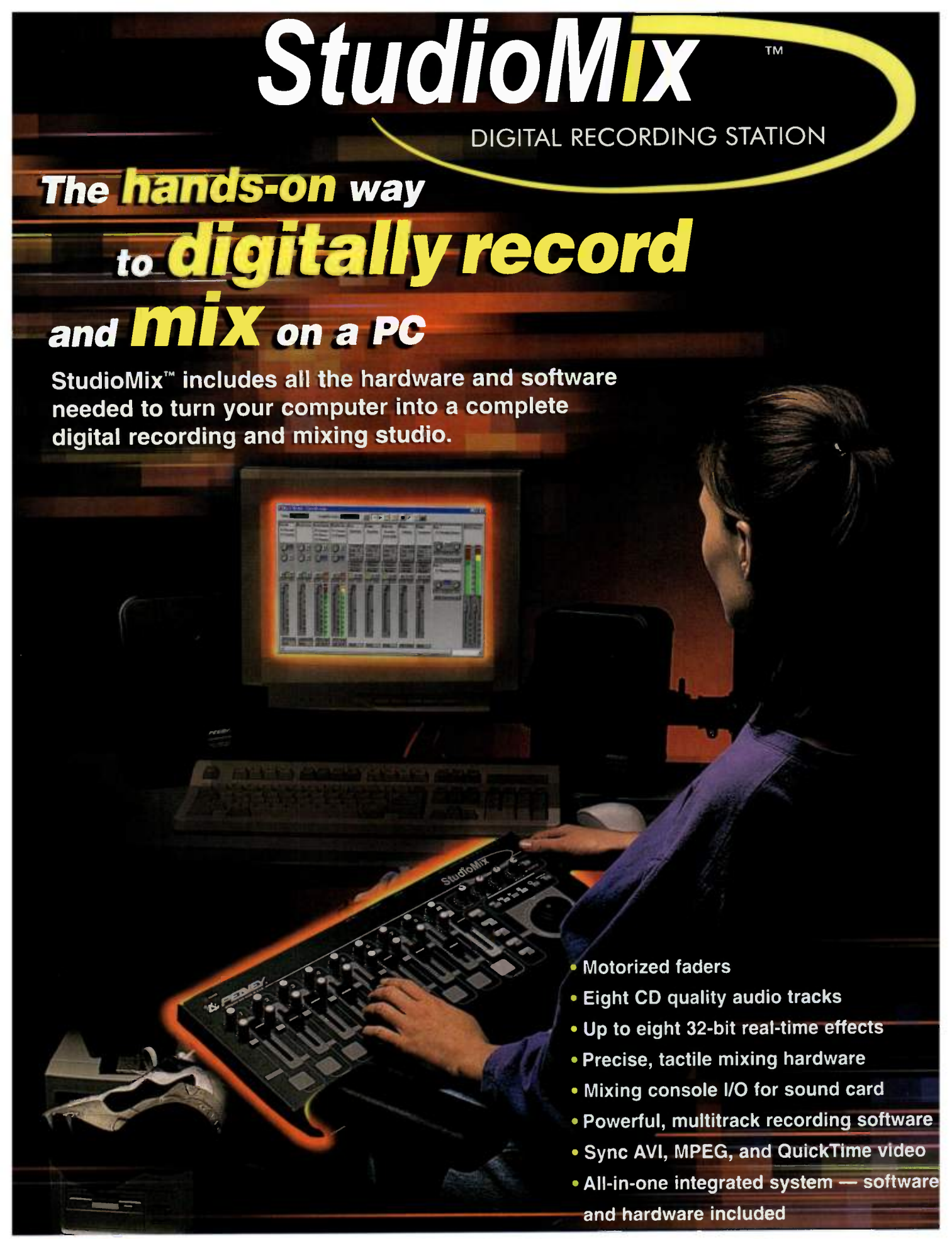

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bus. It will also let you back up audio tracks to SCSI CD-R, tape, or other removable media to free up space on your internal drive.

Sharing the desktop. So how does it all balance out? Your notebook system is less upgradable than a desktop, and you'll need to invest in a docking station or expansion chassis if you want to use PCI cards. If mobility matters to you, those may be very manageable trade-offs.

Virtual Piano isn't going to replace your Kurzweil PC88, but it fits much better in a backyard hammock.

Suppose, however, that for some reason you are unable or unwilling to part with your desktop setup. Does going mobile mean that you'll have to duplicate all of your existing hardware with notebook equivalents? Not necessarily.

First, keep in mind that USB devices are equally at home with a laptop or desktop. Make your next audio I/O upgrade an Opcode DATport with a Midiman Flying Cow or other external converter, and your desktop and laptop will share equally in the sonic rewards. The same principle will apply to FireWire devices as they proliferate, although currently Apple is way ahead of PC manufacturers in this area.

The one additional challenge is getting material, especially huge audio files, back and forth between the two machines. If you use the same backup medium for both, it's as easy as shuttling Jaz disks, tapes, or CD-Rs. If your notebook has an infrared port, as most do these days, you can add a similar port to your desktop pretty cheaply and transfer files through the air. A direct cable connection is reliable but slow. If you're willing to invest a little time and money, one of the best ways to transfer files is to link the two computers via Ethernet. Such a network connection is fast and dependable, but currently a bit easier for Macs than PCs.

The World Is Your Desktop

Okay, I confess. Occasionally, when it seems like companies are on the verge of giving away 10 GB hard drives with every tank of gas, I start to wonder whether a desktop system might be worthwhile. For raw power, desktops have the bang-for-the-buck advantage. But "bang" can't always be measured in power alone. Often, the most valuable tool is the one that's at hand when it's needed.

For example, when I needed a part for piccolo trumpet in A instead of B-flat as I had written it, I grabbed my laptop, transposed the part, and printed it on the spot at the rehearsal (through a nearby fax machine!). Another time, when my alma mater was searching for a new fight song, my muse waited until I was boarding a plane to deliver a melody. As soon as the captain gave the okay, I fired up my notebook and developed the idea. I orchestrated it and copied the parts in my parents' backyard hammock and sent them on to my old school.

Ultimately, this is why your next computer should be a laptop. When your mind is running free, the last thing you want is a studio that can't even get out the door. As the heart of your studio or as an adjunct to your desktop setup, a laptop lets you be ready when inspiration strikes. Just think: the next time someone asks you to write something evocative of sunset at the beach, you won't have to imagine the sand between your toes. ◆

BRIAN SMITHERS IS A MUSICIAN, CONDUCTOR, AND ARRANGER AT DISNEY WORLD. VISIT HIS WEB SITE, HTTP://MEMBERS.AOL.COM/NOTEBOOKS1, FOR EVEN MORE TIPS ON MAKING MUSIC WITH LAPTOP COMPUTERS.

Multichannel I/O the Hard Way

Nobody makes multichannel audio hardware for laptop computers—yet. But that didn't stop me from recording a brass quintet with two close mics and two ambient ones. Using four portable mic preamps, I routed the primary mics into my PC Card sound card and the ambient ones into my laptop's line inputs. By keeping the ambient tracks low in the mix, I was able to hide the noisier characteristics of my notebook's stock audio circuitry.

Phat City

David Javelosa—game composer, Yamaha XG evangelist, and author of *Sound and Music for Multimedia* (IDG Books Worldwide, 1996)—suggests tucking a Keyfax Phat.Boy MIDI controller in with your notebook. "A laptop running a soft synth with a Phat.Boy hooked up gives you real-time control like a classic analog synth," he says. The Phat.Boy's 13 knobs are preconfigured to control such parameters as filter cutoff and resonance on XG, GS, and AWE synths (such as the E-mu 8710). Keyfax's new 4-knob Baby Phat is even more travel friendly and can be powered from the MIDI port.

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A Musician's Guide to USB

By Scott Wilkinson

A new peripheral-connection standard is headed your way, so get ready to hop on the bus.

When I worked as a product specialist for Roland some 15 years ago, one of my primary jobs was helping customers who called about problems they were having with Roland products. One problem in particular came up over and over again: installing an MPU-401 MIDI interface in a PC. The MPU-401 consisted of a plug-in card and an external box, and it required the user to assign a particular IRQ, I/O address, and DMA to the interface. Often these settings were already in use by the PC's mouse or other serial devices. Fixing the conflict usually involved several cycles of opening the case, fiddling with tiny DIP switches, closing the case, booting the computer, running some tests, shutting the computer off, and trying different settings until everything worked.

Fortunately, the days of such tedium seem to be over thanks to a new peripheral-connection standard called Universal Serial Bus. USB offers many advantages over the old-style serial buses found on PCs and Macintoshes and solves many of the problems associated with connecting peripheral devices to computers.

That's good news for desktop musicians, who rely on peripherals such as MIDI interfaces and digital audio I/O boxes. It's especially important to understand USB if you're a Mac user, because the new G3 Macs have abandoned serial and SCSI ports in favor of USB. The PC seems to be migrating rapidly toward USB as well.

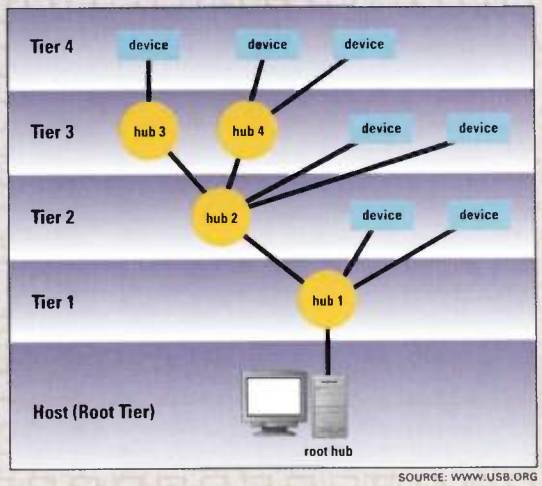
USB Basics

A USB system consists of one *host* (the computer) and one or more USB devices. USB is a *polled bus:* the host polls (asks) the connected devices about any pending activity and initiates all data transfers. The underlying concept is to give the host the ability to communicate directly with connected devices instead of blindly beaming data out a port.

USB is serial, like RS-232/422, IEEE 1394, and MIDI: data is sent one bit at a time. The maximum bandwidth is currently 12 megabits per second (Mbps). That's much faster than "legacy" serial connections, which max out at about 1 Mbps, but a lot slower than IEEE 1394, which can accommodate 100 to 400 Mbps (see the sidebar "What's Up with FireWire?"). USB also provides a low-bandwidth option of 1.5 Mbps for certain devices that don't need the extra speed, such as a mouse.

For comparison, SCSI—which is parallel rather than serial—can sustain average data rates between 2 and 14 Mbps, with maximum momentary rates between 5 and 80 Mbps, depending on the type of SCSI being used.

Join the hub. You can connect up to 127 USB devices to a single computer port. The devices aren't daisy-chained, as in a SCSI configuration; instead, they're connected to one or more multiport *hubs* (see **Fig. 1**). To get additional ports, you can simply attach additional hubs. A device can also include an integrated hub, making it physically easier



SOURCE: WWW.USB.ORG

FIG. 1: A USB system includes one host (the computer) and a number of hubs and devices, arranged in a tree-branch or tiered-star configuration.

to connect other devices to the system.

Because USB is a serial bus, its cables can be relatively simple. Unlike MIDI, USB is bidirectional, so the cable includes two signal wires, one to carry data in each direction. The cable also includes a ground conductor and a +5 VDC one. The latter can provide up to 500 mA of power to each device in the system. (A bus-powered hub can supply only 100 mA.) If a device needs more juice than that, it must have its own power supply.

The maximum cable length between any two devices is five meters (16.4 feet). You might find passive cable extenders, but they should not be used; USB was not designed to accommodate them. Unlike SCSI, USB requires no termination, which simplifies hookup considerably.

To prevent circular hookups, USB cables have a different connector at each end. These are called Type A and Type B (see Fig. 2). The flat Type A connectors are used at the "upstream" (host/hub) end, and the squarish Type B connectors are used at the "downstream" (device) end. A host typically has two to four Type A connectors, and a hub typically has one Type B and several Type A connectors. A device might have one Type B port or a permanently attached cable with a Type A connector on the end.

Finally—plug and play. One of the most convenient things about USB is that it supports *hot plugging;* that is, you can connect and disconnect devices while the host computer is on. In addition, there's no need to open your computer to install anything. The host automatically detects newly connected devices and assigns a unique address to each one on the fly. Each device provides information about what it is and what it does, and the host keeps track of all connected devices. It can even keep track of multiple identical devices if the software driver supports this feature.

USB devices can, in theory, be shared between Macs and PCs with the appropriate software drivers (more on drivers in a moment). However, there can be only one host (computer) in any USB system; you can't have a Mac and PC in the same system.

System Requirements

Of course, the host's operating system must support USB. For PCs, Windows 98 is strongly recommended. Windows NT 4.0 does not include USB support, but Windows 2000 will.

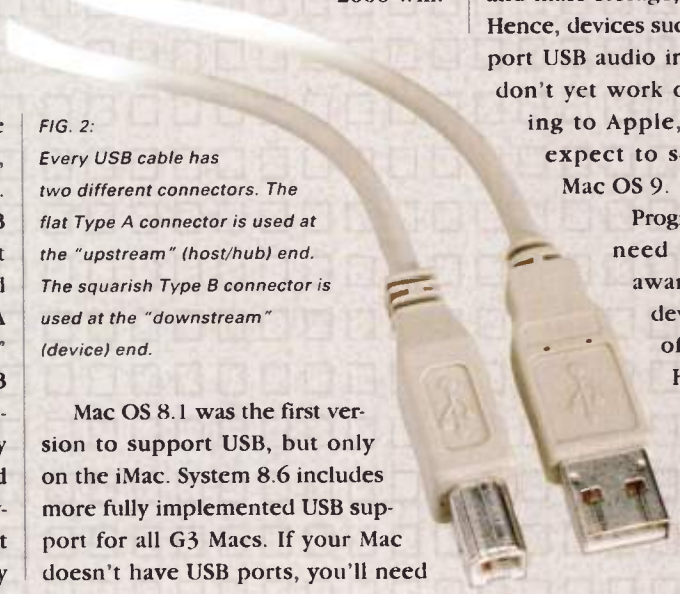


FIG. 2: Every USB cable has two different connectors. The flat Type A connector is used at the "upstream" (host/hub) end. The squarish Type B connector is used at the "downstream" (device) end.

Mac OS 8.1 was the first version to support USB, but only on the iMac. System 8.6 includes more fully implemented USB support for all G3 Macs. If your Mac doesn't have USB ports, you'll need to install a USB adapter card as well as Apple's *USB Adapter Card Support* software (free at http://asu.info.apple.com). Apple recommends using machines that have native USB capabilities (see the sidebar "Serial Killers").

You might have heard of some problems in early Windows USB systems. For example, some graphics cards grab the entire PCI bus, preventing any USB activity. Also, a few bad USB chips have been shipped. According to Microsoft, one version of a popular BIOS hangs when USB devices are plugged in at startup. However, most of these problems have been solved by now. Windows users can run *USBReady* (which is free from www.fileworld.com/magazine) to diagnose their systems.

Class Action

The USB spec defines a variety of functional *classes* of devices, such as the audio class, mass-storage class, printer class, input class (for example, keyboards), and locator class (for example, mice or graphics tablets). If your OS includes class drivers, you won't need specific device drivers for devices in those classes; if not, individual device drivers are required.

Individual drivers are also needed for less common devices or those with unique functions. Mac OS 8.6 includes class drivers for hubs, keyboards, mice, and mass storage, but none for audio. Hence, devices such as Opcode's Sonicport USB audio interface (see Fig. 3) don't yet work on the Mac. According to Apple, however, you can expect to see audio drivers in Mac OS 9.

Programs themselves don't need any particular USB awareness; the class and device drivers take care of business for them. However, USB-aware applications can provide enhanced capabilities. For example, a USB-savvy sequencer might be able to determine

the polyphony and available sounds on a connected USB sound module. Therefore, it seems reasonable to expect such applications in the near future.

Making Music

Of course, desktop musicians are most interested in the musical applications of USB. They want to know about the USB MIDI interfaces that are now appearing in the marketplace. What about sending digital audio over USB? Before I can answer these questions, you need to understand how USB sends data over the bus.

USB can transmit data in four ways: *control, isochronous, interrupt,* and *bulk.* Every millisecond, the host initiates control, isochronous, interrupt, and bulk transfers (in that order of priority) as needed. Control transfers are used to configure a device when it's first attached to the bus and for other device-specific control purposes.

Isochronous (pronounced "eye-*sock*-ro-niss") transfers are used for continuous, real-time data such as audio. A specific amount of bandwidth is reserved for each device using this type of transfer. Isochronous data transfer exhibits low *jitter* (timing inaccuracies within the stream) at the cost of increased overall *latency* (delays in the entire stream). If any data is lost, it is not recovered; streaming continues regardless of missing data.

Bulk transfers are used for relatively large "bursts" of data that require varying amounts of bandwidth. This type of transfer can use whatever bandwidth is available—that is, whatever is not being used or reserved by isochronous transfers. If the bus is busy, jitter may become a problem (some data may be delayed), but delivery is practically guaranteed thanks to check-sum error correction and retransmission (up to three times) if necessary.

Interrupt transfers are similar to bulk, but they are used for small amounts of data, such as mouse coordinates. They also support retransmission in the event of errors.

FIG. 3: Opcode's stereo Sonicport offers both analog and digital audio I/O. No wall wart is needed: the device is powered by USB.

Roughly 10 percent of the total USB bandwidth is reserved for control and interrupt transfers to make sure that basic functions—such as mouse and keyboard input—are not disrupted by large bulk transfers or isochronous bandwidth reservations. That leaves

USB Music Products

MANUFACTURER	PRODUCT	PRODUCT TYPE	COMPUTER PLATFORM	SPECIAL FEATURES	PRICE
Altec	ADA 70	Powered monitor speakers	Win 98		$149.95
Emagic	AMT8 Active MIDI Transmitter	8 x 8 MIDI interface	Win 98, Mac OS 8.5	RS-232 and RS-422 ports	$499
Mark of the Unicorn	FastLane USB	2 x 2 MIDI interface	Win 98, Mac OS 8.5		TBD
Mark of the Unicorn	Micro Express USB	4 x 6 MIDI interface	Win 98, Mac OS 8.5	MIDI/SMPTE interface	$295
Mark of the Unicorn	MIDI Express XT USB	8 x 8 MIDI Interface	Win 98, Mac OS 8.5	MIDI/SMPTE interface, patch bay, merger with sync	$395
Mark of the Unicorn	MIDI Timepiece AV-USB	8 x 8 MIDI interface and synchronizer	Win 98, Mac OS 8.5	Merger plus sync for 2408, 1224, ADAT, Pro Tools, and video	$595
Midiman	USB MIDIsport	2 x 2 MIDI interface	Win 98, Mac OS 8.5	MIDI Thru button	$129.95
Opcode	DATport	Audio interface	Win 98	RCA S/PDIF connectors	$249.95
Opcode	MIDIport 32	2 x 2 MIDI interface	Win 98, Mac OS 8.6		$149.95
Opcode	Sonicport	Audio interface	Win 98	RCA S/PDIF and ⅛" analog I/O	$299.95
Opcode	Sonicport Optical	Audio interface	Win 98	Optical S/PDIF and ⅛" analog I/O	$299.95
Roland	MA-150U	Powered monitor speakers	Win 98	RCA in; can be used analog	$245
Roland	SC-8850	MIDI synthesizer	Win 98, Mac OS 8.5	128-note polyphonic, 64 MIDI channels	TBD
Roland	UA-100 Audio Canvas	Audio/MIDI processor	Win 98	Vocal transformer/harmonizer	$595
Roland	UA-30 Audio Canvas	Audio/MIDI processor	Win 98	Vocal transformer/harmonizer	TBD
Roland	UM-2 (MPU-32)	2 x 2 MIDI interface	Win 98, Mac OS 8.5	2 MIDI I/O	TBD
Roland	UM-4 (MPU-64)	4 x 4 MIDI interface	Win 98, Mac OS 8.5	4 MIDI I/O	$295
Virtual DSP	MIDI Oxygen 44	4 x 4 MIDI interface	BeOS		TBD
Yamaha	YST-MS55D	Powered monitor speakers	Win 98		$199.95

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about 11 Mbps for other devices—more than 350 times the 31.25 kbps bandwidth of MIDI. That's theoretically enough to transmit 15 channels of 16-bit, 44.1 kHz digital audio (or 10 channels at 24-bit, 44.1 kHz resolution). In reality, USB can handle only 6 to 8 channels of audio (unless data compression is used). This limit is due to computational overhead and the headroom that designers must build in to accommodate other devices on the bus.

Roland's Sound Canvas SC-8850 USB sound module supports 64 MIDI channels internally. Dual MIDI jacks on the back let you access an additional 32 channels on external instruments.

MIDI Options

MIDI is mentioned within the audio device class, but it will soon have its own class definition—probably by the time you read this. Until the class definition is finished, however, manufacturers of USB MIDI devices must include individual device drivers with their products, and they can use any data transfer method they wish. (To accommodate special functions, manufacturers will probably continue to provide custom drivers even when the spec is finalized.)

The current USB MIDI devices from Midiman, Opcode, and Roland use bulk and interrupt data transfers. Bulk transfer can handle large amounts of data, it works even when the bus is relatively busy, and data is nearly guaranteed to arrive without lost bytes. This is critical for MIDI data; if a Note On is sent but the corresponding Note Off is lost, you end up with a stuck note. In addition, when MIDI is not being used, the bus is available for other devices. There is a possibility of jitter if the bus is very busy, but this problem seems to be rare, and you can avoid it by reducing other devices' bus usage.

On the other hand, Mark of the Unicorn uses isochronous and interrupt transfers for its USB MIDI products. With isochronous transfer, each device is guaranteed a certain amount of available bandwidth all the time. This method suffers from almost no jitter, but it does not guarantee data delivery. However, MOTU reports that it has done extensive testing and found that data loss occurs only if users do something silly like unplugging a USB cable while playing a sequence. MOTU has also run MIDI systems containing both bulk and isochro-

nous interfaces with no problems.

There is some disagreement among members of the MIDI Manufacturers' Association (MMA) about which data transfer method is best for MIDI, and even about which *factors* determine which one is best. For example, if a Note Off is lost in a strictly configured MIDI system, Active Sensing would shut off any stuck notes. A similar function could be implemented with isochronous transfers over USB.

The root of the dilemma is the fact that MIDI data must share USB with other devices. In a traditional MIDI system, the MIDI cable is dedicated to MIDI, so it is unlikely that data will be lost. Because of this, manufacturers have been free to concentrate on accurate timing without concern for guaranteed delivery. According to Tom White, president of the MMA, many manufacturers believe that this is a fundamental reason for MIDI's success, and we should be very careful about how we design future systems that can be interrupted.

Interestingly, the legacy serial interface is actually faster than USB when the overall data rate is low; for example, it takes an average of 0.5 ms to send a single byte over USB—roughly twice as long as it takes with legacy serial. However, USB kicks legacy serial's butt when the data rate is high: it takes about 1 ms to send a MIDI Note On message over legacy serial, but USB can

Serial Killers

USB is likely to become ubiquitous within a year or two. For now, it's important to know how to connect "legacy" devices to USB computers and USB devices to older, non-USB computers.

Connecting legacy devices to new USB computers is relatively easy; several *mapper* products are available to convert USB to legacy serial, parallel, Ethernet, SCSI, and other data formats. Older serial MIDI products (such as multiport interfaces) require an *externally clocked* USB-to-serial mapper; not all adapters have this feature. According to Opcode, the Griffin gPort and Gee Three Stealth Port work well with its older serial products. Both of these mappers replace the blue G3 Mac's internal modem with a legacy serial port. Mark of the Unicorn reports success with Megawolf's Romulus and Remus PCI adapters, as well as with Keyspan's SX-Pro card.

Connecting USB devices to non-USB computers is more difficult because USB is so host-centric. There are PCI cards that add USB ports to older computers, but the operating system and BIOS must be updated to support USB as well. It's not generally a good idea to use older computers with USB; if you want to use USB products, it's much better to get a newer computer with native USB capabilities.

What's Up with FireWire?

The ascension of USB might seem surprising when you consider that another high-speed serial interface, IEEE 1394, has been bandied about for years as the next connection standard. Like USB, 1394 is hot-pluggable, and it's even faster: 100 to 400 Mbps compared with USB's 12 Mbps. In addition, 1394 needs no host—it uses *peer-to-peer* organization—and it can be implemented with electrical conductors or fiber-optic cables. (Apple's implementation of 1394 with electrical conductors is called FireWire.)

So why wasn't 1394 adopted as the only interface on the new G3 Macs? Why isn't it becoming commonplace on PCs? Perhaps the most important reason is that 1394 is significantly more expensive to implement than USB. In addition, many products don't need that much bandwidth. Would you pay $100 for a 100 Mbps mouse?

On the other hand, applications such as video and multitrack audio would greatly benefit from 1394. Many companies are now working on 1394 products that should make their way to the marketplace sooner or later.

One of the most dedicated 1394 developers in the music industry is Yamaha, which has been working on its implementation, called mLAN, for several years. We should see product introductions in 2000.

A USB 2.0 spec is also in development. It's slated to deliver data at either 120 or 240 Mbps—10 or 20 times the current bandwidth. However, such high speeds necessitate building termination into the chain. To maintain backward compatibility with unterminated USB 1.1 devices (a stated goal of the 2.0 spec), manufacturers will have to do some fancy engineering. USB 2.0 systems are expected in late 2000, but IEEE 1394 may end up being the bus of choice for heavy-duty audio and video.

send 100 Note Ons in the same time. Microsoft intends its USB MIDI class driver to be accurate to within 1 ms well over 99 percent of the time.

Digital Audio

The USB audio class encompasses powered speakers (including subwoofers), microphones, telephones, CD players, DATs, multitrack recorders, synthesizers, and so on. It also supports compressed and uncompressed digital audio, including S/PDIF, MPEG, and Dolby AC-3. Controls include volume and many types of processing, such as compression and EQ.

The isochronous transfer method is used for digital audio because audio demands a much more constant data flow than MIDI. For example, USB sends 192 bytes/ms for 16-bit, 48 kHz stereo audio. At the lower 44.1 kHz rate, it sends 176 bytes/ms for 9 ms, then 180 bytes during the 10th millisecond.

One of the biggest advantages of running audio over USB is that it allows manufacturers to take the analog audio circuitry out of the electrically noisy computer chassis. This is especially beneficial for laptop users, who can now hook up USB speakers (such as Yamaha's YST-MS55D units) for clean playback, and use a compact USB audio interface (such as Opcode's Sonicport) for recording.

USB and U

Clearly, USB is a growing force in the computer world, and desktop musicians will have little choice but to use it before long. (During this transition period, it is possible to use older serial products with USB computers, and USB products with older non-USB computers; see the sidebar "Serial Killers.")

Although there may be some growing pains, USB is ultimately a very good thing for desktop musicians, offering a relatively speedy, inexpensive, easy-to-use connection standard for all sorts of musical devices. So what are you waiting for? It's time to get on the bus! ◆

SCOTT WILKINSON IS A CONTRIBUTING EDITOR AT EM. HE THANKS BILLY BRACKENRIDGE (MICROSOFT), JIM COOPER (MOTU), MIKE D'AMORE (YAMAHA), PAUL DE BENEDICTIS (OPCODE), RICH FRANTZ (OPCODE), MIKE KENT (ROLAND), MIKE SHEBANEK (APPLE), TOM WHITE (MMA), AND RANDY WILSON (OPCODE) FOR THEIR HELP WITH THIS ARTICLE.

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The Desktop Guit

Strap On

By Mark Nelson

Whether you play acoustic or electric, a computer can take your music further.

We guitarists are finally getting our due from the desktop music revolution. Computers are making it easier for us to take on all sorts of rewarding musical projects, such as recording, learning licks, printing notation, creating MIDI-based music, and even capturing that elusive killer tone—all without leaving the comfort of our fretboards. (Hey, it's a guitar article; I have to use the phrase *killer tone* at least once.) Here I'll explain the many benefits of introducing your guitar to your computer. I'll also profile some hot new guitar technology and share tips on using it to enhance your music.

Play Better

No amount of production and editing is worth beans if you can't play. But your computer can be one heck of a guitar teacher, regardless of your style, skill level, operating system, or balance sheet.

While many fine instructional CD-ROMs are available from such companies as Play Music, PlayPro, and Ubi Soft, the inexpensive G-Vox Guitar system is especially intriguing. In addition to the software, you get an interface box that connects your guitar to a Windows PC, allowing the system to critique your playing. The package includes a hexaphonic pickup that attaches to any steel-string electric or acoustic guitar. Every note you play shows up onscreen in real time.

Beginners should definitely check out G-Vox's *Guitar 101, the Fender Method* for a thorough grounding in the basics. (A demo version of the program is included with the G-Vox system.) *Guitar 101* takes advantage of the G-Vox hardware to analyze your playing, but it can also run independently.

Hey, it's a guitar article; I have to use the phrase *killer tone* at least once.

If you're looking to expand your repertoire while copping some hot licks, try the G-Vox *SongBooks*, three add-on programs that monitor your progress as you play along with hits from Eric Clapton, the Police, or B. B. King.

Software-based chord finders, transposition tools, and even tuners are out there, waiting to help you become a better guitarist. Many are either inexpensive shareware or free. Start your search on the Web at www.download.com (navigate to Home and Personal, then choose Music) or Harmony Central (www.harmonycentral.com/Guitar).

arist

One Thing after Another

MIDI sequencing has long been the province of keyboard wizards, but it offers big advantages to guitarists, too. Basically, *MIDI* (Musical Instrument Digital Interface) is a way to transmit a description of a musical performance electronically. In a typical setup, a musician might play a series of chords on a synthesizer keyboard. With every keypress, the synth sends out MIDI data that specifies which notes were hit and how hard. If the synth is connected to a computer (through a *MIDI interface*), a *sequencer* program can record those performance instructions. Clicking the sequencer's Play button (most sequencers resemble multitrack tape recorders) will transmit the data through a second MIDI cable back to the synth—or another synth—re-creating the performance.

This process can be repeated over and over (perhaps with different sounds, depending on the synth), allowing a single player to build up complex orchestrations. And because the sequencer records only performance instructions, not audio signals, it's a simple matter to edit the performance. You can drag a flubbed note to the correct pitch, for example, or *quantize* a sloppy drum part so it plays on the beat. You can try out different tempos or even different sounds.

Until recently, guitarists had only two choices if they wanted to experience the joys of sequencing: either invest in a MIDI guitar system (see the sidebar "Exploiting MIDI Guitar") or learn to play keyboard.

Several innovative guitar-oriented sequencers have stepped in to fill the gap. Scott Lahteine's *FretPet,* a Macintosh program that's a steal at $15, uses an onscreen guitar fretboard as its primary interface. Select a tuning, click on the frets to create a chord, and enter a picking pattern into the sequencer. Wanga wanga, instant song. *Power Chords Pro,* from Howling Dog Systems, ups the ante on the Windows platform with a drum-machine-style grid for creating grooves, a pattern-based sequencer, and note entry from your mouse onto a guitar fretboard. You can download a free, fully functional copy of an earlier version at www.howlingdog.com.

What's the Score?

Notation-printing programs are powerful music tools in their own right. Even entry-level programs are guitar friendly, often supplying chord symbols and diagrams you can add to your lead sheets. All let you enter notes with a mouse, but entry from a MIDI guitar controller or SMF (Standard MIDI File) is faster and far more powerful.

Need tablature? Programs like Passport's powerful *Encore* and Coda's *Finale* (both Win/Mac) create tablature from MIDI files. Not only is that useful for writing scores, but it's also a cool educational feature. One trick I use is to input a melody and then have the

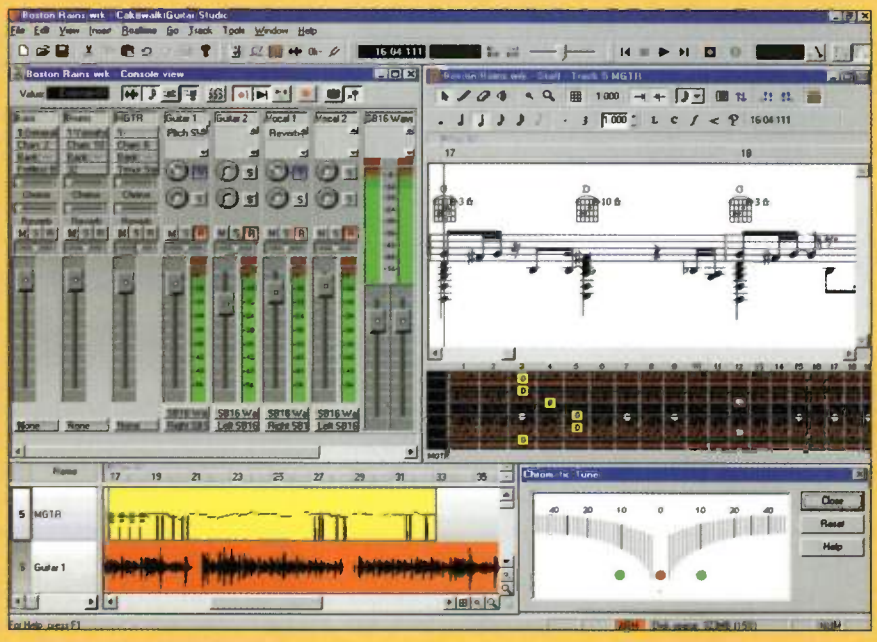

FIG. 1: Can't play keyboard? Cakewalk Guitar Studio *lets you enter notes in a fretboard window. It's an 8-track digital audio recorder, too.*

FIG. 2: In addition to software emulations of Boss effect pedals, Roland's UA-100 USB audio interface has a built-in vocal transformer program.

software place it on a tab staff. It's a snap to transpose the notes onscreen and try out alternate tunings on my guitar until something clicks.

A few programs (such as Nicolas Manel's shareware *Guitar Studio,* not to be confused with Cakewalk's product of the same name) will convert onscreen tablature to MIDI files—a handy way to create realistically voiced guitar tracks in your sequencer.

Control Freak

Guitarists should take note of one more MIDI trick. Many preamps and effects devices have MIDI jacks. With your computer and an *editor/librarian* program, you can back up your custom presets to disk. In fact, many devices have parameters that can be accessed only via computer. And I can't even begin to describe what you can do with real-time MIDI control of your effects during a mix.

Rage Against the Machine

Okay, but we're guitarists, dang it, and we want to record our guitars, not just a bunch of sissy MIDI stuff. Relax. It's a piece of cake. All you need is software that lets you record audio, and some way to stuff the sound of your beloved axe into your computer. (For more information, see "Hard-Disk Recording Handbook" on page 42.)

On the software side, choices abound. *Guitar Studio* from Cakewalk (see **Fig. 1**) is one program that speaks our language. It combines a guitar-oriented MIDI sequencer with an 8-track audio recording studio. To create MIDI parts, you enter notes on an onscreen fretboard or via a MIDI controller. During playback, *Guitar Studio* scrolls through a notation window, highlighting each note as it's played—handy for testing your sight-reading skills. It simultaneously highlights notes on the fretboard.

The combination of MIDI and audio provides an elegant, powerful music-production system. Command the Song Wizard to generate MIDI backing tracks, then play along. Process your guitar sound with the built-in effects or any DirectX plug-in. Taking "plug and play" to the max, Cakewalk thoughtfully includes a ¼-inch-to-⅛-inch guitar-cord adapter so you can patch right into your sound card.

Little Boxes, Little Boxes

If squeezing your guitar signal into the computer through a Walkman-style jack won't cut it, try a dedicated preamp/processor/interface like the Rocktron PC Preamp. Plug one end into your guitar; plug the other into your computer. Instant tone.

Or check out the Roland Audio Canvas UA-100, distributed by Edirol. It's

Guitar Recording Tips

Want a huge sound? Crank up a tiny amp to the breaking point. Place one mic in front of the speaker and another a few feet away. No one will ever know you were playing through 5 watts. You can lay down great guitar tracks with the amp close-miked inside a very full hall closet. (Maybe last winter's overcoats mimic the sound of sweaty nightclub patrons.) Don't forget to experiment with aiming the mic toward different parts of the speakers. Try the cone, the edge, or slightly off center. Check out each individual speaker to see which sounds best.

FIG. A: Just because you're recording into a computer doesn't mean you have to abandon tubes. Lexicon's Signature 284 recording amp serves up superb tone and effects.

On a recent demo, I couldn't get a good sound from my amp no matter what I tried. I finally aimed it into a corner and built a padded enclosure around it with couch cushions, blankets, and pillows. I miked it from the open back of the cabinet. Weird? Yes. But it worked.

If cranking up the Verb-O-Doom stack in your bedroom studio at 4 a.m. is not an option, the obvious solution is to plug into something that sounds like an amp to your computer but not to your neighbors. Simply plugging a stompbox into your mixer won't give you the whomp. But combining your favorite footpedal with a tube preamp may be just the ticket.

Believe it or not, pro studios often achieve blazing guitar tone with direct-recording gear. Tech 21's SansAmp, DigiTech's 2120 Artist VGS, Rocktron's Voodu Valve On-Line Guitar Preamp, and Lexicon's amazing Signature 284 all-tube stereo recording amplifier (see **Fig. A**) are just a few options. Big sound *does* come in small packages.

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Tech Specs

PCI card
- DSP: 28-bit internal processing RISC based Dream processor
- 4MB RAM on board. Expandable to 36MB RAM

External rack
- 8 full-duplex inputs / 4 outputs (1/4" unbalanced)
- 20-bit Burrbrown™ DAC / ADC converters
- S/PDIF: Consumer mode master or slave 32 / 44.1 / 48 KHz
- MIDI interface = In / Out thru Din

An external rack with 8 full-duplex inputs, 4 outputs and a studio full of other pro connections. Includes S/PDIF (optical & coaxial) in and out that cards priced up to six times more lack. DirectSound3D, A3D, GM and Roland GS support. Bundled with unrivaled software. With the **Maxi Studio ISIS**, you'll be far out of your mind, and deep into pro music.

Console 8/4

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FIG. 3: Steinberg's Red Valve-It *plug-in adds tube tone to VST-compatible audio software such as Steinberg* Cubase, *Emagic* Logic Audio, *and Opcode* Vision DSP.

an all-in-one interface box for both MIDI and audio, and it's optimized for guitar and vocal recording. The UA-100 includes analog-to-digital converters and connects via the computer's digital USB port—no sound card needed. (It currently supports only Windows PCs, but Mac drivers are promised.) At about the size of a summer novel, the UA-100 sports an impressive array of ins and outs: two ¼-inch inputs for guitar and high-impedance mic, a headphone jack, stereo analog RCA I/O, two sets of MIDI I/O, and an optical S/PDIF digital audio output for mixing to DAT or MiniDisc.

Effects processing takes place inside the UA-100, leaving your CPU free for other tasks. The knobs on the unit's front panel give access to only a handful of effects, which seem designed mostly to demo the unit in the showroom. Real control comes via software. The unit shines for guitar processing. Roland thoughtfully included software emulations of its popular Boss guitar effects processors for your tone-bending pleasure. Additional effects include reverb and delay, a microphone simulator, two-part harmony, and even a voice transformer (see **Fig. 2**).

I was skeptical of the unit at first; neither the limited manual nor my initial test of the effects did much to engender confidence. But once you fire up the UA-100's controller software, another picture emerges. The processing is limited—you must choose between using multiple stompbox-style effects or a single high-quality reverb—yet every effect I tested was of good quality and offered a tremendous amount of control. If you're thinking, "Wow! I can set up a portable recording studio with my laptop," you're dead-on. I know I want one.

Tone Zone

Recording great electric guitar tone from an amplifier is one of the most difficult tasks an engineer faces. (Convincing the guitarist that you *have* recorded great tone is another.) Even with computers in the equation, it's useful to know some tricks of the trade (see the sidebar "Guitar Recording Tips").

Thanks to the latest in digital signal processing, we're witnessing the dawn of a whole new approach to recording premium sound: digital *modeling* (simulation) of classic amplifiers and guitars. Roland's innovative VG-8 virtual guitar system set the stage; now amplifiers from Line 6, Crate, and Johnson re-create the sound and feel of a whole roomful of tweed-and-black boxes. Connect the direct outs to your computer and wail away.

But what if you don't want to commit to a particular tone until after you hear the rest of the tracks? Maybe what you thought was a speed-metal/thrash-punk power ballad will morph into lite jazz *mit spritz*. Don't laugh; it's happened. Luckily for you, chances are that whatever audio software you use supports *plug-ins*, cool mini-applications that add capabilities to their host software and are cropping up everywhere. With plug-ins, you can record clean guitar sound and process it later.

Plug-in tube simulators like Mark of the Unicorn's *PreAmp 1* and Steinberg's *Red Valve-It* (see **Fig. 3**) add warmth and a hint of distortion. Almost everybody has plug-ins that offer such standard guitar-processor fare as chorus, reverb, tremolo, and flange. *Audio FX 2*, from Cakewalk, brings 32-bit, real-time

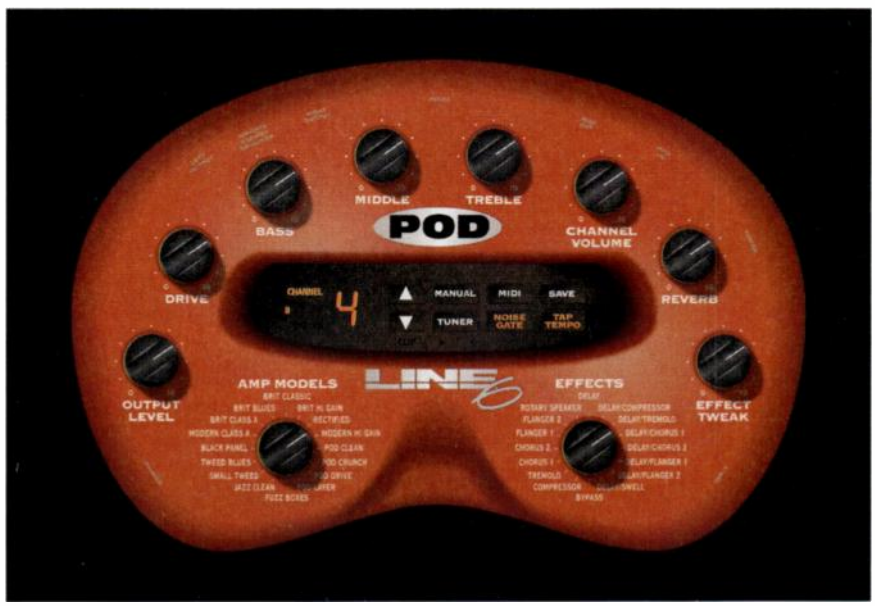

FIG. 4: Insert Line 6's Pod between your guitar and your sound card to record through stunning amp simulations.

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Exploiting MIDI Guitar

Ever since Link Wray deliberately shredded his speaker cone, guitarists have looked to technology for a bold new voice. With the development of MIDI, the race to create a guitar as flexible as a keyboard was on. Some of the early attempts were less than spectacular, but the dream remains the same.

After numerous fits and starts, workable MIDI guitars are now at hand. Lots of hands, actually. Packages from Roland (the GR-30), Shadow (the SH075), and Blue Chip Music (the Axon AX100) give guitarists unprecedented power without sacrificing the expressiveness that makes guitars so personal. Each of these packages has its strengths and weaknesses, as well as vociferous fans and detractors.

I suggest spending a few weeks reading the Digital Guitar electronic mailing list and cruising FAQs at the MIDI Guitar Unofficial Home Page before making a decision. (Go to www.egroups.com to sign up for the former and http://home.epix.net/~joelc/midi_git.html to view the latter.) One thing is certain: at a street price of under $100, the Fender G-Vox system is MIDI guitar for the masses—or at least the masses with a Windows computer.

Acoustic types can play, too. The magnetic pitch-to-MIDI pickups made by Roland, RMC, and Shadow will work on both electrics and steel-string acoustics. Nylon players will need to install individual piezo saddles—Shadow and RMC make them—and interface to either Shadow or Axon converters. The venerable Shadow GTM6 interface is a good option for classical guitarists; used units turn up online from time to time.

You can also buy guitars with the MIDI pickups built in, such as the Godin Multiac guitar (both steel- and nylon-string versions) and the "Roland-Ready" models from Ovation and Fender. Parker's MIDIFly—an electric with a built-in MIDI converter—and Virtual DSP's MIDIAxe are the ultimate in self-contained instruments (see **Fig. B**).

The trick is to transform a living, breathing guitar gesture into a MIDI message. Most systems use a hexaphonic pickup to send a signal from each individual string to a box that decodes the pitch and outputs MIDI data. From there you connect to a keyboard, sampler, computer, or any other device that surfs the data stream.

Why should you care? This very cool technology does a lot more than just make your guitar sound like a happy organ. For example, a MIDI sequencer doesn't care how a note is entered, so using your guitar to input synthesized horn lines or drum parts is easy.

Such power does come at a cost: a slight delay while the converter's tiny brain decides which note to trigger. This pause usually lasts between two and three cycles of the waveform, so lower notes exhibit slower response. Minimizing this slight delay is the Holy Grail of MIDI guitar technology, as a few days browsing any MIDI guitar newsgroup will attest. That's why some players prefer a dedicated guitar like switch controller such as the Ztar from Starr Labs (see **Fig. C**).

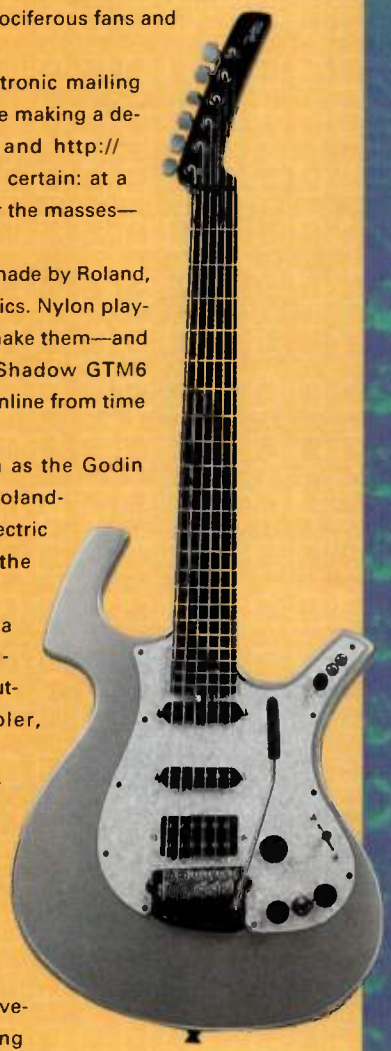

FIG. B: The Parker MIDIFly has an onboard pitch-to-MIDI converter.

One place MIDI guitar really shines is in transcription. Why waste time entering notes on the ivories when your keyboard chops suck? Or worse, one at a time with a mouse? It's so much easier to play into a notation program. Once notes are entered, you can transpose, harmonize, edit, and tweak to your heart's content. Then print out perfect copies of your masterpiece, sell them on the Internet, and retire to Tahiti. Just don't forget to thank me.

FIG. C: By employing switches instead of strings, the Starr Labs Ztar MIDI controller delivers fast response.

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amp and analog-tape simulations to Windows users via the DirectX plug-in architecture. Don't be afraid to try something off-the-wall: running a guitar signal through a vocoder plug-in such as Opcode's *Fusion:Vocode* might put the funk in the chicken, baby.

No, Not *Ant* Farm

The *Amp Farm* plug-in from Line 6 (Digidesign TDM format only) is in a class by itself. Imagine having a warehouse full of classic and boutique amps at your command—then imagine tweaking your sound on the fly. *Amp Farm* works nondestructively in real time, so you don't ever change the original file. That means you can try out as many settings as you like.

For those of us not blessed with a TDM-compatible system, Line 6 created Pod, a direct-recording preamp box with multi-effects processing and 16 amp simulations. Pod puts the power of *Amp Farm* into an unassuming little red blob (see **Fig. 4**). Plug a guitar into one end, your computer into the other, and proceed to lay down some serious *killer tone*. (Okay, I said it again. But I mean it this time. Pod is stunning.) Purists may debate whether the Small Tweed preset really sounds identical to a classic '50s Fender Deluxe, but I don't care. It sounds *good,* and that's fine by me.

It's a snap to transpose notes onscreen and try out alternate tunings until something clicks.

Incidentally, Pod excels at clean acoustic tones, too. Connect it to your computer via MIDI, fire up the included Emagic *SoundDiver* software, and you can access amp models and features not available from the front panel. You also get a free copy of Digidesign's *Pro Tools* 3.4. Good tone, lots of control, *and* digital recording—brings it all together, doesn't it?

The Global Band

One of the most promising developments on the horizon is real-time interaction over the Internet through services such as the Rocket Network (www.resrocket.com). With this system, you can jam with an old buddy across the continent, or "fly in" a track to a recording session on the far side of the Atlantic. Held up on the way to a gig? E-mail your part. From what I know of playing bars, no one will notice.

A few years back, Pete Townshend of the Who warned us to never sell our guitars or our pens. With the many ways that computers are changing a guitar player's life, maybe we need to add something else to the list. ◆

MARK NELSON HAS BEEN PLAYING AND RECORDING GUITAR SINCE COMPUTERS WERE AS BIG AS HOUSES. HE'D LIKE TO THANK THE FOLKS AT MUSICIAN'S FRIEND AND CONNECTING POINT COMPUTERS IN OREGON FOR THEIR ASSISTANCE WITH THIS ARTICLE.

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Hard-Disk Recording Handbook

By Mark Nelson

Learn how desktop digital audio can ignite your music.

The call came while I was working on the Great American Novel. "I need to record some weird Middle Eastern cues right away—dumbek, tambourine, reeds. Oh, and can I use your cardboard zurna?" It could only be Sue.

As codirector of the Terra Nova Consort, an eclectic early-music ensemble in residence at the Oregon Shakespeare Festival, Sue Carny is a master of all manner of strange and wonderful musical instruments. She'd been asked to provide "otherworldly" music for *The Tempest,* which would open in a week. "One more thing," she added. "The director isn't sure yet how many cues we need, or how long they'll be. Bye."

You may have expected an article about hard-disk recording to focus on cutting-edge synths and MIDI gadgets. But acoustic musicians and singers have much to gain from the desktop recording revolution. I should know; after a long career as a touring folkie and recording artist, I now use my trusty computer to record and master projects in the tiny loft above my garage. Yet in talking to my friends and peers around the country, I'm surprised at how many think you have to be a MIDI expert, samplehead, or loopmeister to make music on your computer.

Another common misconception is that hard-disk recording is technically demanding and hugely expensive. Not true. Even avowed Luddites have recorded and mastered CDs at home, and for far less than the cost of a working stiff's guitar. As for esoteric knowledge, look at it this way: mountains of scholarly papers have been written on the properties of tone, but do you need a physics degree to sing in the shower?

In this article, I'll lead you through a number of real-world examples designed to give you a general introduction to desktop recording. Although I'll focus on the acoustic musician, much of what I'll cover applies to MIDI users, electric guitarists, and loopers who want to add vocals or additional acoustic tracks to their projects. (Even a single "unplugged" track can make a world of difference in an all-electronic production.)

I promise to get as deep into the subject as I can without getting caught up in technical jargon. After all, a lot of my friends still haven't forgiven Dylan for going electric. Some jargon is unavoidable, so if any of the italicized terms are unfamiliar, see the glossary on page 46.

Starting from Scratch

Anything that can be converted to ones and zeros can be stored on your computer and manipulated in much the same way that text is stored and manipulated in a word processor. With hard-disk recording, an audio signal—your voice, say—is transformed into digital code via an *analog-to-digital converter* (ADC) so you can store it and mess around with it. A *digital-to-analog converter* (DAC) lets you hear the results. Some computers, including almost all current Macs, have ADCs and DACs built in. Other computers require a *sound card* or *audio interface,* which we'll cover in a moment.

Software conventions. Most audio recording programs use a tape recorder–style interface, with Play, Record, Cue, Review, and Stop buttons (see **Fig. 1**). The onscreen controls for software *mixing* consoles and *effects*

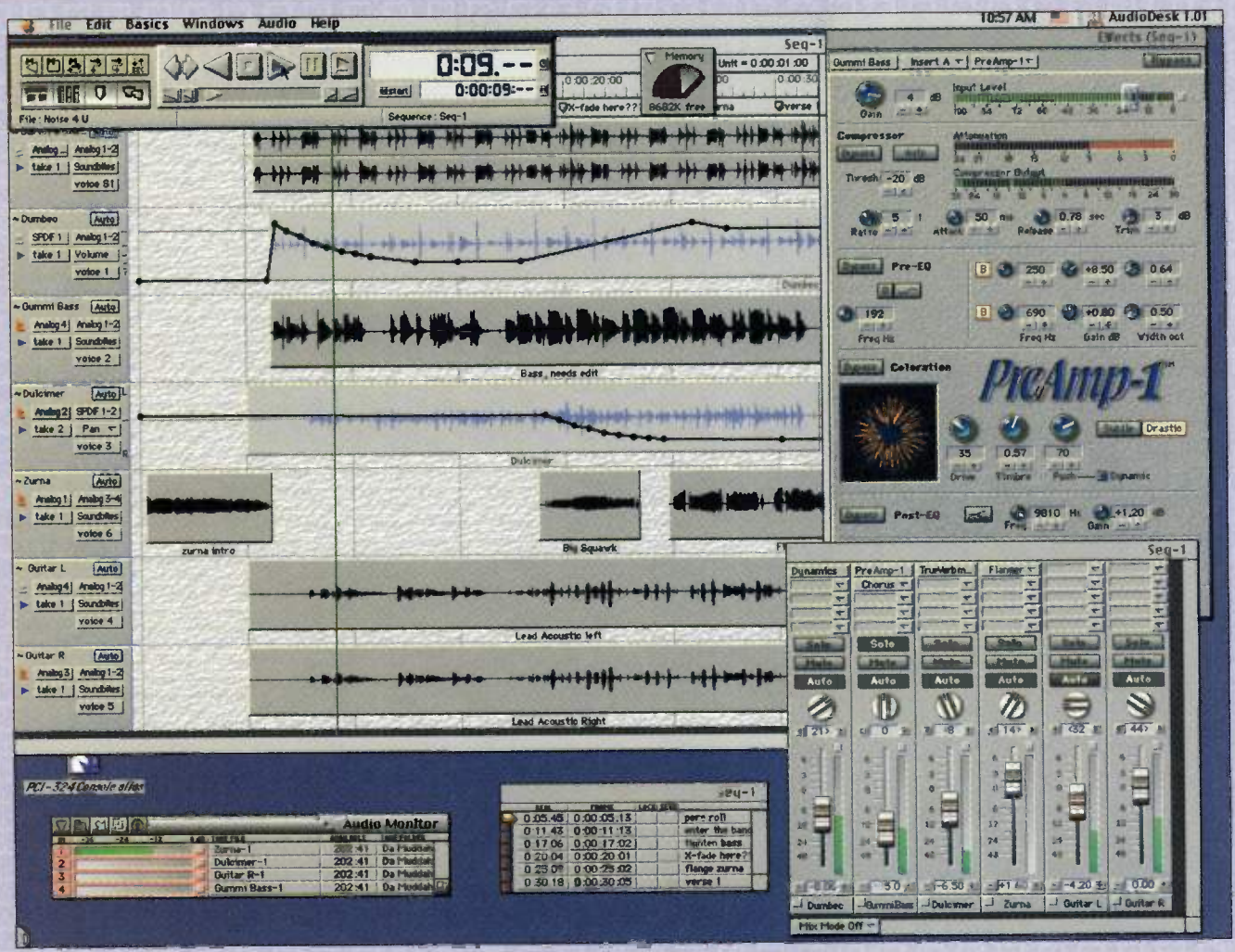


FIG. 1: MOTU AudioDesk *(Mac) contains the main windows you'll find in most multitrack recording software. Clockwise from upper left: transport controls, disk-space gauge, plug-in effect controls, mixer, region markers, and record-level meters. At center is the tracks window.*

devices often resemble their real-world counterparts, too.

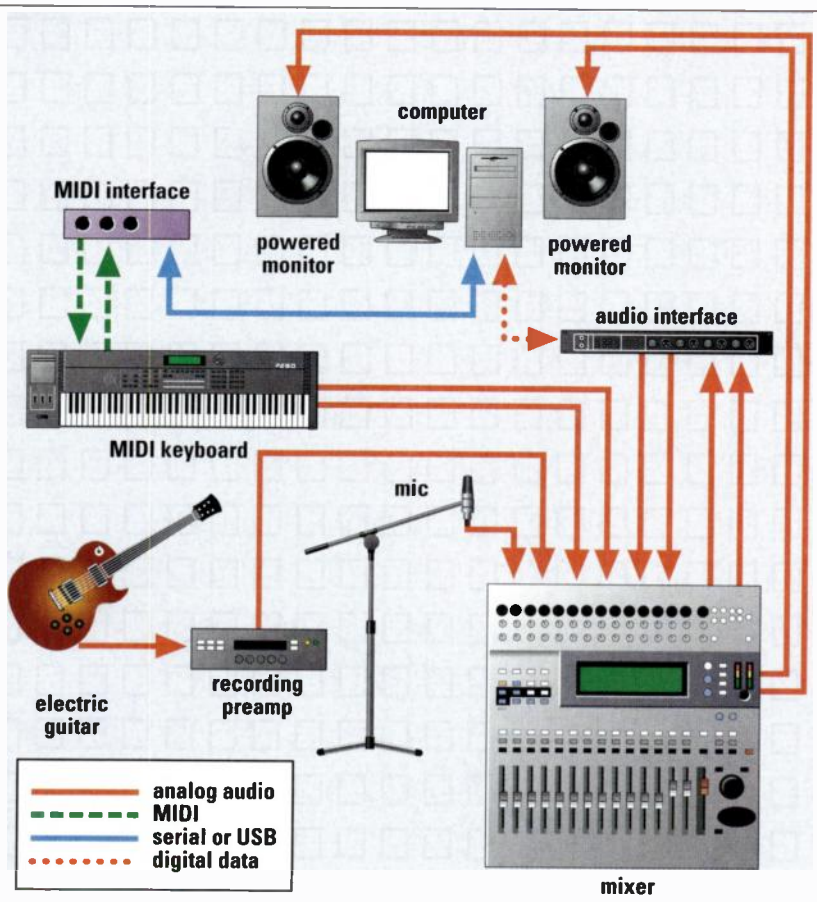
As with a tape deck, you record your performances on multiple *tracks*, with one horizontal time line for each recorded part (or two, if you're recording in stereo). Though the number of tracks that can play back simultaneously depends on the speed of your computer and your hard drive, many programs support hundreds of *virtual tracks*. These tracks can be used to store metronome clicks, alternate takes of a solo, spoken commentary, and so on.

One big difference between desktop recording and using tape is that most recording software lets you see a display of the actual audio waveforms in a track, which makes it easy to zoom in on downbeats and snip out lip smacks. Another important difference is that you have *random access* to a hard-disk recording: you can instantly jump anywhere in the file, with no rewinding or fast-forwarding.

Computer requirements. How big a computer do you need? The short answer is that you want the fastest you can afford. On the Mac side, most current audio software requires at least a 603e chip running at 150 MHz. Better is the 604e; used Mac 9600s are holding their own in price. The best bet is one of Apple's fast G4 minitowers. Those adorable iMacs and iBooks won't cut it until Apple updates the Mac OS to support audio over the *USB* port.

As for Windows machines, again, faster is better. Avoid the no-name bargains sold in discount stores; for the most part, neither the logic board nor the sound card will be up to the demands of professional digital audio. (And avoid PCs with audio functions built into the motherboard; they may cause conflicts when you upgrade to a quality audio interface.)

You can do a lot with a 200 MHz Pentium, but it's best to get at least a 300 MHz Pentium II machine. RAM is cheap, so buy lots—at least 64 MB. Windows 95 and 98 are widely supported; NT is becoming so. Audio hardware and software are emerging for the BeOS and Linux operating systems, as well.



Although this desktop studio uses an external interface to get audio in and out of the computer, a typical stereo sound card would also work. Similarly, the mixer is used here to amplify the mic, but an external mic preamp could be used instead.

Take 1

"'You're recording onto your computer? Isn't that just for keyboardists?' I can't tell you how many times I heard that," laughs Brian Freeman. After a long career as a traveling singer with his own independent label, the Oregon artist thought his recording days were over. "My last CD was recorded using studio musicians and 24-track tape," Brian explains. "It was a grand effort, but what with a family and a small graphics business, I doubted I'd ever do it again."

Then he got a program that promised to turn his Mac into a desktop studio. In a matter of months and with no prior experience, he recorded a limited-release CD for a special gig. His tools? Nothing more than a pair of inexpensive microphones and his P.A. mixer, which he plugged into the ⅛-inch jack on the company computer.

Brian worked at night to keep down traffic noise. To dull the whine from his computer's fans and internal hard drive, he set up a couple of couch pillows as baffles. Although purists may scoff at the less-than-stellar quality of the Mac's built-in audio circuitry, Brian says, "The recording is still ten times cleaner than anything I'd been able to achieve with multitrack cassette." With an almost unlimited number of tracks, he never had to suffer the sonic degradation of bouncing analog tracks to make room for harmony vocals. What's more, creating a composite track from the best takes was a snap: just line them up, cut, and paste.

Another trick Brian discovered: pointing the rear of his vocal mic (a Shure SM57) toward the computer let him record while facing the monitor to keep an eye on levels. This is important because digital recording should be done as hot as possible without clipping—the higher the meters go, the more bits the software is using to record the signal, which results in greater fidelity. (Until you hit the red zone, that is, at which point the signal distorts horribly.) Because the SM57 is less sensitive at its rear, this orientation also reduced the amount of acoustic noise it picked up from the computer.

Working in tight quarters meant Brian had to close-mic all his instruments, using an AKG C 1000E for mandolin and Autoharp. Here, he relied on his live experience for microphone placement, adding *EQ* and reverb from his mixer while recording. For guitar, he added the direct sound from his pickup to the miked tone and panned the tracks left and right for a wider sound. To differentiate between multiple takes recorded on the same instrument, he varied the tones subtly on each overdub.

Recording purists may scoff at some of the things Brian did—like recording to his system drive instead of to a dedicated one and not using a professional audio interface—and some of his homegrown methods may seem crude. Yet the fact is, he succeeded in recording a complex project involving multiple acoustic tracks. Oh, and one other thing: he never cracked the manual. Not once.

What's more, he did it on the cheap. Multitrack audio software is surprisingly affordable. The all-around best deal out there is PG Music *Power Tracks Pro Audio* (Win); a paltry $29 buys you a very capable audio recorder/MIDI sequencer. Programs like Cakewalk *Home Studio* 8 ($129; Win), Emagic *Micro-Logic AV* ($99; Mac/Win), Steinberg *Cubase AV* ($99; Mac/Win), and Opcode *Vision DSP* ($59.95 via the Web; Mac) offer pro features at entry-level prices.

Pick a Card

One thing is certain: when you get serious, you'll want better audio quality than you can get by simply connecting a Walkman-style plug to your computer. Which audio interface you buy depends on a number of factors. How many tracks do you expect to record at a time? Do you plan on mixing inside the computer or through a console and outboard gear? Will you need to connect to a multitrack recorder, digital mixer,

Digital Audio Definitions

ADC Analog-to-digital converter. Converts an audio signal into digital data. Compare *DAC.*

audio interface A hardware device that connects to a computer and converts analog or digital audio signals to and from a digital format the computer can understand. Usually configured as a circuit board with external audio connectors, but may include a breakout box. Compare *sound card.*

bit depth The length of the binary "word" used to describe digital audio data. Greater bit depth means higher resolution, and hence greater fidelity. Compare *sample rate.*

channel A discrete signal path. A stereo cassette deck has two channels (left and right), but its tapes contain four tracks (two running in each direction). Compare *track.*

DAC Digital-to-analog converter. Converts digital data into an analog signal. Compare *ADC.*

DAT Digital audiotape. A 2-track (stereo) format common in professional studios and mastering houses.

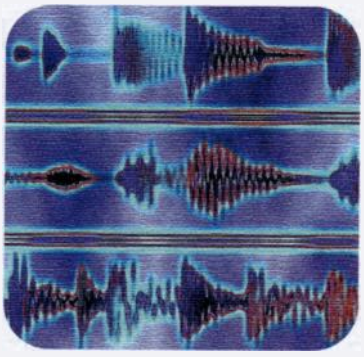
DAW Digital audio workstation. Either a stand-alone hardware device or a computer-based system containing both software and hardware for MIDI and digital audio production.

Disc-at-Once A mode in which you record a CD-R in one pass, without turning off the laser between tracks. Necessary for CD masters.

disc image A single large file containing all the songs and data necessary for burning a CD-R. Recording from a disc image is less risky than recording from individual files spread across one or more hard drives.

DSP Digital signal processing. Altering a digital signal using mathematical computations, for example, to add effects. The computations can be done by a computer's processor or a dedicated DSP chip.

effects A catch-all term for different ways to alter sound. Dynamic effects, like compression, gating, and limiting, change the overall dynamic intensity of a signal. Time-based effects include reverb, chorusing, flanging, phasing, and echo. Other popular effects include distortion, wah-wah, tube emulation, and vocoding. Just about any kind of effect imaginable is available as a software *plug-in.*



EQ Short for equalization, a selective boost or cut of certain frequencies in the audio spectrum. A graphic equalizer has a number of sliders at fixed frequencies; parametric EQ allows control over the affected frequency and bandwidth (called Q).

mastering The final editing and processing of a group of audio files before the finished project is recorded on a delivery medium, such as CD, DAT, or cassette.

MDM Modular digital multitrack. A stand-alone audio recorder that can be synchronized with other units of the same type to provide more tracks. The 8-track Alesis ADAT and Tascam DA-88 are two common examples.

mixing The process of combining multiple audio tracks into stereo, mono, or some other final delivery format. Once a project is mixed, it is ready to be mastered.

plug-in Audio processing software that works inside a host application.

random access The ability to access a recording immediately at any point, as from a hard disk. Tape-based recording, by contrast, provides linear access.

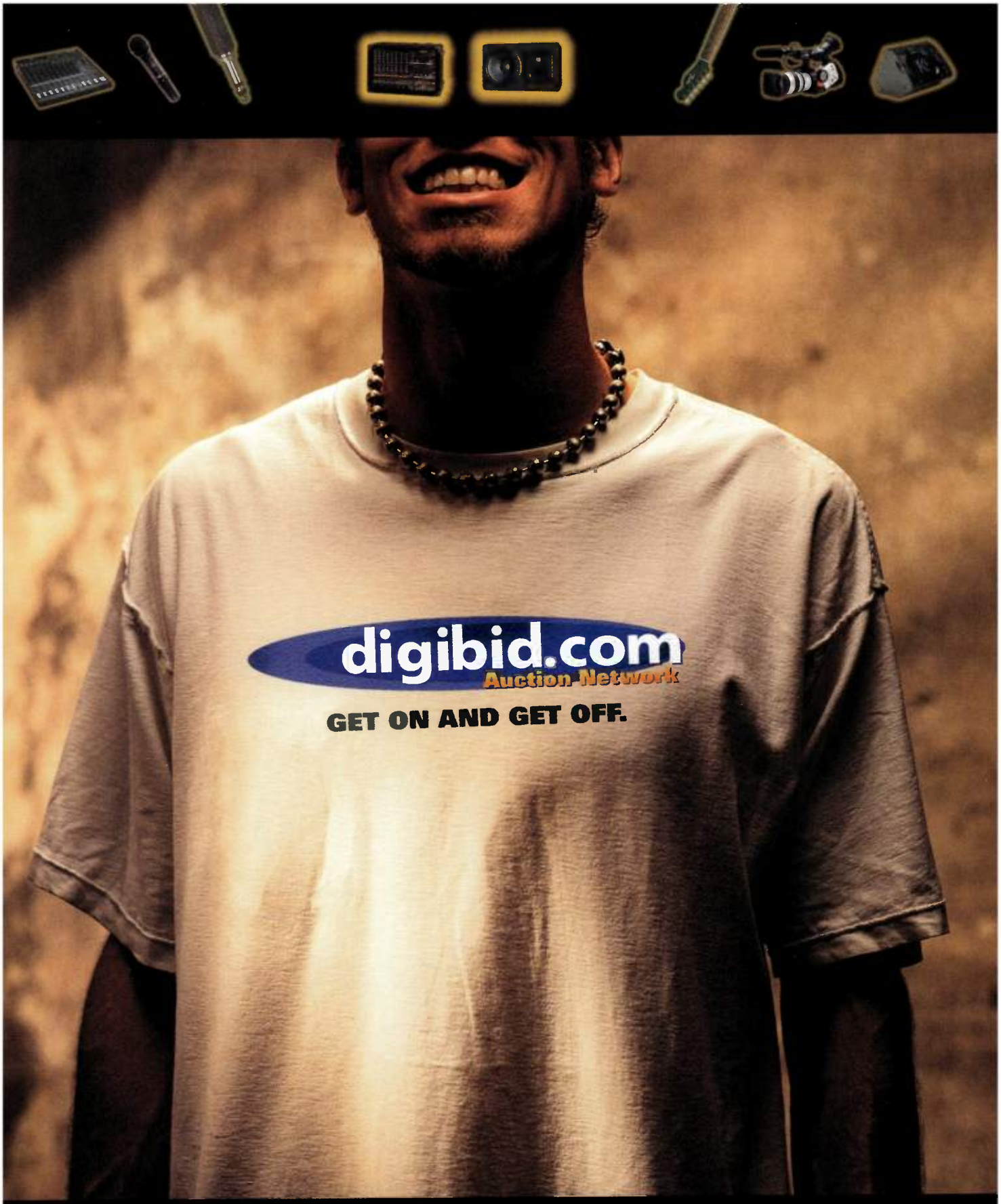
sample rate The number of times per second that the level of an audio waveform is measured when it is converted from analog to digital format. (Also the number of times per second those values are read out when the data is converted back to analog form.) The higher the rate, the higher the frequency (pitch) that can be recorded. Compare *bit depth.*

sound card A circuit board that, when installed in a computer, adds analog (and sometimes digital) audio inputs and outputs, as well as a MIDI synthesizer. The term is often used interchangeably with *audio interface,* although the latter lacks a synthesizer.

track On tape, lines of recorded information laid down by the record head; a 24-track tape recorder divides a strip of tape into 24 lengthwise sections. Each track is independent and can be routed to an individual audio output. Although hard-disk recorders manage audio in a different manner, most maintain the illusion of linear audio tracks. Compare *channel.*

USB Universal Serial Bus. A new standard for connecting peripherals such as *audio interfaces* to computers.

virtual track A track that contains audio data but is not currently playing. Typically used for recording and storing alternate takes.



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MiniDisc, or DAT recorder?

Most home recordists can get a lot of mileage from a straightforward audio in/out card like the Midiman DMan 2044 (Win). For sequencing or even just generating a click track, get a card with a MIDI interface. Yamaha's innovative SW1000XG card (Mac/Win) has a powerful synthesizer onboard.

For transferring tracks from a digital mixer or a *modular digital multitrack* (MDM), find an interface that supports the Alesis Lightpipe or Tascam TDIF multichannel digital connectors. Mark of the Unicorn's 2408 (Mac/Win) supports both. AES/EBU or S/PDIF digital audio connectors are essential for any *mastering* work involving a DAT or stand-alone CD recorder. (See "The Well-Connected Studio" on page 96 for much more background on interfacing.)

On the right DAC. Two factors remain to be considered: the physical placement of the ADCs/DACs and their resolution. Because computer circuitry generates electrical noise, pros favor audio interfaces such as the SeaSound Solo that put the converters in an external box. But even a one-piece interface can be upgraded provided it has digital audio inputs. Just attach a high-quality external converter such as the Apogee Rosetta AD.

Resolution is dependent on *sample rate* and *bit depth*. Compact discs set the standard at 44.1 kHz and 16 bits. At this resolution, the ADC measures the level of the incoming analog signal 44,100 times per second and assigns it a value between 0 and 65,535 (the range of numbers that can be represented by 16 bits). Currently 20- or 24-bit resolution is the norm for pro gear, with sample rates moving up to 96 kHz and beyond. Basically, the higher the numbers, the greater the fidelity—every additional bit doubles the resolution. The trade-off is that this requires more storage space and processor power.

Of course, to put your music on CD, you'll have to bring it back down to 16-bit, 44.1 kHz resolution, but doing your editing and processing at higher resolutions can still improve the overall sound. You can also keep a high-resolution archive.

Magic bus. For years, PCs relied on ISA-bus sound cards, but the newer PCI bus offers much better performance and is now the standard on both PCs and Macs. The latest development is USB, a type of serial port that lets you connect all manner of peripherals without even opening your computer. As of this writing, Opcode and Roland are shipping USB audio interfaces for the PC; Mac support is due in Mac OS 9. (See "A Musician's Guide to USB" on page 24.)

Whichever card you choose, be sure to check for software compatibility. Even better, select your software first and build your recording system around it. Look for compatibility tables on company Web sites. An easy way to be sure everything runs smoothly is to choose a complete system bundle that includes an interface, recording and editing software, effects plug-ins, and maybe even a CD burner and mixing control surface. CreamWare TripleDAT (Win), Digidesign Pro Tools (Mac/Win NT), Digital Audio Labs V8 (Win), and Ensoniq PARIS (Mac/Win) are in this category. On a much smaller budget, you could go with the E-mu APS, Guillemot Maxi Studio Isis, or Voyetra Montego II Home Studio (all Win).

Three blind mics. To connect a microphone to your interface, you'll need a mic preamp (a few interfaces include them). Most hardware mixers have onboard preamps, but you could also invest in a dedicated unit. Another appealing option for recordists with limited gear is a rack-mount "channel strip." These boxes combine a mic preamp (often tube based) with multiple signal-processing features such as compression, noise reduction, and EQ (see **Fig. 2**). Direct boxes (DIs) are handy for recording instrument-level signals from guitars and vintage keyboards.

While we're spending your money, let's pick up a good set of headphones and at least one good microphone. You can't go wrong with a multipattern large-diaphragm condenser mic such as the Neumann TLM 103 or Røde NT2 for vocals and most instruments.

Take 2

Although I'm an old studio dog, singing is not one of my skills. Yet sing I must, if only to demo my songs. Here are a few things I've discovered that make the process less painful.

Benefit of the grout. Ever notice how much fun it is to sing in the shower? That's because all that reflective tile makes your voice sound soooo good. (An attentive rubber ducky helps, too.) So grab a long mic cable and turn your bathroom into a vocal booth. If you don't want to lug your computer down the hall, use a MIDI keyboard with a long cable as a remote control; most software lets you assign MIDI note messages to transport controls. Patch in a limiter after the mic preamp to guard against clipping, and wail away.

Ride the mic. Sing slightly off center from the mic to minimize pops. With cardioid-pattern mics, move closer

Desktop Recording Web Resources

Many manufacturers maintain online forums on their Web sites. Be sure to check out the FAQs and compatibility tables. Other worthwhile sites include:

DAW-Mac (a mailing list for Mac-based digital audio workstation users): www.bakalite.com/Pages/DAW-Mac.html
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Electronic Musician: www.emusician.com
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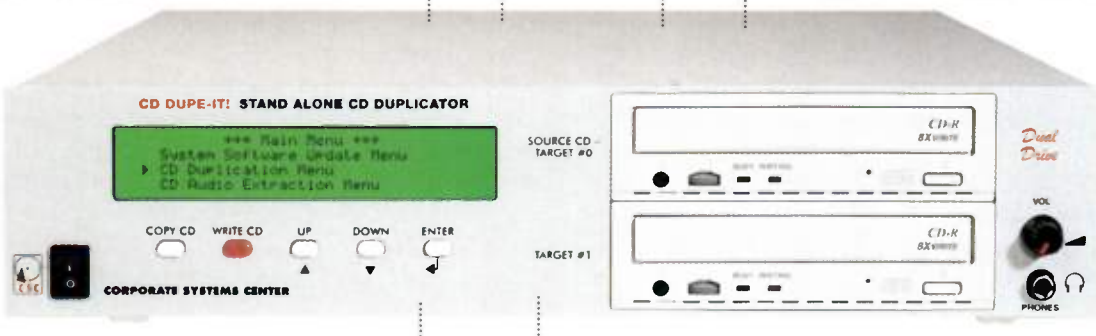

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FIG. 2: You can add analog processing to your digital recordings with a "channel strip" such as A.R.T.'s Tube Channel. It's a combination mic preamp, compressor, and EQ.

for more bass—you, too, can sound like Elvis. If you can avoid them, don't record with effects; add reverb to the headphone signal if you need the effect to sing better. Rather than simply sticking up a mic and twisting the EQ and compression settings, listen to the sound in the room and move the mic, the singer, or both.

For effect only. Remember, once you've recorded an effect, it is almost impossible to change it. If you must record with effects, try laying down two tracks—one dry (no effects) and one 100 percent wet (only effects)—and mixing them later.

Ice the ess. De-essers are your friends. If you don't have one, just select the nasty sibilant bits of the track and EQ them out. A quick way to find the offending frequency is to sweep the upper mids (2.5 kHz and up) with a parametric EQ while boosting the gain 12 dB. You'll know when you've found it.

Outside pitch. Pitch correction the hard way means selecting the clam and transposing it a few cents up or down in your audio editor. The easy way is to use Antares *Auto-Tune,* available in plug-in or stand-alone versions (see **Fig. 3**). If it helps *me* sing in tune, think of what it can do for you. Pitch-shifting software can also be used to produce multipart harmony. Try altering the formants (characteristic frequencies) of your vocal track to produce the illusion of a second vocalist.

Drive to Succeed

Once you get your precious audio into the computer, it has to go somewhere. Audio files aren't small. You'll need 5 MB per track-minute at 16-bit, 44.1 kHz resolution, so one four-minute song with multiple tracks can easily fill a couple hundred megabytes. Recording with 24-bit resolution will add 50 percent to that figure, and using the 96 kHz rate will more than double it.

No problem, you say. Your new PC came with a 6 GB hard drive. Here's why you ought to invest in another one: the constant demands of digital audio put some serious strains on your drive's read/write head. Also, when your main drive needs to respond to instructions from your operating system, it could bog down, causing audio glitches. Furthermore, audio editing tends to quickly fragment your drive, making it slower. It's much easier and safer to defrag a second drive.

Once again, you can choose between several bus flavors. IDE (ATA) drives are often used as the primary internal drive. SCSI, because it allows multitasking, is the recommended option for a second drive. SCSI-2 (found on Jaz drives and beige Macs) is a proven workhorse. Ultra Wide SCSI, with a throughput of up to 80 MBps, is an excellent choice; just remember, though, that your chain is only as fast as the slowest device connected. Fortunately, Glyph Technologies' new Hi-9 adapter lets you mix old and new devices with no loss of throughput.

Almost any hard drive made in the last few years is adequate, but again, faster is better. High-performance drives spin at 7,200 rpm and faster, cutting access time to as low as 5 or 6 ms. That is important because the faster the access time, the lower the chance your audio data stream will be dammed.

Take 3

In my tiny studio, machine noise can be a problem. My solution was to build a custom-baffled enclosure for the CPU and external drives. (Removable panels let me vent excess heat between takes.) When Sue Carny arrived to record her cues, I'd already launched MOTU *Digital Performer* and set up a file with track assignments, editing windows, effects sends, and a virtual mixing console.

First we did the rhythm tracks. I placed Sue in an uncarpeted section of my room and listened with one ear to the sound from a number of different angles to determine mic placement. Sticking a large-diaphragm condenser about a foot in front of the dumbek, angled at 45 degrees to the head, produced the best "tek," the high-pitched rim-shot sound so important to Middle Eastern music. The room made the low-pitched "dum" resonate wonderfully. Miking the tambourine was simply a

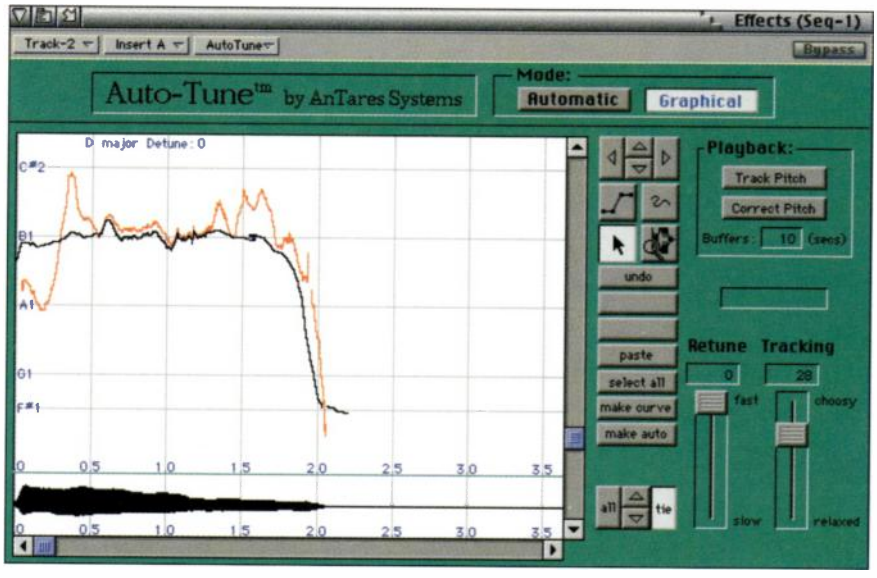

FIG. 3: When author Mark Nelson recorded this vocal, his pitch (graphed in red) warbled between A and C-sharp. He used Antares Auto-Tune *to correct the intonation during the body of the note (black graph), but he kept the fall-off at the end because it sounded good.*

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matter of moving Sue farther away and watching the meters. Digital clipping is not anything you want to hear twice.

Her offhand request for the zurna (a Middle Eastern double-reed instrument) proved a little harder. I handed her the contraption I'd built for a kids' book. Cobbled together out of a PVC pipe, a plastic drinking straw, and cardboard, it possessed a tuning system not found in nature. Sue wailed on it, but it was utterly uncontrollable. Try as she might, Sue couldn't be sure what effect her breath would have on the beast. Here again, hard-disk recording made the impossible real. While Sue recorded multiple passes, I typed in markers at every point where some egregious squawk or, worse, dead silence interrupted the music. By the time she'd caught her breath for the next pass, I'd already edited together a rough composite track. I dare anyone to do *that* with tape.

Sue's impassioned performance, with some creative editing, sold the cues. In fact, the director asked for a new, extended piece for the end of the play. No need for a new recording session; I created an overture from the various themes, mixing and matching the audio files on hand. I even faked a percussion solo in the middle by selecting some rolls and individual hits Sue had played when we were setting levels.

10 Tools to Improve Your Recordings

1. Accurate close-field monitor speakers and amplification. Those itty-bitty speakers next to your computer screen won't cut it—unless, of course, you're mixing for multimedia.
2. A dedicated microphone preamplifier or "channel strip" voice processor.
3. A MIDI fader box or control surface to handle onscreen virtual mixing and effects tweaking.
4. Acoustic treatment for your room. This is the least sexy but most cost-effective investment you can make.
5. Another microphone. No matter how many you already have.
6. Professional headphones.
7. A CD-R or CD-RW drive to make audio CDs and back up your data.
8. A modem to access Internet forums and newsgroups, stay abreast of software updates, and share your music with the world.
9. Accurate meters, so you really know what's getting to disk.
10. A positive attitude, a willingness to learn, and the ability to listen.

I want to call your attention to a couple of points in the preceding anecdote. When setting up microphones, listen to the sound in the room. Even the funkiest studio has several distinct sounds. And notice how tasks that were once separate actions—like recording, mixing, and editing—become blurred within a desktop studio. I doubt we would have been able to record the zurna successfully in a tape-based studio.

Rack 'Em

Big studios tweak and massage audio into shape using rack upon rack of outboard gear, connected via huge patch bays and a spaghetti-factory mess of cable. The computer equivalent, audio processing software and *DSP plug-ins,* fits on a hard drive with little or no loss of functionality. (Click the DMPG link at www.emusician.com for a comprehensive list of each type.)

As the term implies, plug-ins are small software packages that add new features to a host program. There are two types: file-based plug-ins, which change the recorded waveform on disk; and real-time plug-ins, which affect only the incoming or outgoing audio signal. (You can record this signal back to disk.) To use a file-based plug-in, you simply highlight a section of the waveform, pull down a menu, and select the effect you want. A new window with controls for the effect will open. Real-time plug-ins are even more intuitive to use; you typically select them from a

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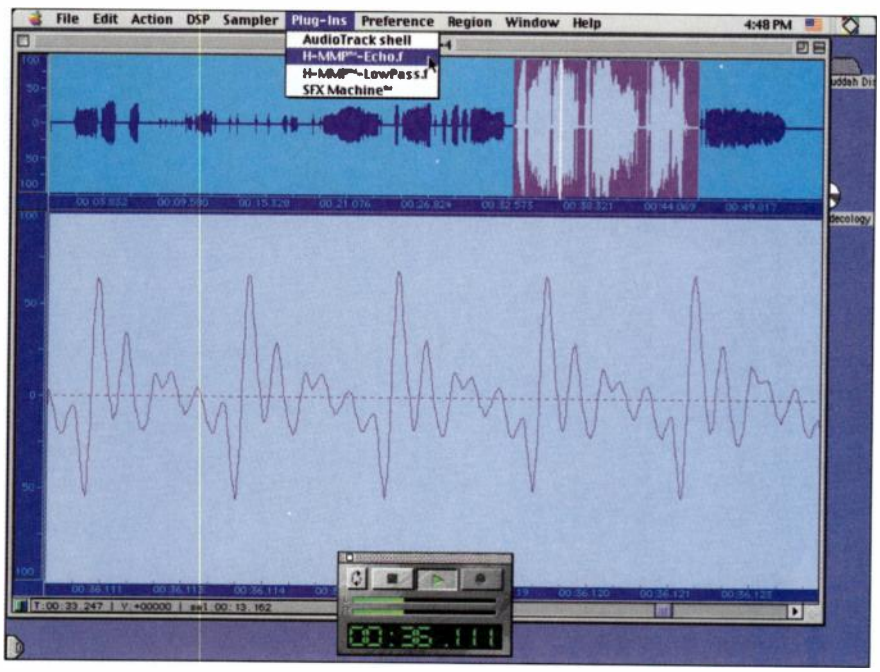
menu within the onscreen mixer.

There are quite a few plug-in formats, so before you go shopping, be sure you know which formats your software supports. The top of the heap is Digidesign's high-performance TDM format (Mac/Win NT), but it requires dedicated Digidesign hardware. For the rest of us, DirectX and VST are the most popular Windows formats. On the Mac, Premiere, VST, and MAS are most common; all but Premiere are real-time.



Hard-disk recording gives you unprecedented control. The large window in this Macintosh audio-editing program, BIAS Peak, is displaying an extreme close-up of a sound.

Applications. Plug-ins make every part of the recording process easier. Embarrassed by wimpy mic preamplifiers? Warm up your signal with tube simulation or virtual tape saturation. Noise from your single-coil pickup got you down? Zap it with noise reduction. Flute sounds thin? Try mixing in some doubling and chorus effects. De-essers can reduce overbearing *t* and *s* sounds on your vocals and tame finger squeaks on acoustic guitars. Bass enhancers can soup up your bottom end.

Virtually any effect or processor known to man is available as a plug-in, often for a fraction of what the hardware version costs. The TDM and VST plug-in formats even support automation, letting you play back your complex effects moves alongside your tracks during mixdown.

Take 4

A light rain falls in a tropical forest. Gradually, as if from across a mist-enveloped valley, comes the sound of an ancient chant, punctuated by the slow pulses of the *ka'eke eke* (tuned bamboo pipes) and the clicking of small stone castanets. Keola Beamer turns to me with a smile. "What do you think?"

"It's breathtaking," I murmur. And then, ever the engineer, I reach for the mouse. "Mind if I add a tad more predelay to the vocal?"

The space is tiny, but the sound is not. Using only one or two microphones routed through a high-end tube preamp, Keola makes extensive use of a large acoustical foam baffle to isolate the sound of each instrument and voice. Anything that makes noise, like his CPU, hard drives, CD-R, and uninterruptible power supply, sits in a hallway outside, with extra long cables routed through the wall for his monitor, keyboard, and mouse.

All processing and mixing is automated in software; the only outboard gear visible, besides the mic preamp, is a tiny mixer and a pair of powered monitors. A quick glance around reveals pro-studio features like diffusers and absorbers glued to the walls and ceiling, low-noise dimmers on the lighting, double doors, and an efficient air-conditioning system. Yet, like most home studios, the space started out as a spare bedroom.

Keola uses his high-tech studio both for inspiration and to record the lovely homespun tales of his mother, Nona. Her award-winning CD, *The Golden Lehua Tree,* was produced entirely in this tiny space. "It's important for everyone to feel comfortable when it's a family project," says Keola. "Having the kitchen right next door helps a lot."

Mix It Up

Even if you record only solo voice and dulcimer, sooner or later you're going to have to mix the tracks down to stereo. With 24 or more tracks all screaming for attention, the process gets intense.

Relax; let the computer do the work. Focus on difficult sections rather than on the complete song. Drawing volume and pan moves on individual tracks with your mouse is an effective form of mix automation (note the curves drawn over two of the tracks in **Figure 1**). Work one track at a time, listening and adjusting as you go. Tedious? You bet, but what's time to a computer? If you have a MIDI keyboard, you may be able to use its mod wheel and data sliders to control levels, panning, and effects parameters in the software. Better yet, invest in a MIDI fader box or full-featured control surface like Mackie's HUI for Pro Tools.

Following are a few more tips to help you get the most out of your mixes. Although these aren't unique to hard-disk recording, they're much easier with a computer.

Put things in their place. Rather than recording everything in stereo and panning hard left and right, try setting the instruments on an imaginary stage between the speakers. Use EQ, volume, and reverb to move them around. Increasing the reverb amount and reducing high frequencies with EQ moves a track back; doing the opposite brings it to the forefront.

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FIG. 4: IK Multimedia's T-Racks *stereo mastering software features a 6-band parametric equalizer, a compressor, a multiband limiter, and a stereo enhancer. The program emulates the sound of vacuum-tube gear.*

EQ the mix, not the instrument. Simply soloing each instrument and making it sound great isn't enough; listen to the whole ensemble and adjust accordingly. It's counterintuitive, but a guitar that sounds thin by itself may smoke in the mix. Automate your EQ changes to highlight different instruments at different times. The same goes for effects.

If you don't need it, mute it. Mutes are another candidate for automation. Be careful with vocals, though—absolute silence between words sounds spooky. (Though it could be cool. Your call.)

Can't decide where to fade? Don't. Save fade-outs for mastering, when you can hear how the fade will segue into the next track. Alternatively, you can create multiple mixes of just the fade-out section and splice them on later when you're sure. No one will ever know.

Mr. Master

Mastering is the final stage in audio production; it's your last chance to tweak, prod, and polish before your loving creation heads out into the world. Yes, you can do it on your desktop. Is this a cool world, or what?

Mastering software can make all those late-night mixes you've done over the last year sound good together. Typically, some tunes need to be louder, some will need EQ to bring out (or tame) the top end, and some will need a tad more compression to even out the levels. "Look-ahead" peak limiters, such as Waves' *L1 Ultramaximizer,* ensure killer-loud CDs with no danger of clipping. Tube and tape-saturation effects, such as Gadget Labs' *WaveWarm,* can heat up your sound. There are some all-in-one solutions, too, such as IK Multimedia's *T-Racks* (see **Fig. 4**).

Use mastering software to set song order and spacing—even to crossfade from one song to another. A nice effect is to start counting at the end of one song and then start the following song on what would be the next downbeat.

It's easy to optimize your music for a number of different delivery systems. With just a few mouse-clicks, you can create 8-bit, 22 kHz multimedia files, MP3 files, CD-ROMs, audio CDs, or even Red Book CD masters suitable for mass duplication.

The software that comes bundled with most CD-R drives is adequate for archiving and one-offs, but you should invest in professional mastering software for anything more precious. Windows leaders include SEK'D *Red Roaster,* Sonic Foundry *CD Architect,* and Steinberg *WaveLab.* On the Mac, there's Adaptec *Jam,* BIAS *Peak,* and Digidesign *MasterList CD.* At the very least, you should burn your disc in one continuous pass (called *Disc-at-Once* mode) to minimize problems down the line. For trouble-free burns, first defragment the source drive and then create a *disc image* file.

The Time Is Now

Recording acoustic instruments and voice on your desktop has never been easier or more affordable. In many ways, it's actually easier than using tape, and you don't need to dedicate a wing of your house to storing your outtakes. Chances are you already possess the essential skills: patience, musical chops, willingness to practice and learn, and a basic understanding of what sounds good. After that, it's just details.

Oh, and let me hip you to a secret: you don't have to run out and buy the latest gear right away. Check the used market; last year's perfectly adequate tools can be had for a song. If you have a new machine, so much the better. Jump in and start recording. I promise you won't regret it.

Take 5

It's well past midnight and I'm noodling around, hoping that the ideas in my fingers will somehow jell into a new song. Just before packing it in, I throw up a mic. "It doesn't matter; just some sketches, no pressure," I think as I start to improvise, pass after lazy pass.

Playing them back the next morning, I idly grab a phrase here, a bridge there, as the song unfolds. Before I know it I've assembled a final take, one with a languid island feel I'd never been able to achieve with the tape rolling. For me, this is the strongest argument for desktop recording. It's not about the cost, the convenience, or the processing power. It's a whole new way to make music. ◆

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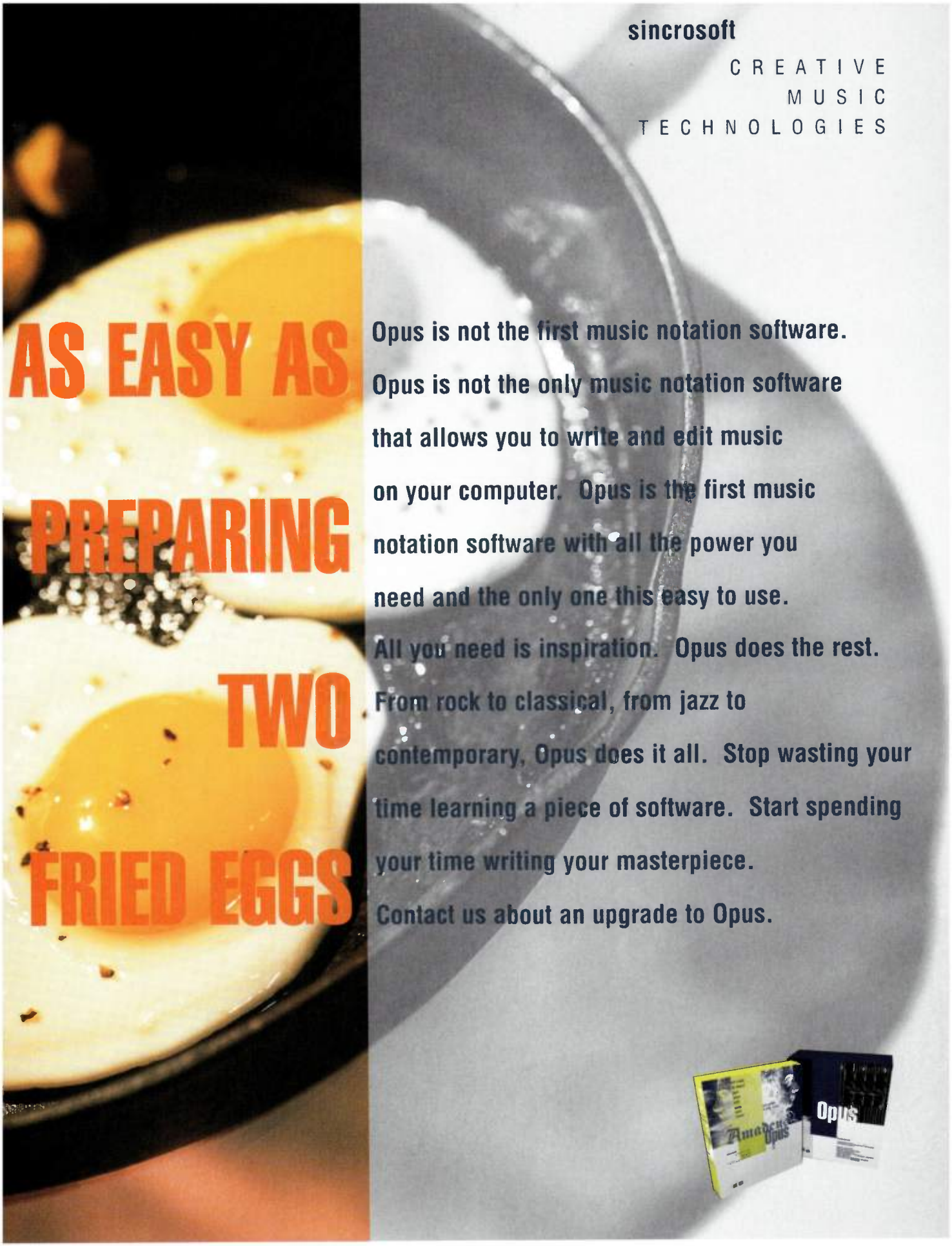

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MP3 for Musicians

By John Krogh

You know how to play them. Here's how to *use* them.

Music on the Internet is a hot topic, but MP3—the good-sounding yet compact Web audio format—is positively molten. According to Searchterms.com, the term "MP3" recently eclipsed that *other* three-letter word to become the most sought-after item on the Web. Whether you plan to bypass the all-powerful record companies by distributing your own tracks online, or just want to check out some fresh tunes, the file format of choice is MP3.

MP3 file players abound, led by the inexpensive @Soft *Macast* and Nullsoft *Winamp*. (Download them from www.macast.com or www.winamp.com.) There are also thousands of user-created DSP plug-ins and graphic "skins" for these programs.

While the explosion of free and inexpensive MP3 players is encouraging for musicians, you still won't find many professional production programs. That is changing. Big names such as Arboretum, Creative Labs, and E-mu have jumped into the ring with MP3 products aimed at pros, joining such pioneers as Beatnik, BIAS, Mixman, and Sonic Foundry that already support the format.

So what MP3 tools *are* available for musicians? I scoured the Web and quizzed some of the leading audio companies, and I turned up some very cool stuff—everything from onscreen DJ turntables that let you beat-match audio files to portable recorders that can capture live gigs or collect in-the-field samples. If you're eager to get started, jump to the sidebar "Cool Tools." For more background on MP3 and how to use it effectively, read on.

MP3 Basics

There are other technologies for putting music online, but MP3 (short for MPEG 1 or 2, Audio Layer 3) is the favorite for a number of reasons. Most important, MP3 offers a good ratio of sound quality to file size. For example, a four-minute song saved as a 16-bit, 44.1 kHz stereo WAV file consumes about 45 MB. After MP3 encoding at a 128 kbps rate, this file would be just under 4 MB—and would sound darn close to the original (see **Fig. 1**).

One widespread misconception is that MP3 files are CD-quality. MP3 files have noticeable sonic shortcomings. Simply put, when a sound file is compressed into MP3 format, certain frequencies are removed. These frequencies are supposedly redundant because they are overpowered by adjacent frequencies in the same way that running water masks the sound of conversation. However, in comparing a WAV file with its compressed MP3 counterpart, you will typically notice a loss in the highs and lows and perhaps a slight grittiness in the MP3.

Furthermore, audio files can be encoded at a variety of bit rates. MP3s created at 128 kbps will be larger and sound better than those created at 64 kbps. The lower the bit rate, the lower the sound quality.

The software you use to encode the audio files also affects the quality; not all encoders are created equal. (See the sidebar "MP3 Encoder Software" for a list of popular programs.) In the next section, we'll discuss some tricks you can use before encoding to make your MP3s sound great. For more background on the MP3 format, check out "Desktop Musician: The MPEG Audio

So what MP3 tools are available for musicians?

I scoured the Web and turned up some very cool stuff.

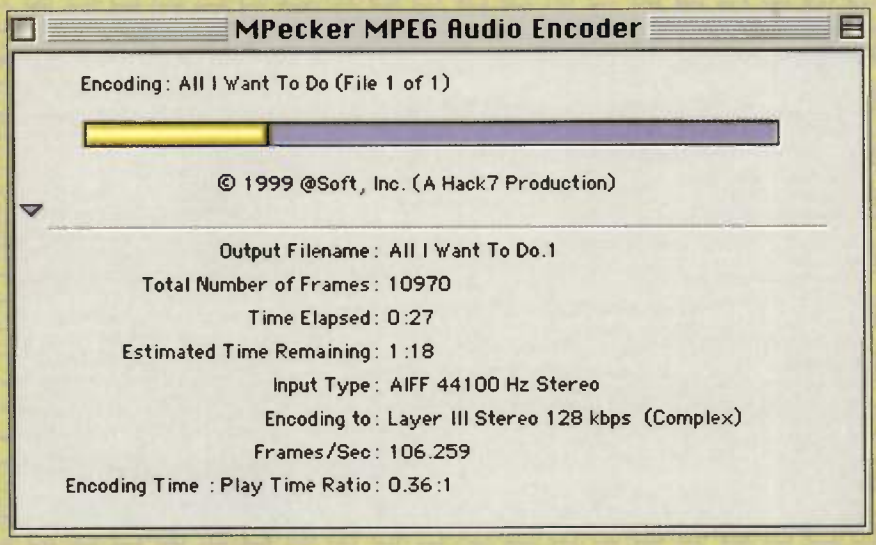


FIG. 1: My band's demo track is being encoded as a 128 kbps stereo MP3 file. Converting the four-minute, 49-second track will take about two minutes. The result will be about one-twelfth the size of the original audio file.

Craze" in the January 1999 EM. Or cruise the enormous resources at www.mp3.com, www.mp3now.com, and www.mpeg.org.

Making Hi-Fi MP3s

Once your MP3 music is online, very little can be done to ensure that it will sound as good on a listener's system as it does on your computer. That's why it's important to process and enhance your audio before it gets MP3-encoded.

Before processing the original audio file, make a copy of it. This will give you a benchmark with which to compare MP3 versions that use different encoding settings, such as bit rate or number of channels. Here are some guidelines to help you optimize file size and make your MP3s sound their best.

Protecting highs and lows. Poor audio in means poor audio out. Start with a great-sounding mix, making sure you've made the best use of your headroom. Waves' *L1 Ultramaximizer* plug-in is excellent for this, but the normalization function in your favorite 2-track digital audio editor should do the trick. Compressing the source file to reduce its dynamic range (that is, applying *audio* compression) can result in a smoother-sounding MP3.

Use the highest bit-rate setting your encoder allows. Anything below 128 kbps is generally poor: transients can be lost, and the resultant file's fidelity will be noticeably worse.

If your MP3s are lacking in a particular frequency range, try boosting the missing frequencies in the original file slightly and then encoding it again.

Sound density. Busy composite material (dance music, for example) can be successfully encoded at lower bit rates than solo acoustic instruments. Reverb tails often jitter when subjected to low-bandwidth encoding, so if your music depends on ambience, you should use at least 128 kbps compression.

Too noisy? If you can hear noise in the source file, then it's going to be audible in the encoded version as well.

MP3 Encoder Software

Here are some of the latest programs for converting raw audio files (AIFF, WAV, even CD audio) into MP3 format. Several programs can automatically download and embed artist, title, and track information from the CD Database (www.cddb.com), an online service that tracks thousands of commercially available CDs. Pulling digital audio directly from audio CDs is known as *ripping*. Most leading audio-editing programs also export MP3 files.

@Soft *MPecker* (Mac; free) supports SDII, AIFF, ripping, and CDDB. Final version expired on June 30, 1999. If you find a copy, you can turn back your Mac's clock to run it.

Casady & Greene *SoundJam MP* (Mac; $39.95) is a full-featured encoder and player that ships with Arboretum's *Realizer* plug-in. See www.soundjam.com.

Glacier Software *MP3 Strip_It* (Win; $25) encodes tracks from your CD-ROM drive in real time. It features CDDB and tag support. See www.glaciersoftware.com.

MusicMatch *Jukebox* (Win; $29.99) uses Xing's encoding technology. It has a good balance of speed, file size, audio quality, and ease of use. See www.musicmatch.com.

Real Networks *RealJukebox* (Win; free) has cool features and CDDB support, but it offers encoding rates up to only 96 kbps. See www.realjukebox.com.

Proteron *n2mp3* (Mac; $34.95) supports AIFF, ripping, tags, and CDDB. See www.n2mp3.com.

Terran Interactive *Media Cleaner Pro* (Mac/Win; $499) is a high-end, do-it-all program that supports a number of media formats. It's on its way to being the professional's encoder of choice. See www.terran-int.com.

Xing *AudioCatalyst* (Mac/Win; $29.95) is a fast, full-featured ripper/encoder/player with CDDB support. See www.xingtech.com.

Cool Tools

Arboretum Systems *Realizer* (Mac/Win; free beta version) is a real-time plug-in that gives compatible MP3 players (such as *Winamp*) bigger bass, more highs, and better stereo separation. See www.arboretum.com.

Carrot Innovations *Virtual Turntables* (Win; $37) is a stand-alone "dual-turntable" MP3 player. You can mix, fade, and beat-match MP3s in real time and trigger DJ sound effects such as backspin and scratching from your computer keyboard. Effects include EQ, echo, and reverb. See www.carrotinnovations.com.

Creative Labs' Nomad ($249.99) is a handheld MP3 player that can hold over an hour of near-CD-quality music (see **Fig. A**). It can also record up to four hours of voice-quality live audio, making it ideal for lo-fi remote sampling sessions. A docking bay lets you shuttle audio to and from your computer. See www.soundblaster.com.

E-mu's E-Card/Nomad MP3 Authoring Bundle (Win; $750) is a variant of E-mu's APS sound card combined with Creative Labs' portable Nomad MP3 player. You also get software for sequencing, hard-disk recording, and MP3 encoding. The E-Card is a 64-voice MIDI sampler with effects and stereo audio input and output (both analog and digital). See www.emu.com.

FIG. B: PhatBoy Hacker *from Modified lets you combine graphics, video, and audio files into an unfolding multimedia collage.*

Modified *PhatBoy Hacker* (Mac/Win; $34.99) is an interactive multimedia player that creates random real-time mixes of multiple audio, graphics, and video files (see **Fig. B**). It supports GIF, JPEG, AVI, QuickTime, WAV, AIFF, and MP3 formats. See www.modified.com.

MuchFX2 (Win; free) is a *Winamp* plug-in that allows you to run, or "stack," several DSP plug-ins simultaneously. See www.geocities.com/SiliconValley/Lakes/2382.

Nullsoft *Live Input* (Win; free) is a *Winamp* plug-in that lets you broadcast live audio from your computer. With the *CDDA* plug-in (www.url.ru/~copah/CDReader.htm), you can even broadcast music straight from a CD-ROM drive. See www.shoutcast.com.

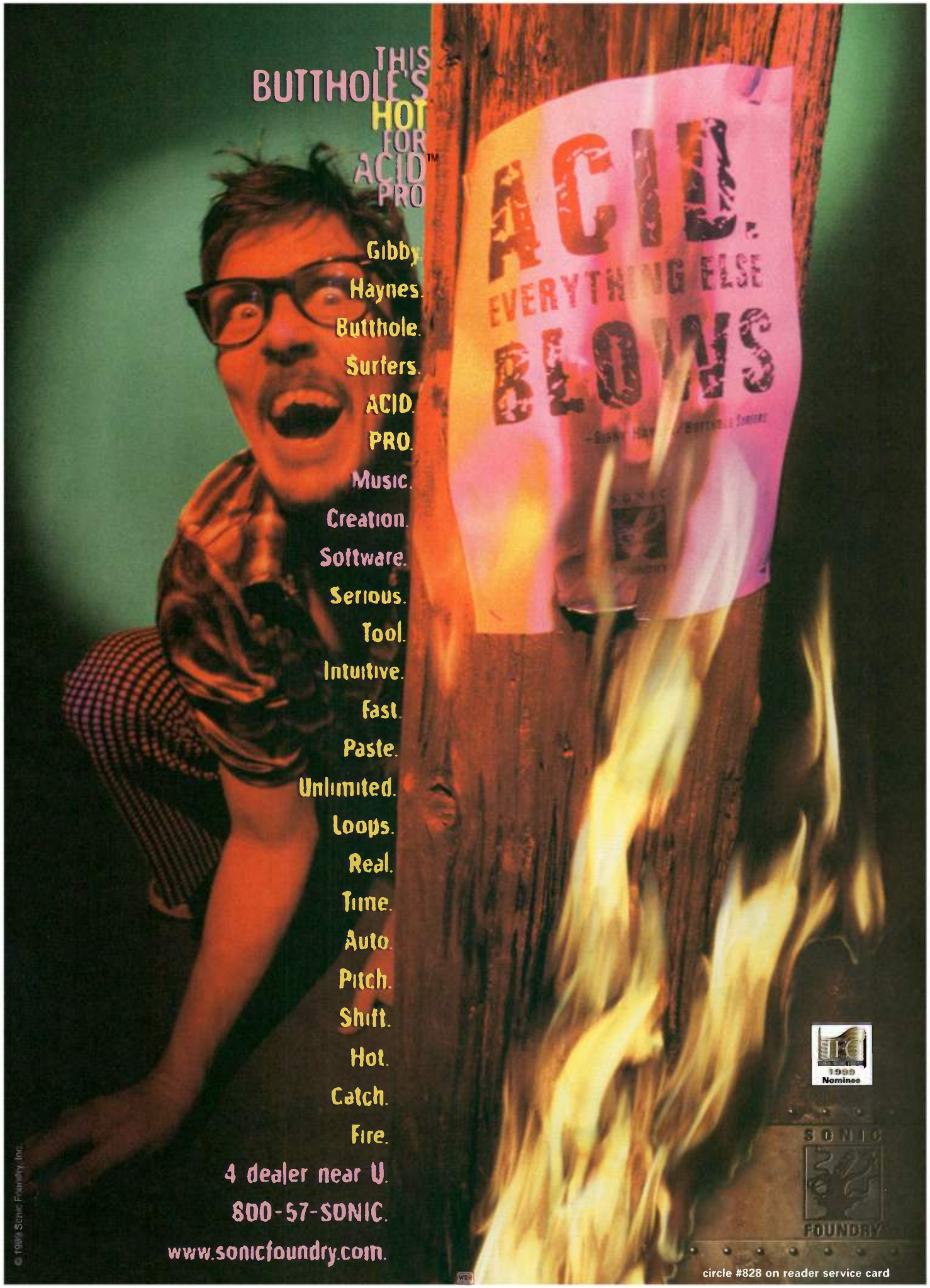
FIG. A: Creative Labs' portable Nomad MP3 player includes a memo recorder that could be handy for lo-fi sampling safaris. For high-quality music production, get the bundle with E-mu's new E-Card sampler.

PitchFork (Win; free) is a *Winamp* plug-in that enables you to change the pitch and speed of two MP3 files to beat-match one to another (see **Fig. C**.) This DJ-oriented plug-in is designed to be used with two *Winamp* players and two sound cards simultaneously for real-time "spinning." Combine *PitchFork* with *Live Input*, and you can broadcast your own sets over the Internet. See http://surf.to/mp3stock.

SSEYO *Koan* (Win; $199.95) is a "generative" sequencer that creates evolving musical arrangements out of short MP3, SoundFont, or WAV files. See www.sseyo.com.

Wave Arts *WaveSurround* (Win; $9.95) is a real-time 3-D plug-in that lets you position your MP3s on a virtual soundstage. See www.wavearts.com.

FIG. C: With the free PitchFork *plug-in for* Winamp *and two sound cards, you can mix and beat-match between two MP3 files in real time.*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The Other Shoe

There's only one major drawback to MP3-encoded audio: it doesn't support copy protection, which means that anyone can pirate an artist's music off the Web and sell it or burn it onto CD. Beatnik (formerly Headspace) has developed a system that overcomes this by "wrapping" the MP3 file in an encrypted shell. See www.beatnik.com for more information.

Another issue involving MP3 (and Web audio in general) is that a fast Internet connection is required to stream it to your desktop. In other words, most listeners won't be able to hear your MP3 file in real time; they'll have to download it completely first.

Use noise-reduction plug-ins or programs on the source material before encoding.

Too big? Encoding at a lower bit rate and/or mixing your stereo file to mono will significantly reduce file size. Listen to make sure that mixing to mono doesn't cause phase-cancellation problems, though.

To hear the results of different preprocessing and encoder settings on the same audio file, click the DMPG link at www.emusician.com.

Uploading Strategies

By now you're crazed with the idea of having *your music* on the Web, right? Before you convert your entire catalog to MP3 format, identify your reasons for putting your music "out there" and then make a plan for achieving your goals. Already the Web seems to be the world's biggest cutout bin, littered with tracks that take five minutes each to download and are more annoying than enriching.

Songs or excerpts? Are you a local unsigned band hoping to entice surfers to buy your CDs? If you have limited server space, posting an entire album's worth of music online probably isn't feasible. Besides, uploading that much audio via a 56 kbps modem just isn't practical. You're better off picking three or so of your best tracks.

But don't waste people's downloading time on excerpts: give them full tracks. These should be representative of your sound so that listeners know what to expect, and club owners know how to book you (in theory). Even better, rotate tracks, posting two new tracks for download every week to keep fans coming back.

Multiple CDs. If you're a solo artist with a catalog of various types of CDs for sale—*Holiday Favorites, Wayne*

Smith Plays the Music of Monk, and so on—then offer a medley of excerpts from each disc. Again, server space is a consideration.

Long form. Are you a programmer or remix musician hoping to broadcast your tracks over the Web? Then complete tracks are a must—not to mention Shoutcast software (www.shoutcast.com) for "Webcasting" MP3 files directly from a Windows computer. You'll also want a fast DSL connection if possible.

Selling files online. If you don't want the overhead of CD duplication and shipping, then selling MP3s as finished products is the way to go. You'll probably need at least 50 MB of server space. You'll also have to consider how to collect money and how to protect your music from being pirated.

An easier solution is to sign up with a site such as MP3.com that gives you a free promotions page (which can include music descriptions, links to personal Web sites, concert dates, band bios, and so on) and lets you upload your MP3 files to its server for purchase by site visitors.

The Future

MP3 technology is still in its infancy, but already there's a lot to crow about. Fast, affordable Internet connections are a reality, and professional MP3 audio tools are on the way. MPEG-4, the much anticipated successor to MP3, promises to be an even bigger deal. This new standard for Internet media features a suite of audio tools, including a software synthesizer capable of FM, physical modeling, sampling, subtractive synthesis, granular synthesis, and more. (You can find out more at http://sound.media.mit.edu/mpeg4, www.ccir.ed.ac.uk/mpeg4, and http://drogo.cselt.stet.it/mpeg.)

No doubt, as musicians migrate to the Web, the ways in which music is made and traded will continue to change. MP3, MPEG-4, and all the other Web audio formats are just interim technology, the wax cylinders of the digital age. Stay tuned. ◆

JOHN KROGH IS THE EDITOR OF EM'S QUARTERLY *REMIX* SUPPLEMENT. HE'S ALSO THE KEYBOARDIST AND COMPUTER ACE FOR WONDERLIFE, WHOSE DEBUT CD IS AVAILABLE ON INTERSCOPE RECORDS.

DM PG 2000

Studio-Tested Shareware

By Dennis Miller and John Poultney

Ten superb music-making programs you can download today.

Software is to desktop musicians as guitars are to guitarists: each instrument can be uniquely inspiring in the right context. But when was the last time you downloaded a *guitar* from the Web and tried it out in your setup to make sure you liked it?

Many commercial software companies offer downloadable demos, but these programs are typically designed to self-destruct or prevent you from saving your work. For this article, we searched out unusual programs that can produce useful musical results in their downloadable state. Quality was the most important criterion, so coauthors Dennis Miller (Windows) and John Poultney (Mac) spent weeks pounding these programs to make sure they're worthy of your time. We want you to laugh with glee as you send in your shareware payments. And please do send them in: supporting shareware programmers helps ensure that there will be more outstanding music software for you to download in the future.

—David Battino

WINDOWS PROGRAMS

Chaosynth

What do you get when you combine techniques for modeling complex natural phenomena such as clouds and wind with the advanced synthesis method called granular synthesis? The answer is *Chaosynth,* an innovative program that generates fascinating and unusual textures consisting of thousands of individual "grains" of sound (see Fig. 1). Nearly all the major sound parameters can be altered in real time, which means

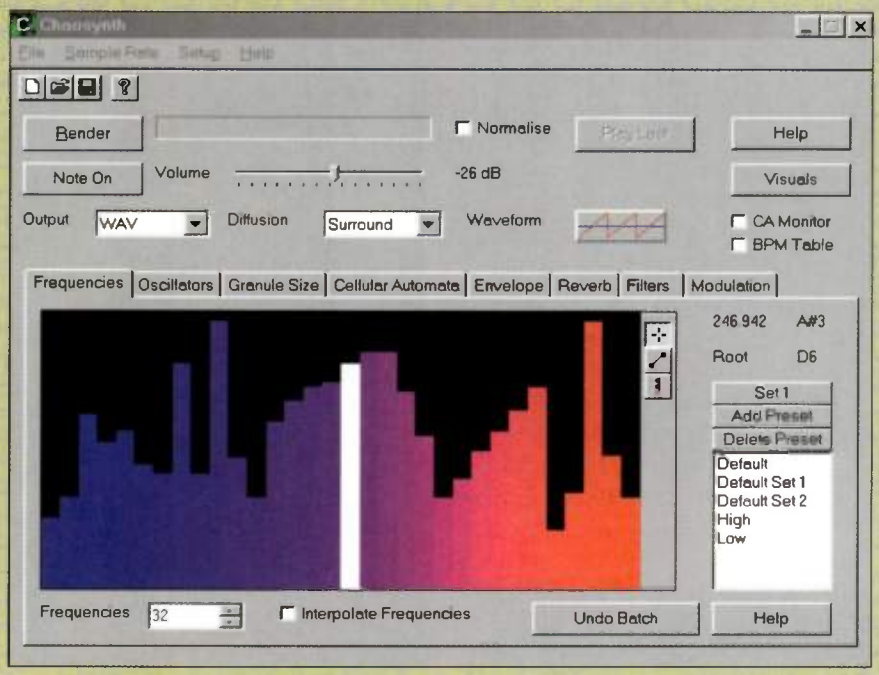


FIG. 1: Chaosynth *generates granular audio and MIDI.*

FIG. 2: With VST Adapter, *DirectX host programs can run VST plug-ins.*

you can "play" *Chaosynth* like your favorite hardware or software synth. You can even alter multiple parameters at the same time via MIDI.

The program generates audio with up to 24-bit resolution and 200 kHz sampling rate. It can output audio in real time but will happily create a WAV file of its output and write it to disk. *Chaosynth* can also create a MIDI file of the data it produces, so you can "orchestrate" your grains using any MIDI sound module you want. (Because today's modules top out at 128-note polyphony, the number of grains is limited in this mode.)

You set your sound's initial parameters by drawing directly on several of the program's screens. For example, you can draw the frequencies for up to 32 oscillators that will be used as the pool from which specific frequencies will be chosen. *Chaosynth* then uses an algorithmic process to spew out continuously evolving variations of these base settings.

Several restrictions have been placed on the downloadable version. It generates only monophonic WAV files and provides just eight oscillators, for example. But because you can save the parameters for a sound as well as the audio output itself, you should find this version more than adequate to give you a taste of what *Chaosynth* has to offer. A Mac version is in the works. **Download from:** www.nyrsound.com. **Price:** £27 (about $45).

VST Adapter

There was a time when PC users had to deal with only one audio plug-in standard. Microsoft's DirectX (formerly known as ActiveMovie) has received near universal support from Windows audio applications since its introduction a few years back. Today, however, a vast array of VST plug-ins is becoming available, due in part to the popularity of Steinberg's *Cubase* sequencer. Yet few Windows programs other than *Cubase* can use them. Enter Amulet Audio's *VST Adapter* (see **Fig. 2**). This useful utility allows any DirectX host program to run VST plug-ins, giving Windows users access to more than 100 free and commercial plug-ins, many of which provide capabilities not found in any DirectX package. **Download from:** www.lawnet-uk.com/amulet. **Price:** $50.

N-Track Studio 1.3.3

Everyone has seen sequencers that integrate MIDI and digital audio, but there aren't many Windows multitrack audio *editors* that incorporate MIDI playback. F.A.Soft's *n-Track Studio* is an inexpensive program that offers many top-of-the-line features. *N-Track* lets you record and play back an unlimited number

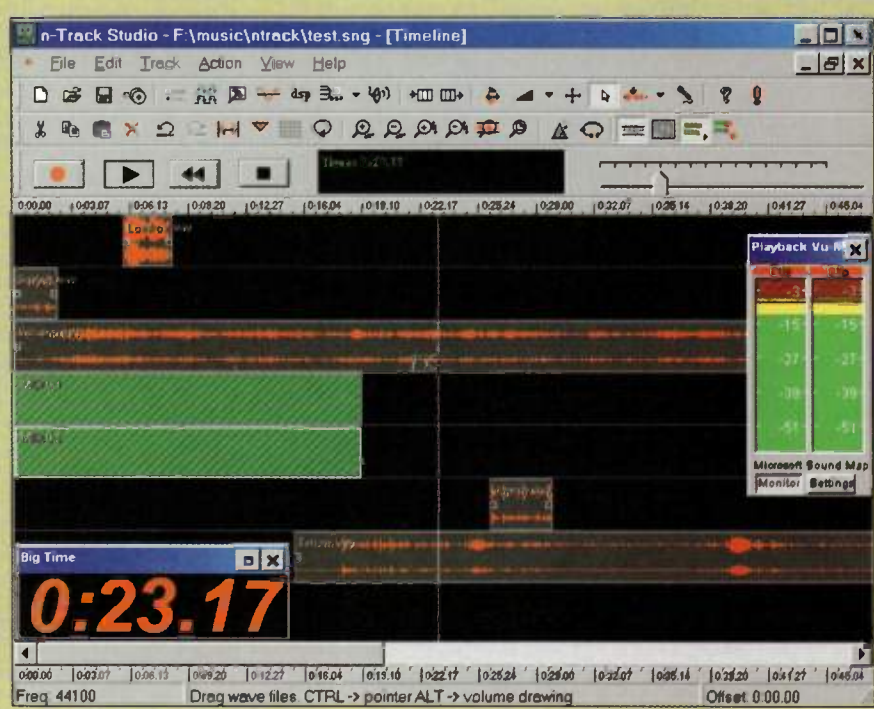


FIG. 3: N-Track Studio *is a full-featured multitrack audio recorder for $35.*

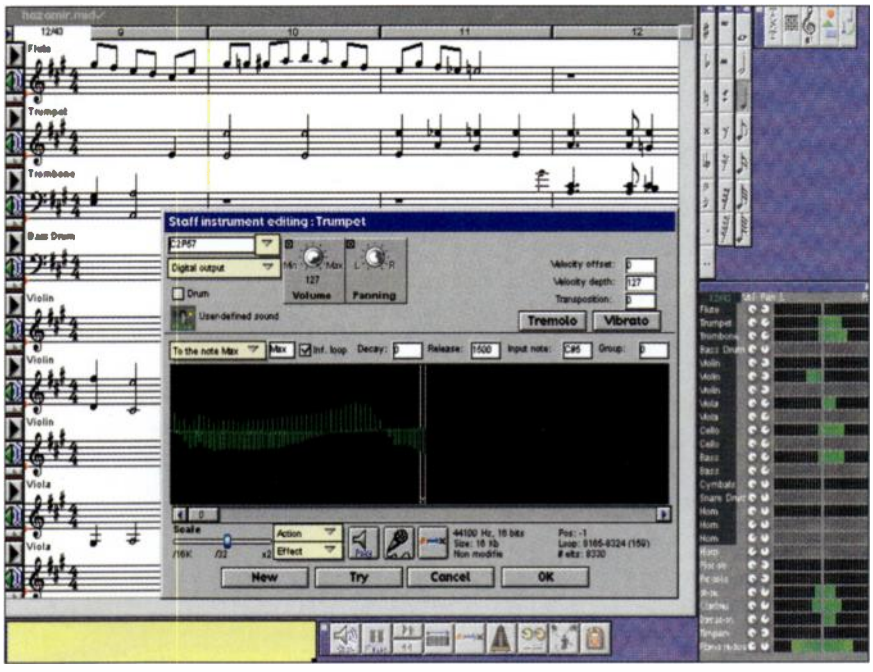


FIG. 4: Melody Assistant *offers sampling, sequencing, and notation.*

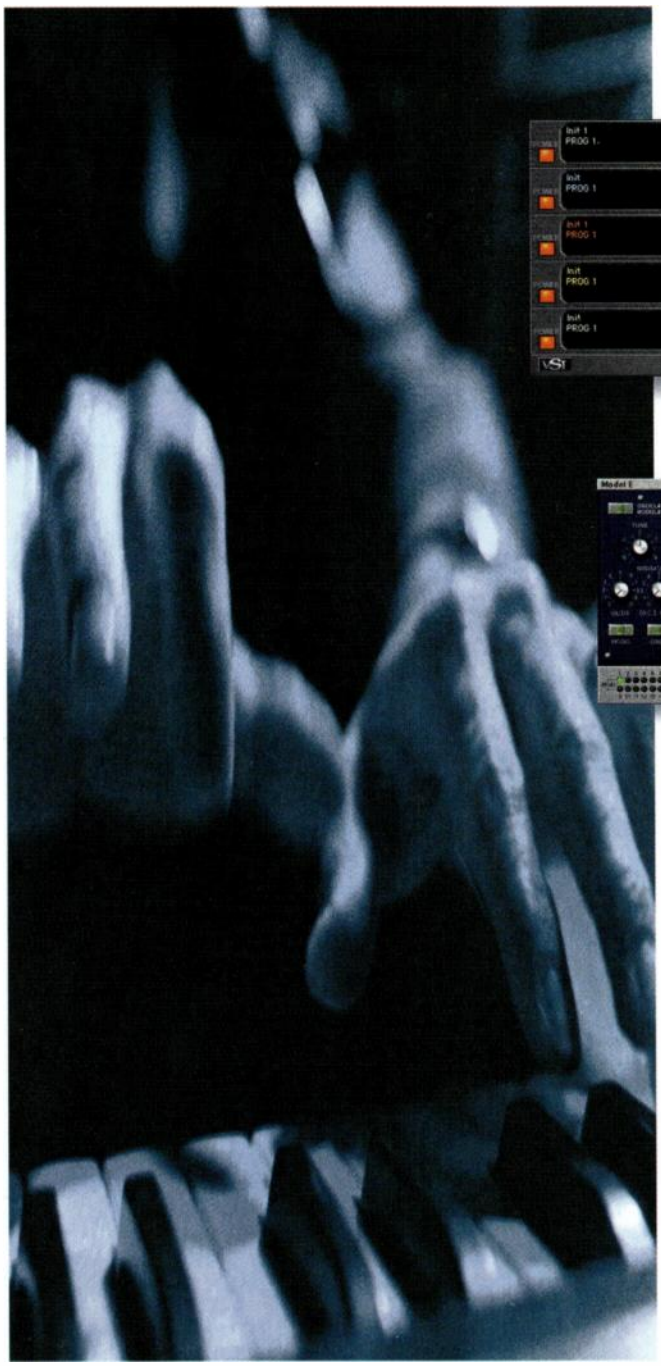
of audio or MIDI tracks, supports DirectX plug-in effects, and can sync playback of a video file (AVI, MPG, or MOV format) with your music (see **Fig. 3**). The registered version of *n-Track Studio* adds the ability to mix all audio tracks—complete with any plug-in effects—to a single stereo WAV file. It can also save audio in MP3 format.

N-Track sports numerous internal effects, such as a useful reverb, echo, and delay, and you also get demo versions of F.A.Soft's own DirectX plug-ins. You can use the plug-ins as track-insert, aux, or master-channel effects, or simply send audio into the program from an external source and use *n-Track* as a real-time effects processor. Keep your eye on the F.A.Soft Web site because updates and enhancements come fast and furious. **Download from:** www.fasoft.com. **Price:** $35.

WINDOWS/MAC PROGRAMS

Melody Assistant

While many desktop music programs are becoming more and more specialized, *Melody Assistant* wants to be your one-stop center for music production. The shareware program offers a unique and elegant combination of notation, MIDI



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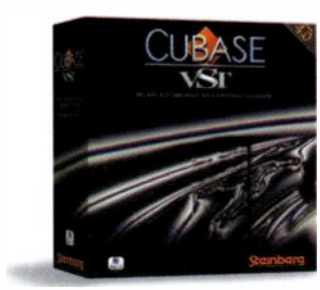

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* The Model E plug-in shown is sold separately.

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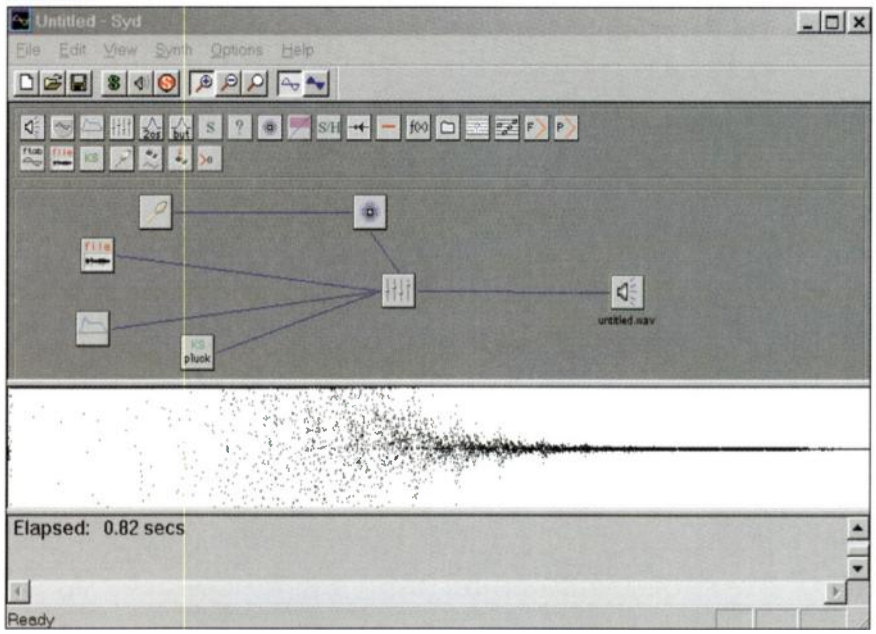

FIG. 5: Build your own synth with Syd. *It's free.*

sequencing, and sampling.

Like most notation programs, *Melody Assistant* groups its symbols into numerous toolbars (see **Fig. 4**). In addition to common symbols for articulation, phrasing, and note durations (values between whole notes and 64ths are supported), you'll find many symbols for guitarists, such as hammer-on, bend-up and bend-down, and "choke."

What sets *Melody Assistant* apart is its sample-playback capabilities. You can load samples from your hard drive and then play them using the note data in your tracks. (A set of samples is provided.) The program will shift the pitch of the samples to match the notes in your score, and it even offers basic audio-editing options. Alternatively, you can play back your compositions via MIDI on a sound card or an external synth. **Download from:** www.myriad-online.com. **Price:** $18.

Syd

Sound design is one of the hottest fields around, and there are many commercial programs that offer extensive tools for shaping and tweaking your material. But Jim Bumgardner's *Syd* is the only completely free program in its category—and it has enough tools to keep you tweaking for days. *Syd* is a modular synthesizer that lets you build complex sounds using various types of sound-generating and sound-processing functions. The functions are represented on the screen as small icons that you "wire" together (see **Fig. 5**). When your design is complete, *Syd* compiles the output into a WAV or AIFF file.

Among the more interesting sound sources are physical models of maracas and plucked strings. You'll also find a nice selection of filters, a mixer, a noise generator, and a function for importing samples. Although *Syd* does not work in real time (you can't play your sounds via MIDI, for example), it can import score files created for the Csound programming language. *Syd* also features a random score generator that's handy for jump-starting your next composition. **Download from:** www.jbum.com/jbum. **Price:** free.

BackToBasics

This tiny (164 KB!) program has big power: it actually turns your computer into a performance sampler. You assign audio files (with up to 32-bit resolution and 64 kHz sampling rate) to computer-keyboard keys, adjust their pitch, volume, and panning, and then trigger them by typing (see **Fig. 6**). Samples can be set to loop or play straight through, and an onscreen ribbon controller lets you perform heroic pitch bends.

BackToBasics is pretty simple to use, though there are a few cryptic icons to learn, and importing multiple sounds on the Mac requires that you mess with suitcase files. The program doesn't have any audio-editing functions, so if you want to use loops on the Mac, you'll first have to insert the loop points with a program such as *D-Sound Pro*. The Windows version loops the entire file.

Although *BackToBasics* can play up to 30 stereo sounds simultaneously, computer keyboards vary in how many keys can register at once. Perhaps that's why each member of Operation Re-Information—the collective of idiosyncratic musicians who wrote this

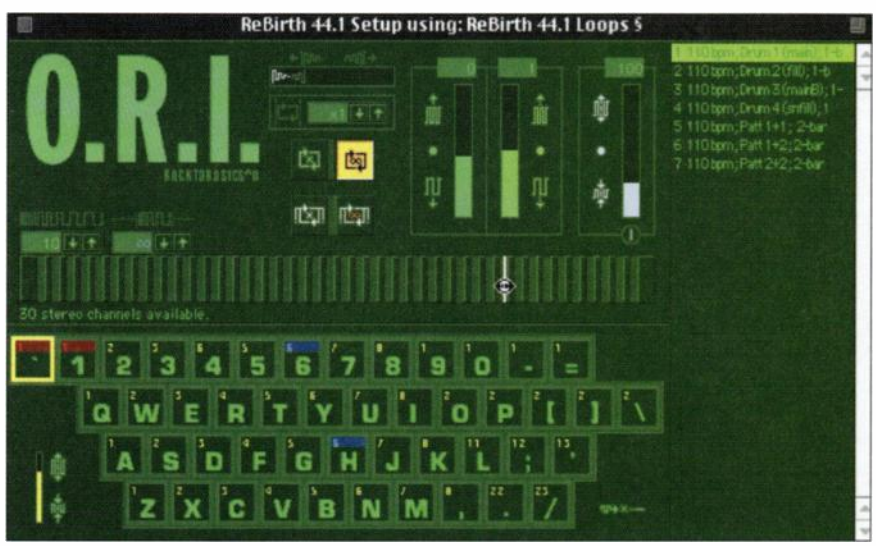

FIG. 6: The BackToBasics *performance sampler.*

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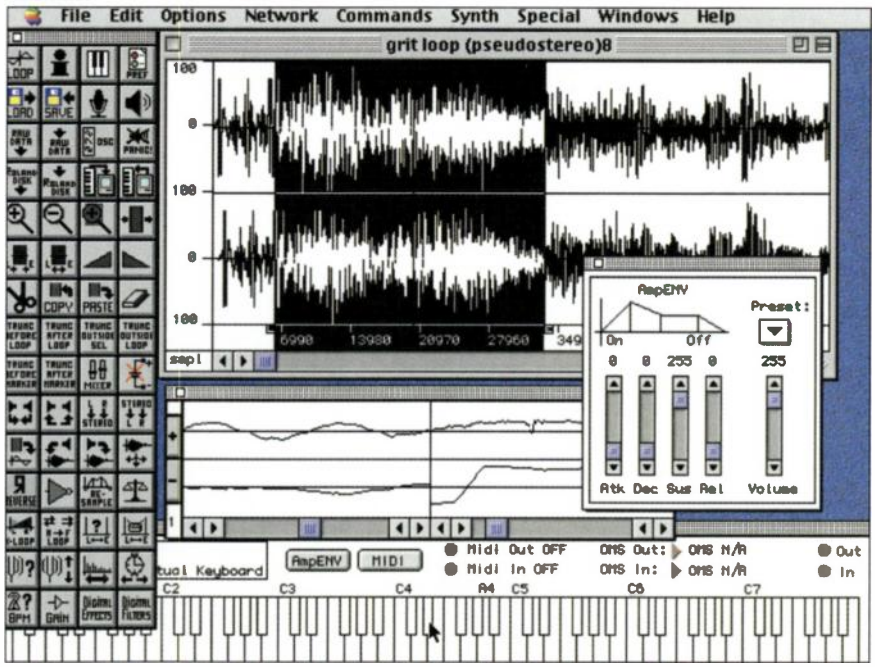

FIG. 7: Make smooth loops in D-Sound Pro.

program—plays their own computer in concert. **Download from:** www.reinformation.com. **Price:** $30.

MAC PROGRAMS

D-Sound Pro

This program is, at its simplest, a stereo sample editor, and at its most complex it is an amazing value. In addition to audio-editing functions and effects, *D-Sound Pro* supports MIDI-note triggering, making it a sampler in its own right. But its integration with hardware samplers is what makes the program indispensable. It can send sample dumps to Akai, E-mu, Kurzweil, Roland, Yamaha, and other instruments, using either SDS or SMDI protocols.

D-Sound's autoloop command does a pretty good job of finding seamless loop points, but the dedicated loop-tuning window makes that easy to do by hand, too. You just click the arrows until the two waveforms flow smoothly into one another (see **Fig. 7**). For the difficult cases, there's also a crossfade function.

D-Sound offers several convenient cropping features, along with a small collection of effects such as reverb, chorus, time stretch, and pitch shift, but the effects algorithms are mediocre. *D-Sound* is RAM based, so unless you have lots of memory, don't plan to work on any really long samples. But hey—that's what loops are for. **Download from:** http://ourworld.compuserve.com/homepages/sdaino. **Price:** $39.

MacPOD

A fun program and a useful one, too—that's *MacPOD*, a real-time granular synthesizer with a straightforward interface (see **Fig. 8**). *MacPOD* produces clouds of sound by breaking input audio files into tiny "grains" and varying the grains' pitch and amplitude. It's as if the dots in a pointillist painting had come to life and started crawling around.

You may have tried other granular synthesis programs, such as *Thonk* (www.audioease.com), that make you wait through interminable processing before giving you the goods. Not this one. You have control over nine parameters, and you'll hear the changes as soon as you make them. The astounding Stretch command lets you vary the duration of the input file from 1 to 500 times its original length without changing the pitch. It's a cinch to transform an innocent sound like a crinkling candy-bar wrapper into a ferocious storm and earthquake.

By varying the number of voices used, you can create extremely lo-fi approximations of your input sound or beef it up massively. The sound will loop continuously as you experiment. Once you're happy with all your settings, you can render the output to disk as a stereo audio file. Registering the

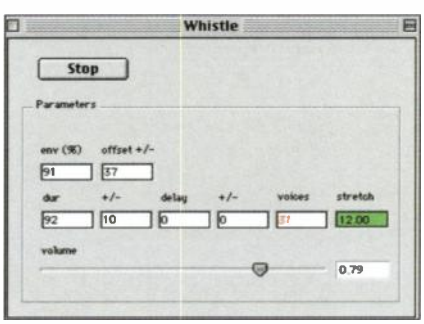

FIG. 8: MacPOD *has a simple interface, but amazing sound.*

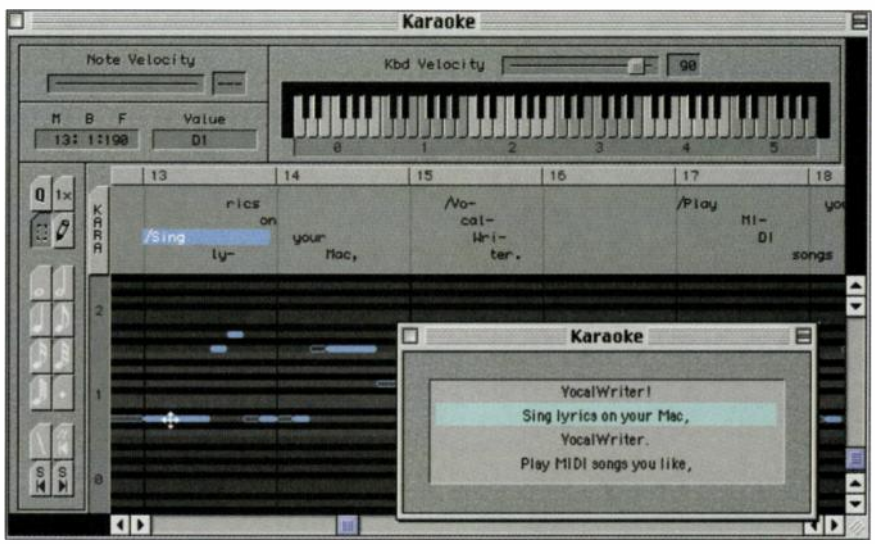

FIG. 9: Your Mac can sing with VocalWriter.

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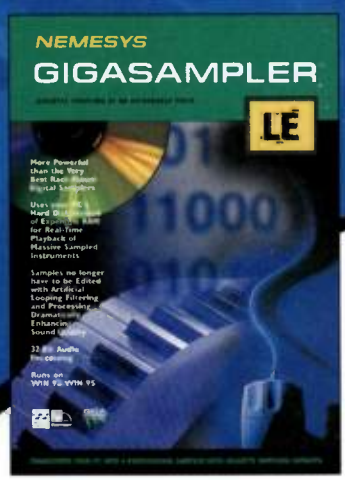

*Based on Mfr. U.S. retail Price List January 1998, prices and features may vary according to make, model, or upgrade options.

† Price not including the cost of a PC with audio (approx $1,350) PII/300Mhz, 128 MB RAM, 8.4GB UDMA, 36X CD ROM, sound card w/ S/PDIF, 4MB SGRAM Graphics, FD, Win98, kbd, mouse and monitor.

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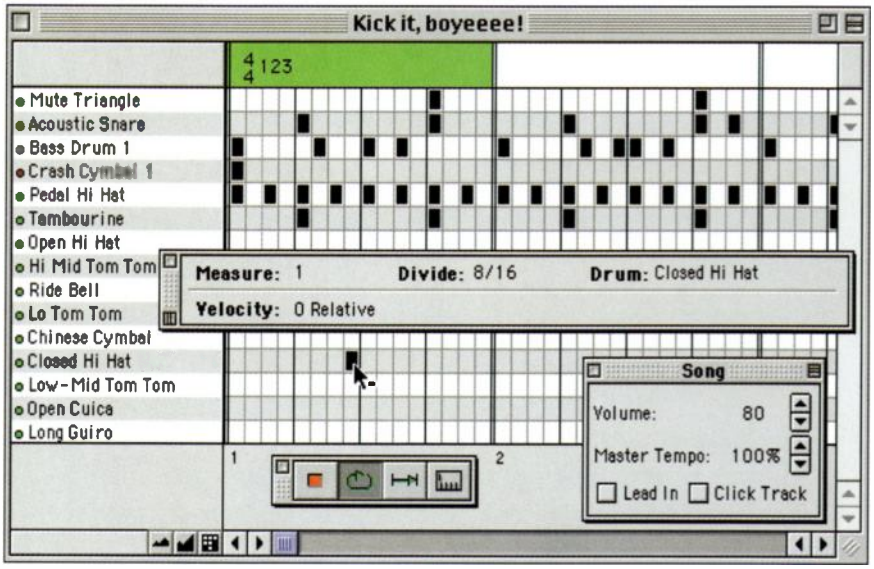

FIG. 10: Virtual Drummer *MIDI drum machine.*

program unlocks *MacPOD*'s MIDI functions; it will then respond to Continuous Controller messages. **Download from:** www3.bc.sympatico.ca/thirdmonk. **Price:** $20.

VocalWriter

You're a pretty fair composer, sure. But when you open your mouth, the trouble begins. Try as you might, you're just not all that great a singer. Sound familiar? Then you may want to check out KAE Labs' amazing *VocalWriter*. It's a 32-track MIDI sequencer coupled with a software synth designed to emulate human voices (see **Fig. 9**).

VocalWriter lets you add lyrics to your sequences and hear the results right away. There are more than 80 vocal timbres, ranging from male and female voices to singing Vibra-slaps. And while they're obviously synthetic, the results are undeniable. You could certainly use the program as a demo to teach real singers your songs' melody and harmony parts. Those who can think of more nefarious applications for crooning robotic voices can render the entire performance as a 16-bit, 44.1 kHz stereo audio file.

Best of all, you don't have to spell out the words phonetically—the speech-synthesis engine knows how to pronounce more than 100,000 of them. **Download from:** www.kaelabs.com. **Price:** $99.

Virtual Drummer

How are your drumming skills? That bad, huh? What if we told you there's an easy-to-use, *free* program that could get you grooving quickly?

Virtual Drummer features a grid-style interface reminiscent of old Roland drum machines, but the grid's size and resolution are adjustable (see **Fig. 10**). You simply click on a square to input a drum sound on a specific subdivision of the beat. Control-clicking allows you to specify the note's velocity (volume). Sounds are generated in real time via Apple's QuickTime Musical Instruments (a free software synth based on Roland samples), so you don't need any external gear.

Although *Virtual Drummer* lacks the humanizing "swing" and "shuffle" features found in MIDI sequencers, it's simple to export your pattern as a MIDI file (or even as an audio file) for detailed shaping in one of those gargantuan applications. *Virtual Drummer* can also *import* drum tracks from Standard MIDI Files, so you can see how other musicians assemble their grooves. A handy "drumlets" database gives you instant access to patterns, and you can make most of the edits while the music plays. Budda bing! **Download from:** www.virtualdrummer.com. **Price:** free. ◆

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Desktop Video Scoring Explained

By Don Veca

Compose and record a movie soundtrack on your computer.

It used to be complicated; now it's simple. It used to be expensive; now it's cheap. It used to be mysterious; now it's obvious. Thanks to the magic of integrated music software, just about anyone can create a video soundtrack. If you've dreamed of creating a score for a movie or have just wanted to add some background music to your home videos, this article will explain how easy it can be. By following the simple steps outlined here, you'll gain the background you need to be the next "Hans Elfman-Goldsmith." (Well, not quite, but you'll definitely get enough information to create a soundtrack for your family-reunion documentary.) At the same time, you'll get a reasonably good idea of what it takes to create a fully orchestrated score for a professional video, without leaving your bedroom studio.

What Do I Know?

When I started working as a composer and software engineer at Electronic Arts seven years ago, I got to watch the

Author Don Veca uses a dual-monitor setup when recording video soundtracks. One screen displays the mixer and digital video; the other shows the sequencer tracks and notation.

"post pros" in action, synching up their high-resolution videos with multitrack music and sound effects via thousands of dollars' worth of high-end gear. Universal Slave Drivers, professional video decks, black-burst generators, control messages flying all over the place—it was mystifying, to say the least.

By the time I got my first crack at it, however, the software industry had made some giant leaps. Apple's QuickTime digital video format was becoming a cross-platform standard, and Microsoft's AVI format was spreading fast. More exciting for us musicians, programs like Opcode *Studio Vision Pro* and Emagic *Logic Audio* were integrating MIDI, digital audio, music notation, and digital video into a single, reasonably priced desktop package. I was amazed at how easy it was to create pro-sounding scores for videos. Today it's faster and easier than ever. Admittedly, this setup won't give you the pretty, high-resolution picture you get from a dedicated video deck, but considering its ease of use and random access, I can definitely live with the trade-offs.

Rather than dealing with all the complexities and expense of synchronizing a MIDI sequencer (or worse, a tape recorder) with a video deck, the desktop composer is now able to focus on what it *really* takes to make music: being musical.

For this thought-provoking image, Veca had the entire orchestra play long, fortissimo unison tones over stiff, staccato unison percussion lines.

Assumed knowledge. At this point I should clarify what I meant by saying that "just about anyone" can do it. I'm assuming that you have a very minimal video background, but I'm also assuming that you're pretty dangerous when it comes to making music on your Mac or PC. This means that you already have experience with MIDI and have the gear and knowledge it takes to at least mix tracks down to a stereo audio file. I use a Mac

This clip started with a Russian victory celebration, then switched to a U.S. one. Veca maintained an up-tempo 12/8 march feel, but he switched keys and changed from a legato low-brass melody to a more pronounced trumpet/flute one.

for all this stuff, but the concepts are virtually the same on both platforms.

Finally, because video editing is beyond the scope of this article, I'm assuming that you already have an edited digital video to work with. There are lots of ways to get one (see the sidebar "How to Get a Digital Video").

Equipment

Although it's far less expensive than it used to be, desktop scoring does require a few cutting-edge widgets. On the hardware side, you'll need at least a Power Mac or a Pentium, lots of memory (more than 64 MB), and a 2 to 4 GB SCSI drive for audio and video. Although your software may state that the minimum requirements are lower, in this case more is definitely better.

You might think you'll need tons of hard-disk space, but the largest digital video from my most recent project was under 38 MB. In fact, my entire project folder—including movies with dialog, digital music tracks, temporary "placeholder" music, MIDI files, and text documents—consumed less than 3.5 GB. The project before that took only 2 GB. Drive *speed* is very important, though. A 7,200 rpm Seagate Barracuda or Cheetah drive will work fine for starters.

Audio input/output. You may also need a decent audio card for your computer. There are lots of choices; it all depends on how professional you need your music to sound. I've done a few projects using the built-in audio circuitry of a 200 MHz Mac. You get a higher noise floor, run into some sync problems, and have to do all your digital effects offline, but you can get somewhere around 8 to 12 voices of digital audio. I now use a Digidesign Pro Tools/24 Mix Plus system, which provides me with a professional digital audio environment. (For the serious musician on a budget, Digidesign just released the $995 Digi 001 package, which includes *Pro Tools 5 LE* and multichannel audio hardware.)

Instruments. For the best results, you'll also need some decent synths and samplers, but you can still make a soundtrack for your home videos with a low-end General MIDI synth. Instruments like the Roland JV-1080, Kurzweil K2000, and Clavia Nord Lead 2 work well for what I do, but you'll find gazillions to choose from. There are also lots of killer samplers, but I stick with Digidesign's SampleCell II; its ease of use, price, and flawless TDM integration work for me. If you're going to be recording any live musicians, you'll need to spring for the usual mics and effects boxes (and/or software plug-ins), too.

Software. You can do your whole project with just one or two software applications. I use *Logic Audio Platinum* for 90 percent of my scoring work. *Logic* is a great example of a totally integrated music workstation. You get first-class MIDI sequencing, intelligent and professional-looking music notation, digital audio recording/editing, serious TDM support, and full digital video synchronization, all from within a single application.

I spend the other 10 percent of my time using a dedicated digital audio editor. I use BIAS *Peak*, but many others are available for both Macs and PCs. A nice thing about *Logic* and *Peak* is that they offer scaled-back versions with lower prices, so you don't have to sell the farm to do the simplest projects. Many other digital audio sequencers support digital video, including Cakewalk *Pro Audio* 8 and *Metro*, Mark of the Unicorn *Digital Performer*, and Steinberg *Cubase VST*.

Now that we've got the gear out of the way, let's talk about the music.

Before You Score

Before you compose a note of music, you have to make a few important decisions. The obvious one is the style or genre of music. This is most often determined by the project's producer, but not always. (Of course, you're the producer on your own projects.) Another choice to make is whether you want "background" music or a score that accents the emotion and action of the video. These two decisions, as we'll see, can greatly affect the scoring process.

See me. One of the most interesting ways to score is the "video-first" approach. Here, the video editor and producer edit a scene without any music to influence them. This gives them total freedom but presents some interesting challenges for the composer. There is no concept of tempo, bars, or beats in the flow of the video, but you may be expected to "hit" many of the events (or *cues*), as well as change the music's mood to emphasize the video's emotional energy.

That requires a lot of creative thinking. For instance, you may be in the middle of an upbeat phrase of 4/4 time at 132 bpm but find that you need to

To express grief, Veca used somber midrange French horn and low flute harmonies, played over warm strings in a minor key.

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This is where all hell breaks loose, so Veca made an extra effort to punctuate the scene with chaotic brass lines and big orchestral accents on the rapid scene cuts.

transition into a slower, moody section for a few seconds. In that case, you may need to end the phrase with a measure or two in a different time signature—while modulating keys as you gradually slow the tempo to 84 bpm—then transition back up to, perhaps, a military-march tempo. The video constantly dictates your tempos, time signatures, and harmonic moods.

With the video-first approach, the music sometimes seems to write itself. I think this method works great for orchestral music, which lends itself well to tempo, time-signature, and key transitions (without sounding like the Mahavishnu Orchestra).

Hear me. Another way to proceed is to write the music for a scene first and let the video editor follow your lead. This approach is usually more inspiring for the editor, and it works much better if the music needs to sound like a song—for example, the theme song of a movie, or the opening video of a computer game. (How many melodies can you recall that have 11/8 bars in them?) The only drawback this presents is that the producer may have specific graphic cues and cuts in mind, and it may be very awkward to fit them to the music.

Tell me a story. A more reasonable way to handle a songlike score is for the producer and/or designer to write out a storyboard that specifies approximately when each event will take place. The composer can then write a song that loosely follows the storyboard over time. The music is next handed off to the video editor, who cuts the video to it, and everybody is happy.

Copy me. There are also cases where the production team already has a piece of music in mind for a scene. It may be a section of an existing film score whose energy and emotion would work well with the video. In this case, the picture may be cut to some "placeholder" music, and you may be asked to replace it with an original piece. Although this method can work just fine, it tends to handcuff the composer, forcing him or her to keep the exact form of the placeholder music to sync it with the major scene cuts.

It's also very easy for people to get "demo-itis" and be disappointed when they don't hear what they're used to. If everyone is careful and cooperative, however, the result can be great.

Take it from me. If the decision is made to edit the video before the music is composed, then there's one thing you need to make very clear to the producer and video editor: *Not a note until the video is frozen.* This may seem a bit overstated, but if you compose your music to fit certain cuts and cues, and then someone makes "just one little change," you can wind up wasting a lot of time trying to patch things back together musically. And even once you do fix it, the overall effect may still suffer as a result.

Now let's move on to a real-world project.

The Project

When I was asked to write this article, I was just finishing up *F/A-18,* a "flight sim/shooter" published by Electronic Arts under its Jane's Combat Simulations brand. This project included 25 action-packed video clips that required orchestral or "cinematic" music (1 intro video and 24 "campaign videos" that you get to see only after killing a sufficient number of bad guys). About 16 of the campaign videos were very short (only about 15 seconds), and the rest ranged between 30 and 90 seconds.

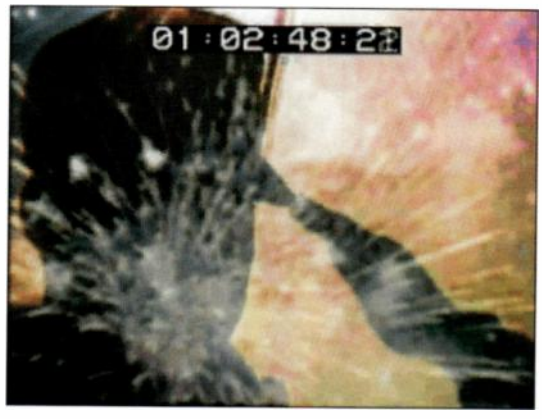
After thorough discussion, the media production team and I decided to go with the background-music approach for the 16 short clips. For these, I used *Logic* to cut up the music I had already composed for the game's menu and credits screens, then added some heavy orchestral percussion and hits to emphasize the cuts and cues. The remaining video clips, however, required music that would directly reflect the action and emotion of every scene.

For all but two of the remaining clips, we decided to go with the video-first approach, which worked out great. For those remaining two (including the all-important intro video), however, the producer already had some specific music in mind, and he and the rest of the production team were very attached to it. Maintaining the mood, energy, and timing of the placeholder music turned out to be a bit more complicated than I had imagined.

Nuts and Bolts

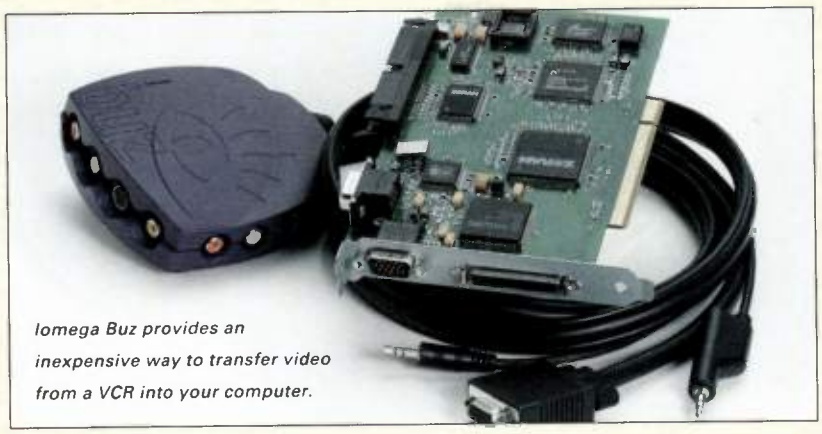
Before you start composing, there are a few things you need to understand. Let's look at how all the tools work together.

Video format. First of all, you need an edited digital video in the proper format for your sequencer. The two sequencers I use most, *Studio Vision Pro* and *Logic Audio Platinum,* both support QuickTime video. Although it's



This multilayered shot shows America's finest saluting Old Glory. Veca captured the patriotic spirit with a big major chord played by the entire orchestra with piccolo on top.

How to Get a Digital Video



Iomega Buz provides an inexpensive way to transfer video from a VCR into your computer.

There are several ways you can create or acquire an edited digital video for your scoring project. The simplest is to grab one off the Web or a clip-art CD-ROM. (Be sure to check the licensing restrictions if you plan to distribute your work.) A unique option for Windows musicians is Magix *Music Maker Professional,* a digital audio sequencer that includes basic video-editing functions and four CD-ROMs of royalty-free video clips.

For a more personal touch, get a "vidiot" to make a digital movie for you. With the advent of consumer digital video cameras, there's a good chance that you know a video enthusiast who would love to collaborate on a project. Just tell him or her what format you need (see the "Nuts and Bolts" section of the main story), and you're there.

To digitize videos yourself, you'll need three things: a VCR or a camcorder with video outputs, a computer video card that accepts audio/video inputs, and video-editing software such as Adobe *Premiere* (Mac/Win). Two cross-platform consumer packages, Avid Cinema and Iomega Buz, combine a card and editing software for around $200.

If you're lucky enough to have one of the newer digital camcorders with a FireWire (IEEE 1394) connector, then you won't even need the video card. (You will need a FireWire card, of course, unless you have a recent Mac.)

If you're just looking for interesting visual effects to enhance your music, check out one of the many eye-candy programs that generate QuickTime and AVI files, such as Steinberg *X<>Pose,* Imaja *Bliss Paint,* U&I Software *ArtMatic,* or MetaCreations *Bryce* and *Kai's Power Goo.*

—Don Veca and David Battino

nice to watch a high-resolution video while you're composing, I've found that a 320 x 240-pixel, 15-frames-per-second QuickTime movie is a reasonable trade-off. (I've experienced some sluggishness with higher rates.) I run my monitor, a 21-inch Radius, in 256-color mode for better update speed. At 1,152 x 870-pixel screen resolution, the movie-playback window is about 4 x 5 inches.

Preserving reference dialog. Most of the *F/A-18* videos contained a lot of dialog, so I had the video editor include a mono dialog track as part of the movie. (I didn't want my music to step on the words.) Before importing the video into your sequencer, you'll need to extract the audio tracks, if any, and save them as AIFF files (or whatever format your sequencer uses). Next, delete the movie's audio track and save the movie as a new file. This can all be done easily with Apple's *MoviePlayer,* which comes with QuickTime. (Cheapskate scorer's tip: *MoviePlayer* version 3 and later require the $29.95 QuickTime Pro for some of these features. But the free *MoviePlayer* 2.5.1 still works fine.)

Importing the video. Now that you have your video in the proper

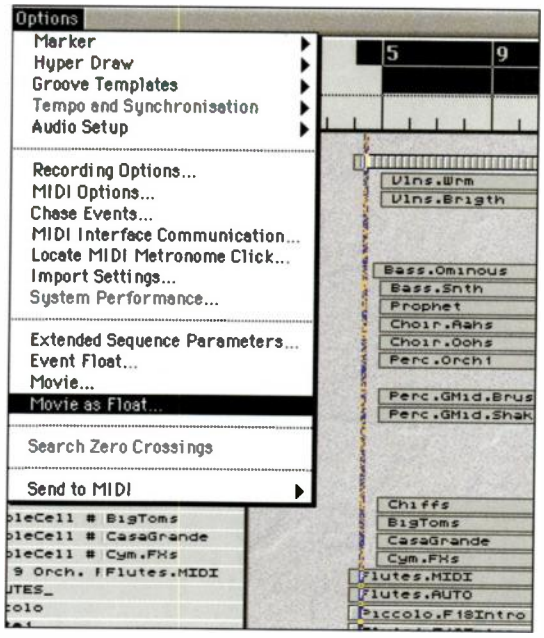


FIG. 1: When importing a QuickTime movie into Logic Audio, *you have the option to display it in a window that will always stay on top.*

format, you need to import it, along with the reference dialog audio track, into your sequencer. In most programs it's amazingly simple to import the video. Just use the Open menu in *Studio Vision*, and select your movie. In *Logic*, use the Arrange window's Options menu to choose Movie or Movie as Float (see **Fig. 1**). The latter command opens the movie in a floating window, keeping it in view at all times.

Synchronization. Just about the only part of this process that may require a bit of brain food is synchronization, so down that Dew now. If the actual footage of your movie clip starts at the very first frame of your digital video (no "leader" frames), and you want it to correspond to bar 1, beat 1, tick 1 of your sequencer, then it's a no-brainer. Just hit your Start button, and everything will play fine.

However, there are certain situations where you may need a bit more flexibility. The 25 QuickTime movies I received for the *F/A-18* project, for instance, were delivered to me inside of just three QuickTime files. Each movie started out with 15 seconds of "black" and then progressed to clip 1, then 15 seconds of black, clip 2, and so on. (This batching method simplifies the digitization process; the video editor can start the process going at the end of the day and return the next morning to find it all done.)

It's very important that everyone have the same time reference when discussing a particular clip, so the video editor graciously "burned" our common reference time code into each frame of the movie. No matter which frame I moved to, I would see the time offset from the beginning of each video clip as part of the picture itself.

When there is lead-in video (the black frames), it's common practice to mark the first frame of the "real" picture with a reference time code of 01:00:00:00 (one hour, zero minutes, zero seconds, and zero frames). So in this case, the *very* first (black) frame of the entire QuickTime movie displayed a reference code of 00:59:45:00 (that is, 15 seconds before one hour).

I usually have the first "real" frame of the movie start on bar 5, beat 1, tick 1. I like to have about four bars of headroom before the actual downbeat for several reasons: you can give live musicians a count-off, store short SysEx patch dumps, or allow the digital audio/video system a chance to "get rolling" before the first tick. It's also handy if you want to start with a few pickup notes before landing on beat 1 (right where the missile smashes into the aircraft carrier!).

This sounds like a big mess (because it is), but a decent music software package makes it very simple. All I had to do was tell *Logic* that bar 5, beat 1, tick 1 should be at the same place in time as SMPTE time 01:00:00:00, and that the very first (black) frame of the QuickTime movie started at 00:59:45:00 (see **Fig. 2**).

FIG. 2: Veca aligned the fifth bar of his sequence with the first frame of the movie (a fade-up from black) to create a four-bar lead-in. The movie itself had a 15-second blank leader, so he also offset the SMPTE display by 15 seconds.

Composing

And now, the fun part. With the science out of the way, we can focus on the art of video scoring. After all, the pictures tell the audience what's going on, but the music tells them what to feel.

Tempo and energy. When I look at a new video, the first thing I like to do is get a feel for the overall energy of the various sections. To me, tempo and energy go hand in hand. That's not to say that faster cues are necessarily more energetic, but the energy of the grooves needs to match the picture, and a video's rhythmic feel is very dependent on tempo.

For the intro video, I was mostly stuck with the tempos of the placeholder music, but I did stray a bit from the original energy. I felt it should be more intense in places to match the action. Whether I'm replacing temporary music or not, my first step is to determine what the tempos will be, and then "spot" the points in the video where the tempo will change. I usually set the opening tempo first, then drag a MIDI drum hit to the point where I want the next tempo change to occur. The video scrolls along frame by frame as you drag the note, making this task very easy (and fun).

It sometimes sounds cooler to ease into the new tempo

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gradually, in which case you'll need to create a *tempo map*. Most sequencers let you specify a list of tempo changes at various positions in your score, but the good ones let you draw a *tempo curve* (see Fig. 3). It can be tricky trying to get from point A to point B smoothly; this is where throwing in a bar of 9/8 or so may come in handy.

Once you've marked all your tempo changes, make sure you're really happy with them. MIDI has no problem adjusting to new tempos, but once you record the first audio track, you're stuck with it. Even if you use only MIDI instruments, altering the tempo later will cause any notes you've already recorded to fall out of sync with the images on the video. Some sequencers, though, allow you to specify that events on a particular track be referenced to real time as opposed to musical time (bars, beats, and ticks), so any events that you spot will stay put.

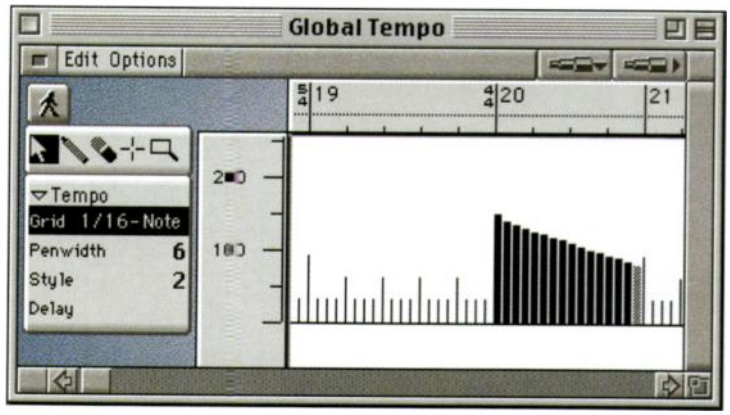

FIG. 3: By drawing a tempo curve in Logic Audio, *Veca created a smooth transition from 150 to 82 bpm over 4 beats.*

To evaluate tempos, you can listen to your cues along with your sequencer's metronome; however, I prefer listening to a custom click track that I build for each piece.

Mood and emotion. Once the tempo changes are spotted, it's time to think about the emotion you want to convey. The *F/A-18* videos were packed with thought-provoking images, so the videos pretty much scored themselves. I like to mark the "emotional sections" in the same way I mark everything else—by dragging different types of (temporary) drum hits into place—but feel free to use whatever makes musical sense to you. After you determine all the tempos and mood changes, it's time to start thinking about notes.

There are two places in any piece of music that you really don't want to blow: the beginning and the end. The *F/A-18* intro video starts out very dark and foreboding. I not only had to capture the mood here, but I also needed to compose a musical introduction to the entire game! I decided to open with the main theme from the music that I'd already composed for the game's menu and credits screens.

This time, however, I tried to make it sound much more ominous. After a few

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This image of pain sneaks in very briefly, with the victim's head swinging up and coming into focus. Veca used a crescendoing cymbal roll to emphasize the head's motion.

bars of very solemn D minor, the video explodes into heavy action—a perfect opportunity for a serious crescendo. It's the big eye-opener of the video, calling for some very dramatic punctuation. This is a pretty typical technique in a video-game intro movie: sneak into it, then explode. From here on out, the music is at "10" (until we get to the ending and turn it up to 11).

Although the intro had only two emotional sections, most of the other *F/A-18* videos had many more hills and valleys; your video will have its own emotional curve for you to explore.

Themes and motifs. Anyone who's ever seen a major motion picture and actually listened to the music understands the idea of the recurring theme. If you have a chance to check out the *F/A-18* videos, you'll notice that the melodies I plundered from the menu and credits music are sprinkled throughout them all, making the music (as well as the video itself) much more cohesive.

Before I start composing any type of orchestral music, I usually spend a good day or two just experimenting with different themes. You can really get a lot of mileage out of a single theme if you play around with it long enough. For instance, try sequencing a very simple melody, and then play the MIDI notes in reverse order. (Some sequencers have a feature for doing this.) Another interesting technique is to use the same melody but change the root to the relative minor key. The relationships of the notes to the new chord become completely different. Moving the melodies around to various instruments, playing them half as fast, and using different modes are just a few ways you can maintain continuity while emphasizing change.

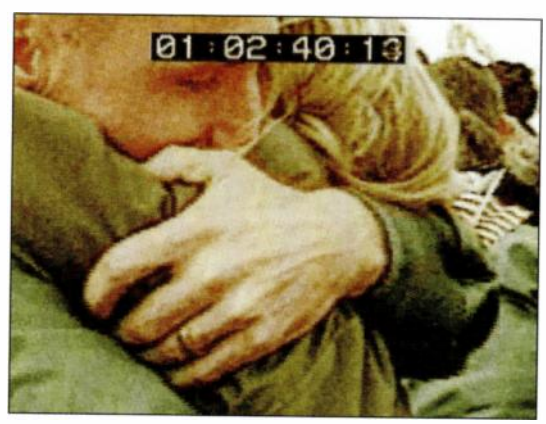
Orchestration. The effect of the emotional curve can be greatly enhanced by your orchestra. An orchestra can range from a guitar and a drum machine to your local symphony, but the former will probably be more in line with most budgets. I used to use only MIDI instruments for my game compositions, but the increasingly frequent pronouncements of "cheesy" and "sterile" (uttered by just about everyone from reviewers to my mother) made me rethink my orchestration. *Composing* your score with MIDI can be very convenient, and it lets you demo your ideas to the production team before you commit to recording live players.

Here are some general instrumentation guidelines: for techno stuff, lots of wacky modular synths are expected. If you're doing rock, don't use MIDI guitars, *period.* (And use a real bass player if you can afford it.) Avoid synth-drum sounds for most styles; dozens of excellent drum sample libraries are available now, and the dramatic improvement they'll make to your music is well worth the price.

If you're doing more traditional orchestral music, then the instrumentation takes a bit more thought. Perhaps the most important rule to follow is, *Never use MIDI brass.* Even brass sample libraries tend to sound pretty dorky. Instead, compose your stuff with MIDI brass, and then record live players to replace the MIDI. Most woodwind patches (flute, piccolo, clarinet, and so on) sound really dumb, too; either don't use any, or hire your next-door neighbor's daughter to play along with your MIDI flute part, or marry a flute player who can play in tune. I would love to hire a full orchestra, but only the big-budget projects can afford it. I try to use only what it takes to do the job yet still make the instrumentation sound credible.

For the *F/A-18* project, I tried not to use any synth patches that sounded too phony. I used layered synth *string-section* patches (with a live solo violin on the credits music), some awesome men's choir samples from Spectrasonics' *Symphony of Voices,* and tons of percussion samples from my K2000 and SampleCell II. I used live French horn, trumpet, tenor trombone, bass trombone, flute, and piccolo, recording roughly three voices per instrument—all in my bedroom studio. (Close-miking helps disguise the sound of the room; I add reverb later to fill things out.) The main idea here is that you need to first determine your orchestra, and then write *for* it.

Scenes and cues. Probably the most fun aspect of scoring for video is writing for all the scene cuts and visual cues. Although the *F/A-18* videos are relatively short clips, they're jam-packed with quick cuts and heavy action. Once again, I started off by inserting a temporary audio marker for the cuts and cues I thought should be accented. For major scene cuts, I usually use a big boomy orchestral bass drum; for quicker cuts and cues, I may use drum fills to match the action. Once all the cuts and cues are marked and the real composition begins, it sometimes feels as though I'm just



This joyous reunion scene just cried out for a big major triad with the fourth in the bass.

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musically connecting the dots. For me, this approach makes the job seem much less daunting.

On the *F/A-18* project, I grouped the quick cuts into logical "scenes" and then changed the musical groove and emotion to complement them. Jumping from section to section, however, can sound unmusical and amateurish. Musical transitions between the scenes not only help make your music flow, but they can really bring out the drama of the movie itself. Transitions are especially important to the video because they help to connect the various scenes. Spending a bar or two setting up a key change, along with a lead-in line in the melody or a drum fill, can make all the difference in the world. If a surprise is what you're after, then simply jump into your next section with no transition at all. (A nice big hit on the downbeat can make an even more dramatic impression.)

When trying to convey fear and anxiety, you'll never miss by using a diminished tonality, but it can sound corny if you're not careful.

I tried to hit the shorter video cuts—and the specific visual events within the cuts—with musical accents: shorter phrases, chords, or percussives. You really need to watch out for the Batman syndrome here, though: in some of my first scoring efforts, I tended to overdo this accent effect a bit, with results that were reminiscent of the fight scenes from the old *Batman* TV series (Pow!). I still like to hit most of the cues, but now I often try to do it a little more subtly.

Sound effects and dialog. Creating sound effects and dialog for your video is beyond the scope of this article, but here are a few tips on how to handle it from the scoring end. Dialog, when present, is usually regarded as the most important thing to hear; therefore, you have to leave room for it. Avoid writing busy musical passages, especially when using instruments that tend to stick out in the mix. If there are sound effects in a clip, then the sound designer and the composer need to figure out beforehand which cues will have heavy effects. Just make sure that you won't all be stepping over one another.

Creating the Master Video

Okay, you're done with your score. Now what? There are a few different ways to create your master video; it all depends on your particular situation.

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Starting out with the single outstretched hand of a beggar, this clip progressed to show additional poverty scenes. A low mid-range horn duo in D minor helped to bring out the mood.

mixdown (along with the edited video) into your favorite video-editing application (such as Adobe *Premiere*), connect your VCR's inputs to the A/V outs on your video card, and record the movie to tape.

The stand-alone digital movie. If a stand-alone QuickTime movie is what you desire, then it's very easy to add your stereo mix to your video using only the QuickTime *MoviePlayer* application. Just launch *MoviePlayer*, choose Open from the File menu, and select your final stereo (or mono) audio file. Then click the Convert button to create a copy of the file in QuickTime format. Open the new file, choose Select All, and copy the audio to the Clipboard. Next, open your QuickTime video, press the Shift key, and drag the "thumb" on the scrollbar all the way from the start of your video to the end of it. Now, hold down the Option key and select Add from the Edit menu. (The Option key changes the Paste command to the Add command.) Finally, use the Save As command to save your movie to a new file, making sure the "Make movie self-contained" button is checked.

There are similar ways to do this using other video-editing programs for both the Mac and PC. *Studio Vision* can actually replace a QuickTime soundtrack in one step.

Video-game delivery formats. For the *F/A-18* project, I needed to deliver my audio to the post-production engineer so he could mix his sound-effects tracks with the music and dialog tracks. Rather than a single stereo audio file, I was asked to deliver several stereo *stems,* or submixes, which would allow the engineer to make room for specific sound effects or dialog without bringing down the entire music track. (Sometimes just lowering or notch-filtering the lead lines or higher-frequency tracks is all it takes to make room for a sound effect or an important dialog line.) The stems varied from score to score, but some examples were strings and choir, percussion, trumpets and flutes, trombones and horns, and solos and lead lines.

Fade Out...and Fade In

If you've read this far, then you're probably interested in trying out some of this stuff, and I hope it doesn't seem quite as complex as it used to. The main concept to walk away with is that the music-software industry has made things a lot easier for us. We don't have to spend so much time and money on technical issues anymore; we can jump right into making music.

All it takes is a decent computer, some average audio gear, a few reasonably priced software applications, and a video camera. Just about everyone I know owns at least an analog video recorder, and a few even have the cool new digital models. A pretty good video card and an entry-level video-editing package are within the reach of most budgets, and compared with all the wacky audio gear we've had to deal with, they're relatively simple to use.

Remember, you don't have to start out with a large-scale project; simply adding some background music to last year's holiday party or rescoring a scene from your favorite *Star Trek* movie is all you need to do to get things going. See you at the movies! ◆

DON VECA (DVECA@EA.COM) WON *COMPUTER GAMING WORLD*'S 1999 BEST MUSICAL SCORE AWARD. HE WORKS EXCLUSIVELY OUT OF HIS HOME DESKTOP STUDIO. SEE HIS *F/A-18* VIDEO CLIPS AT WWW.EMUSICIAN.COM.

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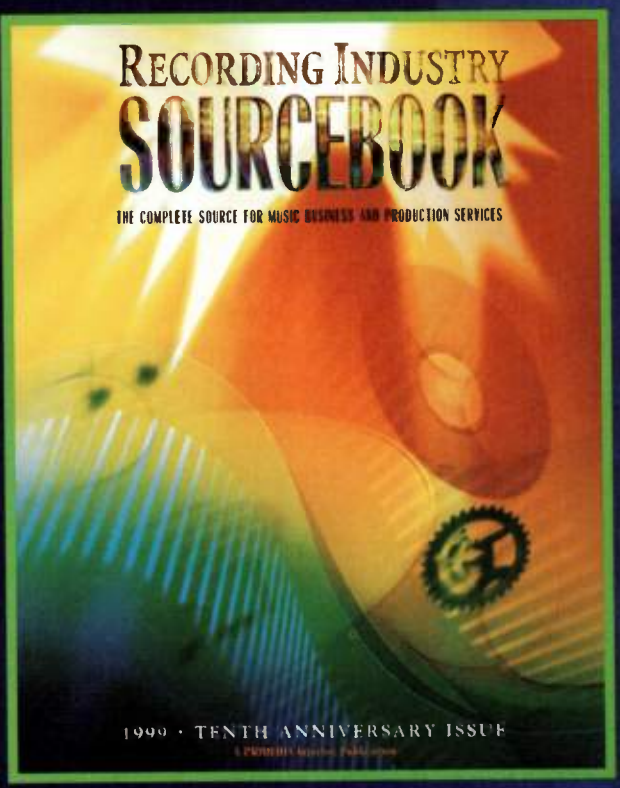

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19 Twisted Sound-Design Projects

By Dave O'Neal

Easy recipes for extraordinary audio effects.

Cut, copy, and paste are okay, but in the right hands, audio-editing software can also fold, spindle, and mutilate. In this article, I'll explain how you can transform ordinary sounds into ear-catching new ones. So fire up your audio editor (or download one of the bargain-priced shareware editors profiled on page 64), pull down that DSP menu, and follow along. For the squeamish, I've uploaded audio examples of all 19 twisted techniques (and much more) to *Electronic Musician*'s Web site, www.emusician.com.

Take Up Thy Shovel

You hear people say "bury it in the mix." Well, give your mix some dirt to bury with. Deep, grinding, obnoxious pads placed low enough in the mix will create an eerie soundstage that can make even a weak lead sound seem soulful, tormented, or evil. Thrash-metal loops transposed down an octave, run through some gated reverb, and turned backward do just the trick.

Hit Me Again

Got a hit (orchestral, jazz, death metal, or whatever) that just doesn't stand out? Take a copy of it, transpose it up an octave, distort it a bit, and mix it back in with the original sound for a brighter, livelier hit. Because the transposed sound will play back twice as fast, you'll probably need to delay it a bit to make sure that the initial peaks of the two sounds match up in time.

Ugly, Grindy, Beautiful Junk

Digital distortion and aliasing aren't necessarily bad. Some audio editors let you amplify a signal with reckless abandon. A heinously mutilated sample can create an interesting sonic texture if you bring it down in volume and put it through a soft reverb to integrate it with the mix.

Sludge Drums

Copy a drum loop, time-compress it so it plays at twice the tempo (but the same pitch), and then cut its sample rate in half. This brings the loop back to its original tempo but produces a deeper, sloppier version of the beat. You can also achieve this effect by pitch-shifting the drum loop down an octave (maintaining the tempo), but time-compression algorithms typically give better results for this sludge effect. Now mix the loop back in with the original for a heavier drum sound. Try putting more reverb on the deeper version to make the ambient soundfield heavier.

Sneak Attack

Much of what we perceive in a musical note happens in the first few milliseconds. Try mutilating the attack of a percussive sample, such as an orchestral hit, to create a couple of different versions. Then string the versions together in an audio editor to form a melody. One effective mutilation technique is to limit the sample excessively with a tool like Waves' *L1 Ultramaximizer*, causing the sustain portion to overpower the attack. Another option is to chop a few milliseconds off the beginning of the sample and put a short, sloping attack on the rest of the sound. Sequencing these varied versions of the original

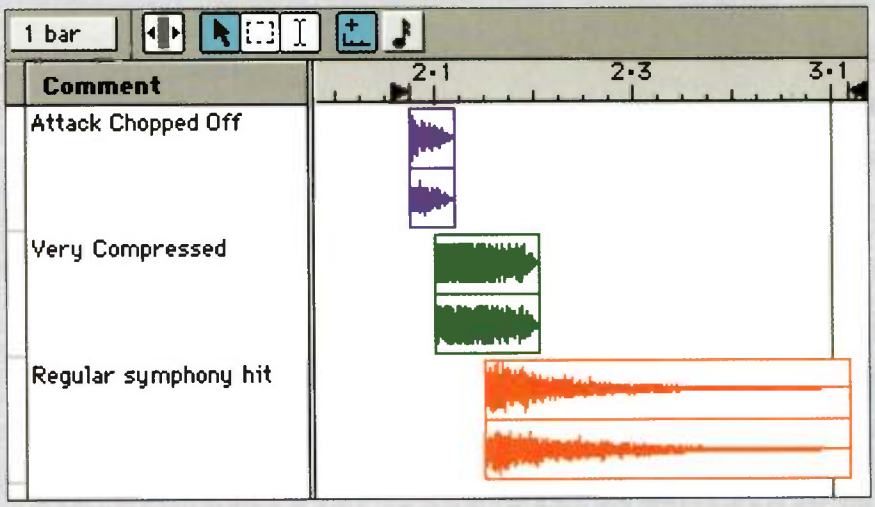

FIG. 1: Altering a waveform's attack is an efficient way to produce interesting variations. This three-note riff (shown in Opcode Studio Vision*) started life as a humdrum orchestra hit.*

sample would turn a three-note riff from "Bap! Bap! Bap!" into "BaaaaaaWaBap!" (see Fig. 1).

Digital Go-Go Dancer

Adding *anything* (within the parameters of tasteful mixing, of course) doing a 16th-note pattern in the higher frequencies can make a lame rhythm pattern get up and show life. You can use a highpass filter to extract the high-frequency components from a sound, but how do you make a 16th-note pattern out of "anything"? Gate the signal. You can run the source sound through the filter of an old analog synth while controlling the filter cutoff with a square-wave LFO set to the right tempo. LFO-equipped software plug-ins, such as Opcode *Fusion:Filter* and BIAS *SFX Machine,* can do the same thing. Or you could just use your audio editor's "silence" command repeatedly to mute every other 32nd-note's worth of audio in the waveform. In any case, you end up with an audio file that looks like a rhythmic set of short signal bursts. Looped, distorted speech is a nice place to start experimenting.

Real-Time Futzification

Sometimes you get caught in spaghetti-wiring mode and hook half your studio together in a bizarre sound-processing patch. (For me, it usually happens when I've had one glass of Scotch too many.) Often, this will suggest other ludicrous configurations, and you'll wish you could use them all in the same song. Try running the same track of audio through each version of your monster effects loop and recording the result onto new tracks in your computer. After you've sobered up, go back and crossfade between the different effected versions for your final mix. It will sound as if your transmodulo futzification effect actually can process things in real time.

Speak Up

Just for kicks, run random tracks through a variety of speakers and mic them. I have a couple of small, battery-powered amps; a 350-watt P.A. system (set up in the garage, where the acoustics are really boomy); a megaphone; a scruffy TV speaker; and more. I'm always playing speech, synths, drums, and everything else through them. I like to mic the big speakers from pretty far away (a shotgun mic is nice) to let the bass frequencies develop. Smaller speakers warrant a close, off-axis miking pattern for that small but in-your-face sound. Sometimes an acoustical contrivance and a mic can pull off the effect that no digital plug-in can.

Start It Again, Sam

Techno musicians often start and restart drum loops in tempo, building a new rhythm pattern out of an existing one. There's no reason to limit this technique to drum beats or the occasional vocal sample. Big guitar riffs and jazz horn lines create nicely melodic alternatives when retriggered.

Parking-Space Echo

"Hi, my name is Dave, and I'm addicted to parking garages." Some of the best-sounding reverbs and delays come from the real world rather than a little box in your rack. I have this nasty habit of burning a CD of a drum, guitar, vocal, or other track, popping it into my car's CD player, and driving off to a great-sounding parking garage. Then I open the car doors, blast the track, and re-record it from several yards away (one floor up is nice) with a portable DAT recorder and some mics. I've found that Crown SASS mics are very good for this mission. I've also clipped a couple of Sony ECM-55 lapel mics onto my glasses for a natural stereo effect.

When I get back to the studio, I mix these recordings with the original dry tracks in my audio sequencer. It takes a careful eye and ear to sync the ambient track with the dry track. CDs and DATs give you much better timing results than cassette tapes, which play at slightly different speeds on each player.

Jackhammer with Feeling

We've been talking a lot about sound design in a music setting; how about music in a sound-design setting? If you're scoring a video with sound effects, try tuning your sounds so that they harmonize with each other. I'm not talking about building elaborate chord changes using motorcycle engines; just try to figure out the pitch of each sound (you can reinforce the pitch with a low sine wave if you want to) and use some basic orchestration techniques. Combine two sounds separated by a tritone interval to create

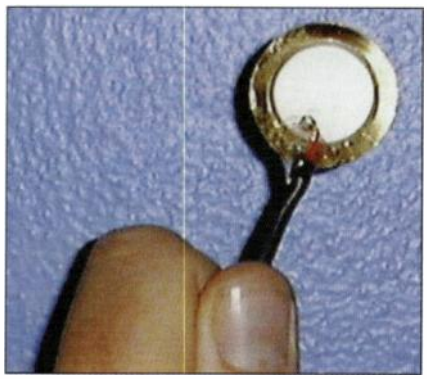

FIG. 2: A cheap, homemade contact mic can help you collect signature sounds.

tension. Use major thirds for "happy" stuff, minor thirds for "depressed" stuff, and minor ninths if you want to drive your listeners crazy.

Kung-Fu Snare Drums

Ever listen closely to a kung-fu movie? All the punches have a whoosh of the swinging fist (or foot, chair, eggplant, whatever) before the contact sound. Not only does this whoosh attract attention to the movement of the fist, but it also emphasizes the contact sound, making it seem louder and more painful. Try this technique on downbeats that need a bit more punch (so to speak). Insert a subtle—or not so subtle—whoosh with a 20- to 50-ms gap before the hard-hitting note. The length of the whoosh, its volume, and the length of the pause before the downbeat will all change the emphasis of the note. Try a variety of parameters (but don't do it too often, because it can get cheesy fast).

Head-Spinning Ambience

Try creating three mono ambient tracks and then panning them as if they were evenly positioned around your head (120-degree angles from one another). You'll need a binaural filter or a 3-D panning plug-in. Move the three sources in a slow rotation (one orbit every five to eight seconds), making sure they always stay 120 degrees apart. You'll need a minimum of three sources to keep the stereo field filled out during the full rotation.

Don't have a 3-D panner? You can pan the tracks with conventional left-right pan pots and still get some decent motion in your ambience. Keep the movements slow and try not to create any silent zones.

First Contact (Mic)

You can pick up piezo transducers pretty darn cheap (less than $10 apiece in bulk) at your local electronics-parts warehouse. Solder a two-conductor cable onto one of these devices, plug the other end of the cable into a mic preamp, and you've got yourself an endlessly amusing toy (see **Fig. 2**). Duct-tape this home-brew contact microphone onto any surface—such as the bottom of your computer keyboard—to pick up the vibrations as you hit the surface with various objects, drag things across it, type bizarre sound-design articles, and so on. You'll end up

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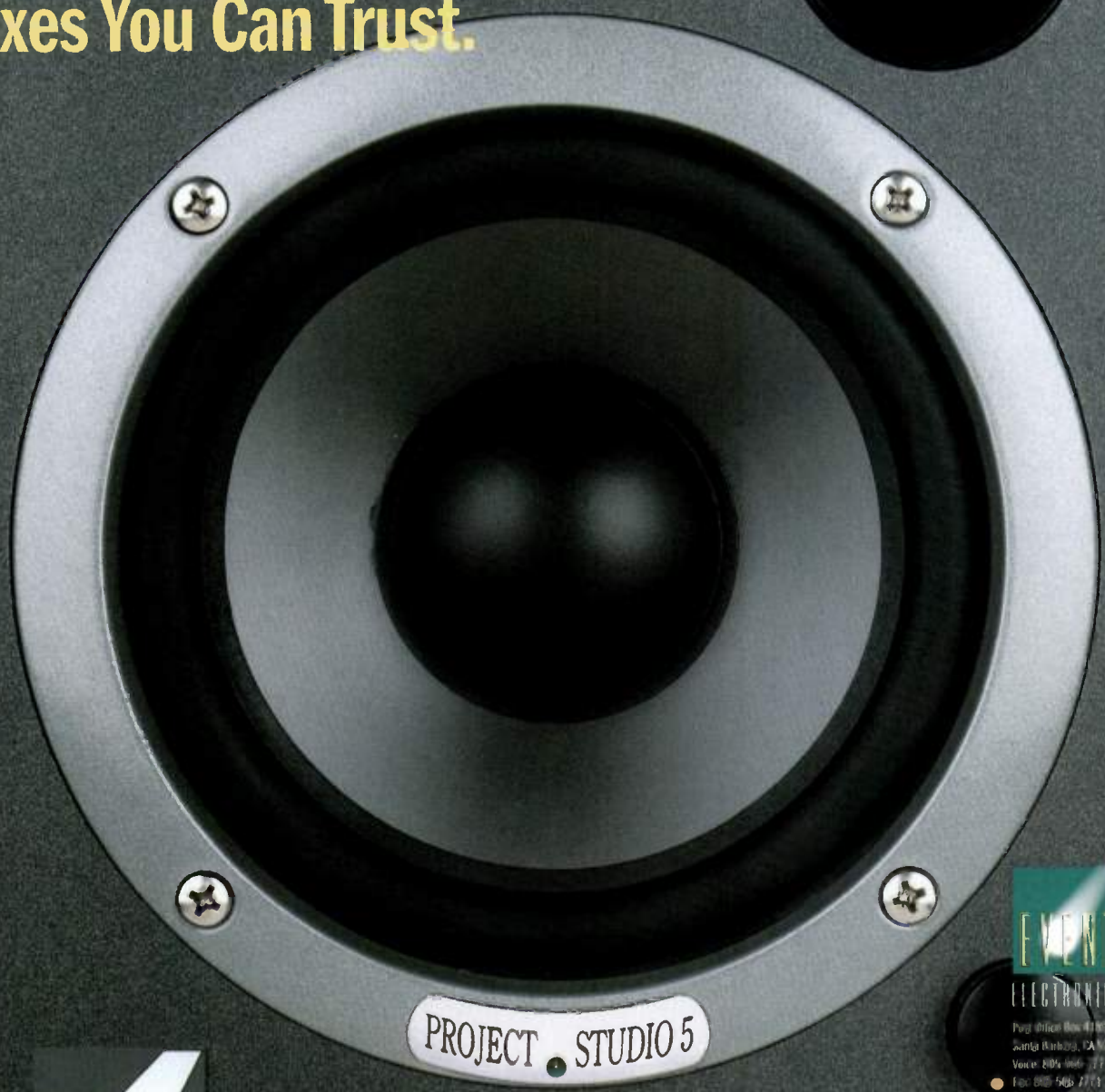

Actual Size

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with an up-close sound that's useful for a variety of small Foley-style effects. Try miking pipes with water running through them, using the walls as an acoustical gathering surface (recording the guy in the apartment next door), and so on.

Beer-Soaked Audio

Okay, I admit it: I have a fetish for Radio Shack lapel mics. They cost so little—less than $25—that I don't mind risking their lives for an interesting recording situation. Wrap one in plastic (a Ziploc bag will do fine), drop it in a can of beer, set the beer on top of your guitarist's amp, get him to do what guitarists do, and ponder how they get the great sound of bottled beer in a can. It's not a "good" sound, but it does have some interesting EQ effects. The can also adds a weird resonance. And we aren't always after the "good" sounds.

That's Not My Reverb

Stacking drum loops on top of drum loops seems to be the big thing these days. Often, such experimental rhythm stacks produce a chaos of beats rather than an intricate groove. Try feeding one of your loops through a reverb and adding just the reverb return—the 100 percent wet signal—to the mix. Keep the other loop dry (see **Fig. 3**). The two loops now groove together, filling each other out, but they don't step on each other's beats nearly as often. A short, nonlinear reverb (such as the "gated reverb" effect that was used on snares in the '80s) works well for this technique.

The Ronco MultiFuzz

Most of the time, we multitrack fuzz guitar (or another source) by distorting it first and then recording a few tracks of it. Instead, try recording a couple of clean tracks and then feeding the mixed signal through a distortion device (such as a Marshall stack screaming its guts out). This way, you can piece together a totally impossible guitar line and hide all the edits in the mondo fuzz.

Hey, Mr. Timbre Man

Ever since musicians started sampling, we've been plagued with samples that won't transpose very far without

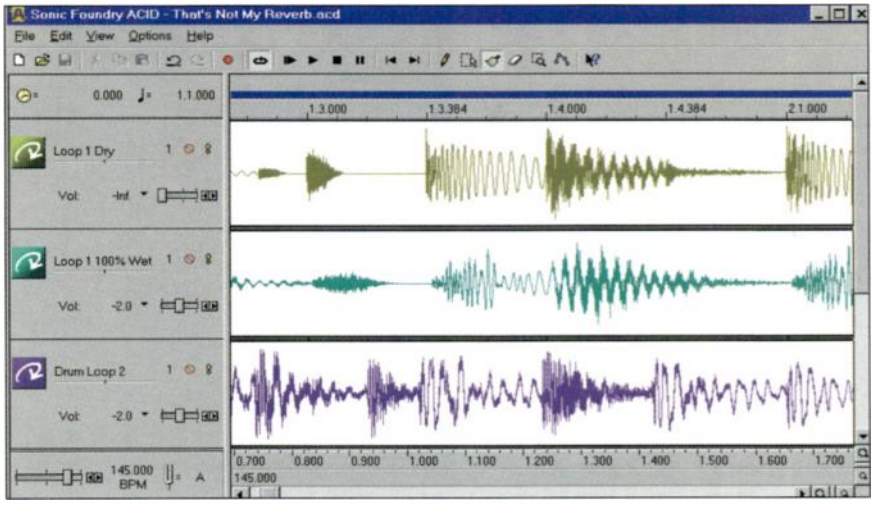

FIG. 3: Combining one drum loop with the reverb from another can create a new loop that's textured without being busy. Sonic Foundry Acid *was used for this ambience transplant.*

suffering from some sort of ugly artifacts. Well, one man's munchkinization is another man's music. Try sampling a piano across its full range and then setting each sample to play back at the same pitch (for example, middle C). The lower keys will be transposed really far up, while the high keys will be shifted far down. Run your finger up and down the keyboard and you'll hear all the transposition artifacts changing smoothly. It becomes a formant-modulation instrument rather than a transposition one. Tweaky and weird, but fun.

Rock the House

It's always nice to put a deep bass rumble somewhere in the mix. However, really low sine waves don't stand out and scream *"Bass!"* until they're too loud, covering everything else. Try layering a sine wave in the mix a couple of octaves above the real note you want to hit and then modulating it with a sine wave that's pitched at the frequency you want. Amplitude modulation is easier to get under control, but I like the effect of frequency modulation a bit better. In either case, the modulation brings out the low rumble you're looking for at a manageable volume, without adding too many uncontrollable high frequencies. ◆

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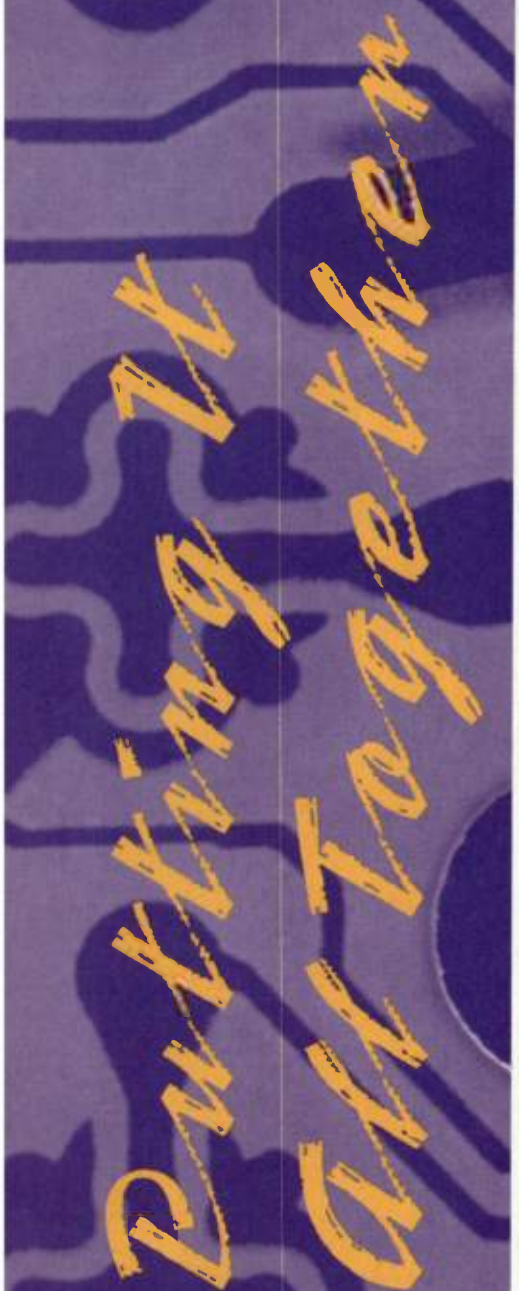
The Well-Connected Studio

By Jon Medek



Hook up your gear the right way and reap the benefits.

Putting together a computer-based recording studio gives you enormous power and flexibility. But as the saying goes, with great power comes great responsibility. Properly connecting a computer and an assortment of other studio gear is a daunting challenge indeed.

Connecting all your equipment with the appropriate cabling is only half the battle; you also have to ensure that the layout won't introduce noise, hum, or distortion into the audio chain. Although numerous noise-reduction plug-ins and programs are available, you can often avoid this "fix it in the mix" solution by setting things up correctly.

The possible combinations of equipment are infinite, so we'll look at some representative real-world setups. And while we walk through these setups, we'll also discuss some synchronization issues, such as using word clock to keep digital signals under control.

Keep a Level Balance

One thing to consider up front is whether you want to run balanced audio. In a balanced system, each cable contains two independent signal wires. One wire carries the original audio signal, and the other carries a copy that has been reversed in polarity. At the end of the cable, the inverted signal is inverted again and added to the original, resulting in a new signal that's twice as strong. Because the two wires are so close to each other, any electromagnetic interference (EMI) induced into one will almost certainly be present in the other. When one signal is inverted, the two noise components will be "out of phase" and will cancel each other out.

Unbalanced systems use just one signal wire and are thus more susceptible to EMI. They also typically use a lower signal level than balanced systems do: -10 dBV as opposed to +4 dBu. Balanced audio is therefore preferable if you need to run long cables or if you live next to a microwave tower or other strong EMI source.

The disadvantage of balanced systems is that they are more expensive and they don't work at all unless every component in the signal chain is balanced. And with cable runs under 20 feet, the reduction in noise may be insignificant. Indeed, mastering engineer Bob Katz writes on his Web site (www.digido.com) that he uses an unbalanced setup because he feels that the extra circuitry required to flip the signals does more harm than good in his already-quiet studio.

Note, too, that connecting -10 dBV gear directly to +4 dBu devices can lead to problems. The weaker -10 dBV signal will need amplification to register on the +4 dBu gear, which will add noise. Going the other direction, a strong +4 dBu signal will likely overload -10 dBV gear, causing distortion or requiring you to lower the input fader so much that you run out of headroom. If you need to connect +4 dBu and -10 dBV devices, use a level-matching amplifier or a direct box such as the Ebtech LLS-2 PKG.

Connector Craze

To hook up your gear, you'll need connectors and cables of the right kinds and quality levels. Wherever possible, I highly recommend using gold-plated connectors, which provide slightly better corrosion protection and conductivity. Here is a list of the most common types of connectors; in case you need to win a bar bet, remember that jacks are female and plugs are male. (Your results may vary, depending on the bar.)

XLR. These connectors contain three pins, with pin 1 wired to the grounded shield (common), pin 2 wired to the positive (hot) side of the signal, and pin 3 wired to the negative (cold) side. XLR connectors appear most commonly on microphone cables, but they're also used on balanced line outputs, AES/EBU digital cable, and high-end speaker cables. They offer the best connection with the least noise of all the connectors discussed here.

¼-inch TRS. More commonly known as *stereo phone* plugs (or jacks), these connectors provide three conductors: tip, ring, and sleeve—hence "TRS." They're found on stereo headphones, balanced mono circuits, and unbalanced send/return connections. Pro studios that need to pack a lot of jacks into a single patch bay use a similarly shaped but smaller connector called a *bantam* or *TT* (for "tiny telephone") jack. Smaller yet are the unreliable ⅛-inch *miniphone* connectors found on Walkman headphones and low-end sound cards.

A TRS connector is normally wired with the tip to the left audio channel, the ring to the right, and the sleeve to ground. In a send/return application such as a mixer insert, the tip may carry the outgoing signal and the ring may bring it back, but sometimes the opposite is true. For connection quality, ¼-inch TRS is the second-best of the bunch, after XLR. A "combo" jack that takes both XLR and ¼-inch TRS plugs has recently emerged (see **Fig. 1**).

¼-inch TS. The familiar "guitar cord" connectors have just tip and sleeve conductors and are used for unbalanced, mono, line-level connections between electric instruments, guitar amps, and most personal-studio gear. The tip of the plug is wired to the audio signal, and the sleeve is wired to ground.

RCA. Also known as *phono* connectors, these are used in desktop MIDI modules, multitrack cassette recorders, and home stereo equipment. They are unbalanced and are wired so that the center post carries the signal and the outer metal "basket" goes to ground. RCA connectors are also used to transmit S/PDIF digital audio signals; in that context, they're called *coax* (short for "coaxial") connectors.

I will discuss digital connectors shortly.

Able Cabling

The cables in your studio are like the arteries in your body: they have to let everything through without leaking. One rule of thumb is to organize your gear so that all cables are as short as possible. This minimizes noise, electrical interference, and the loss of level and high frequencies. (A phenomenon called *capacitance* causes cables to act as lowpass filters, attenuating the high frequencies in an audio signal.)

There is an ongoing debate over esoteric cable designs. One side says that oxygen-free copper, multiple frequency sections, and other high-tech designs provide greater transparency of sound and less distortion and noise. Another school says that advanced cable designs simply waste money.

If you're considering fancy cables, I recommend purchasing one pair and connecting them to one component in your system, such as the analog outputs of your CD player or audio interface. Then play a well-recorded piece of music through the device several times, alternately using plain and high-tech cables. Recordings of percussion, synthesizer, piano, reed instruments, and violin are particularly revealing. The best test is to have a friend change cables when you aren't looking.

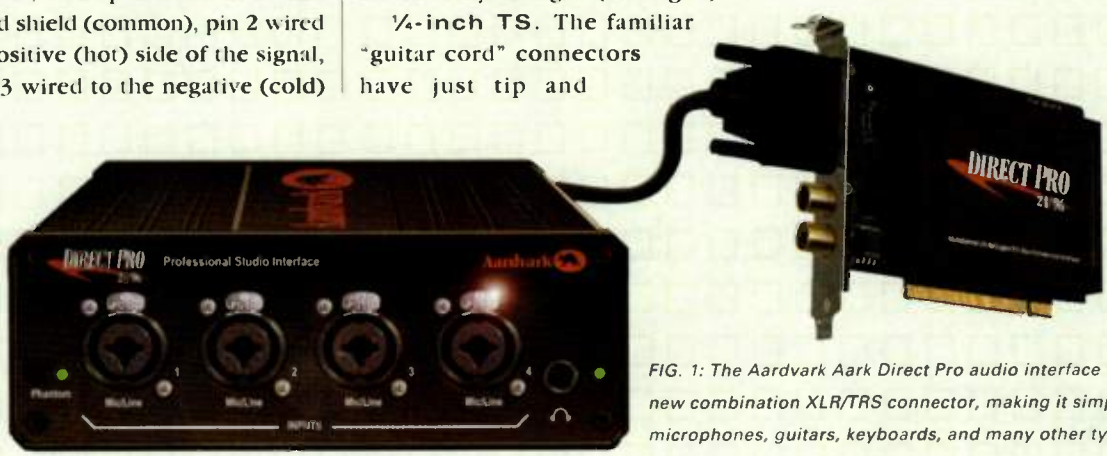


FIG. 1: The Aardvark Aark Direct Pro audio interface uses the new combination XLR/TRS connector, making it simple to attach microphones, guitars, keyboards, and many other types of gear.

Digital Mixer Tricks

Longtime ADAT user Larry the O, a contributing editor at *Electronic Musician*, found that moving up to a digital mixer increased his recording options. "My Panasonic DA7 has great 24-bit converters as well as dithering on every digital output, so I usually run everything through it," he says. "I might run analog audio into the DA7, and then out through its optional Lightpipe card to my ADAT XT20 while dithering the audio to 20 bits." Dithering is a way of converting a high-bit-rate signal to a lower bit rate; it provides a smoother sound than merely chopping off the extra bits.

"I can transfer audio to my MOTU 2408 audio interface at 24-bit resolution," Larry continues, "but not every project demands that. For example, the film I'm currently working on requires only 16-bit audio, so I dither the sound effects I'm recording to 16-bit on the way to the 2408. I started out recording at 24 bits and then converting to 16 bits in the computer, but that took too much time and disk space. Now I just send it to the computer at 16-bit resolution." —*David Battino*

Even if you don't find that their sound quality is better, the superior shielding usually found in high-end cables may reduce EMI enough to make them worth the extra cost. Good shielding is especially important for cables that carry digital data. Upgrading a SCSI cable, for instance, will often lead to more reliable data transfers.

If you know that your studio will stick to one configuration, you may want to make the cables yourself. That way they will be exactly the right length. Check your library or the Internet for tips on soldering, and then practice on a number of short pieces before making your actual cables. If you aren't comfortable making custom cables, buy premade ones that are as close to the lengths you need as possible. As my father, a high-voltage-cable engineer, always says, "Measure twice, buy once."

Solid Ground

Grounding your gear properly is very important for two reasons: safety (for you and your equipment) and noise reduction. The ground provides an "emergency escape hatch" for electrical current and a reference level for the audio signal. However, *ground loop* hum can arise if there are multiple paths to ground. For example, if your computer is plugged into one outlet and your mixer into another with a slightly different ground potential, stray current from the sound card could flow through the audio cables' shields into the mixer and then into its ground, rather than going straight to the computer's ground. Amplified, this stray current produces hum.

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You can eliminate the hum by sticking a ground-lift adapter on one power cord, but doing this can open the door to potentially lethal electrical shocks. A far better approach is to eliminate the voltage difference between the gear by plugging both units into the same outlet (as long as you don't overload the circuit) or to break the ground loop somewhere else. Separating metal gear that's touching, breaking the shield at one end of an audio cable, or adding insulating foam or bushings to rack rails can do the trick. You may also want to buy an outlet tester to find out whether your outlets are correctly wired and grounded.

In Position

Bundling your cables together leads to a much cleaner installation, but power cables spew hum-inducing electromagnetic interference. For the cleanest sound, bundle the audio cables separately from the power cables, and keep the two types several feet apart because EMI falls off rapidly with distance. If the audio and power cables must cross, try to make them cross at a 90-degree angle.

Transformers, such as those in "wall-wart" power supplies, are also notorious hum factories. Route audio cables well away from them. Sometimes one wall wart in an outlet strip will even induce hum in its neighbor; separate the two to solve this problem.

It's tempting to tidy up the slack in cables by coiling them, but this creates an antenna effect, boosting EMI. Flatten out the excess instead.

Processor Placement

Effects are the spice of recorded music, and there are two main ways to hook them up: as *inserts* and as *aux* (auxiliary) *sends*. Processors such as compressors, equalizers, and noise gates are almost always used as inserts. Inserts are placed in series with the signal, meaning that the entire signal passes through the effects processor.

By contrast, effects such as reverb, chorus, and delay are usually set up in parallel with the signal, using the mixer's aux sends to siphon some of the signal from the channel and send it out to the device for processing. The processed ("wet") signal is then brought back through the mixer's *effects return* jacks and mixed with the original ("dry") signal. The advantage of a parallel configuration is that several channels can be processed at once with varying degrees of effect.

In case you need to win a bar bet, remember that jacks are female and plugs are male.

Even though most devices have left and right inputs, not all are true stereo—they may mix the two inputs to mono before processing the signal. In that case, you only need to use a single (mono) aux send per effect, typically connecting it to the box's left input. If you're lucky enough to have a true-stereo processor, use two mono aux sends to feed both its inputs; you'll be rewarded with a more realistic sound.

If you have more processor inputs than aux sends, patch bays become almost mandatory. Instead of crawling behind your equipment with a flashlight to reroute cables, you can quickly reconfigure your studio by moving short cords in the patch bay's front panel. Trust me, if you don't have patch bays to cover all your connections, place some at the top of your shopping list.

Studio Setup #1

Let's put some of this theory to use by examining a simple yet powerful desktop music setup, shown in **Figure 2.** This is the system that most of us start with when turning our computer into a digital recording studio. Here a consumer sound card handles audio input and output through ⅛-inch stereo jacks. (Because ⅛-inch jacks are rather flimsy, they're rarely found on professional gear.) We've connected the card to the mixer using Y-cords with an ⅛-inch stereo (TRS) plug at one end and two ¼-inch mono (TS) plugs at the other.

In theory, you could make do without the mixer, recording directly into the sound card from a keyboard, electric guitar, or microphone preamp. But

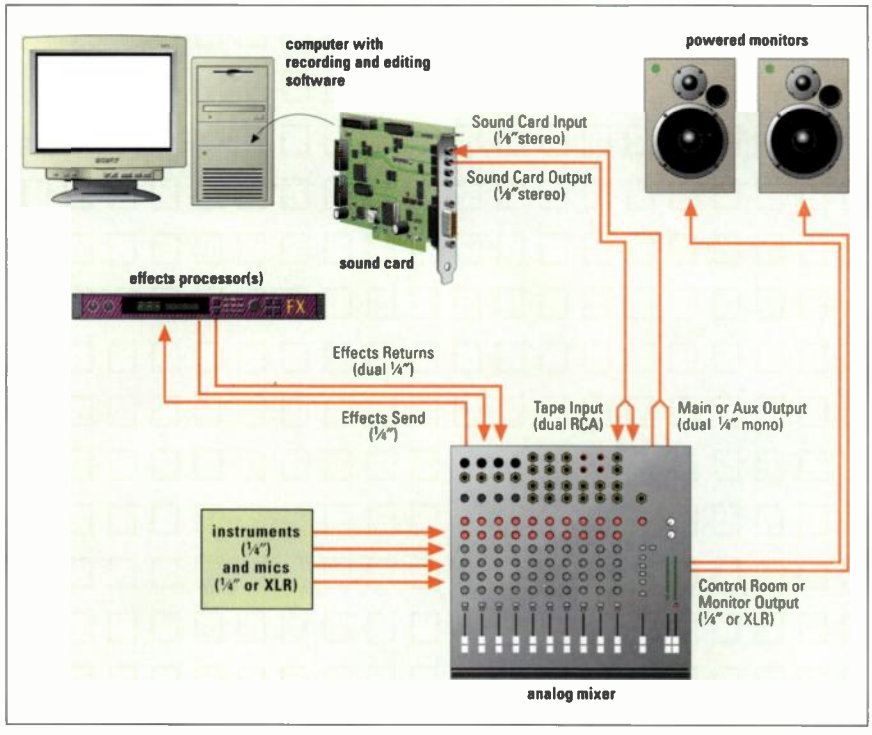

FIG. 2: This simple desktop music setup is surprisingly powerful. But the mixer requires a special feature—tape inputs—to make it work.

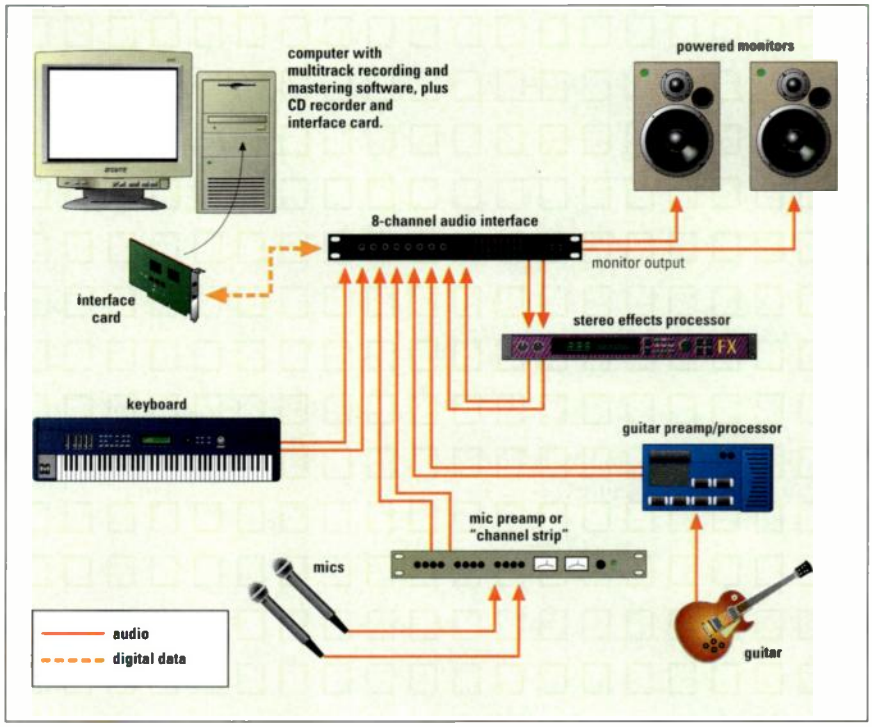

FIG. 3: Trading up to a multichannel computer audio interface eliminates the need for a mixer in this setup. However, a small submixer would allow us to add more effects processors.

that would require you to root around behind the computer to swap cables for each overdub. In contrast, the mixer lets you keep several instruments plugged in and ready to go, and also makes it easy to apply effects or EQ as you record.

If you're recording mainly MIDI tracks with an occasional guitar or vocal overdub, a stereo card such as the Creative Labs Sound Blaster Live may be all you need. (On a Mac, you can use the built-in audio inputs and outputs.) Bounce the tracks down to stereo in the computer—or sing live over MIDI tracks—and you'll get a stereo audio file you can record to CD or upload to the Internet.

For overdubbing to work, your sound card will need to be *full duplex*—able to record and play back audio simultaneously. Watch out for snags with low-cost cards. The immensely popular Sound Blaster AWE64, for example, actually degrades its audio output to 8-bit resolution when recording.

A bigger issue may be signal routing. In the setup shown in **Figure 2**, we're able to monitor the sound card's output through the mixer while recording because that output is connected to the mixer's *tape input*, which gets routed only to the speakers. If we had plugged the card's output into a pair of input channels instead, it would have been routed to the mixer's main output, creating a feedback loop.

A growing number of small mixers, such as the Mackie MS 1202-VLZ, have this handy tape-monitoring feature. If yours doesn't, you can connect the sound card's outputs directly to powered speakers (or to an amp and speakers), but you'll have to control the playback level in software.

Studio Setup #2

A natural upgrade for your studio is to replace the stereo sound card with an audio interface that features multiple inputs and outputs. (If you already have a decent sound card, you may be able to preserve your investment while gaining more ins and outs by adding a second card to your system.) Having extra audio inputs and outputs lets you record multiple musicians live onto separate tracks, giving you extensive control.

In **Figure 3**, an 8-in/10-out audio interface such as a Mark of the Unicorn

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- Comprehensive product charts listing the important features and prices of the hottest recording equipment for the personal studio. *Eight new product categories added in 2000!*
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1224 or an Event Layla provides so many routing options that we can forgo the mixer and record multiple parts straight to disk. We aren't exploiting the interface's many outputs in this setup because we're assuming that the computer and software are powerful enough to mix and process multiple tracks internally. Another option would be to use the six extra outputs as effects sends by connecting them to three or more external effects processors. We could then combine all of the effects processors' outputs with a submixer and feed the resulting stereo signal into the two inputs currently being used by the single effects processor.

Depending on your interface, its drivers, and your software's processing-buffer settings, though, you can run into 750 ms or more of *latency* (delay) when looping signals through external effects boxes. Latency results from the amount of time the computer needs to process the audio before passing the signal back through the interface to the effects boxes. Reducing the buffer size (if possible) will speed response but gobble more CPU power, lowering the number of tracks you can record and process. I recommend that you reduce your buffers until you can't hear any practical delay, then simply learn to work with the number of tracks available.

Good shielding is especially important for cables that carry digital data.

If the latency is constant, another work-around is to record the effects returns onto new tracks and then slide them back in time to match up with the original signals. Systems with on-board digital signal processing, such as Digidesign Pro Tools and Yamaha DSP Factory, typically have the fastest response. Newer software drivers can also reduce latency; check the interface manufacturer's Web site for updates.

Folks who mix entirely in their computer have an easy output-routing task: simply monitor what's going on. For making subtle tweaks while mastering, you may want to run a spare S/PDIF or AES/EBU output to a high-resolution D/A converter such as the SEK'D 24/96 S.

Digital Audio Interfacing

Before we get into the higher-end setups, we need to examine the four interface formats you're likely to encounter when dealing with digital audio.

AES/EBU. Jointly developed by the Audio Engineering Society and the European Broadcast Union, this professional standard specifies 110Ω balanced cables with XLR connectors. (Because of the high frequencies present in the digital signal, microphone cables aren't recommended, although they will work.) AES/EBU transmits two channels

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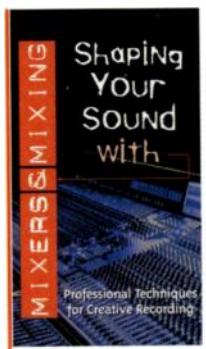

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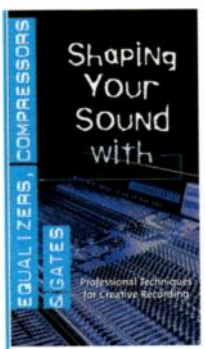

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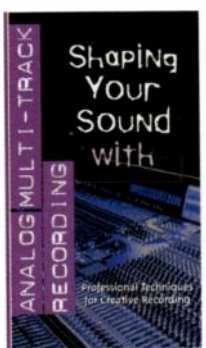

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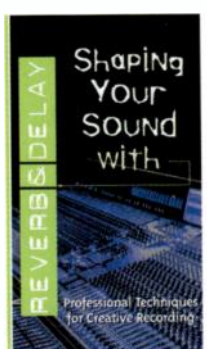

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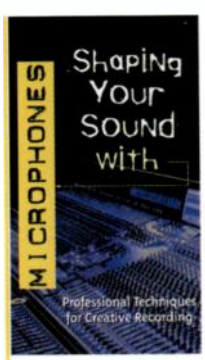

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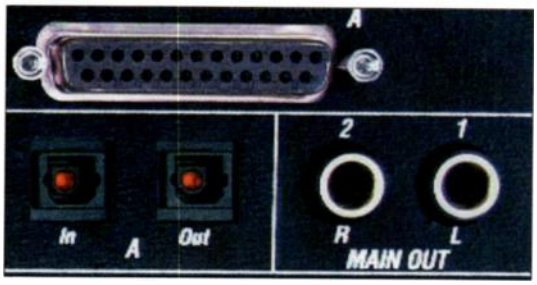

FIG. 4: This close-up of the MOTU 2408 audio interface shows 8-channel Lightpipe and TDIF connectors next to a ¼-inch phone jack. The TDIF connector carries both incoming and outgoing signals.

of digital audio on a single cable and supports up to 24-bit, 96 kHz resolution.

S/PDIF. Sony and Philips developed this 2-channel standard for use with consumer-level equipment. (That's the *S* and *P*; *DIF* stands for Digital Interface Format.) S/PDIF is functionally similar to AES/EBU, although it tops out at 48 kHz and uses unbalanced cables. There are two types of S/PDIF cable: electrical (with RCA connectors) and fiber-optic (with Toslink connectors). For best results in an electrical S/PDIF setup, you should use 75Ω video cables, not audio ones, and keep cable lengths well under 20 feet. Companies such as Fostex, Hosa, and Midiman make inexpensive converter boxes that allow you to interconnect optical and electrical S/PDIF devices.

ADAT Optical (Lightpipe). This 8-channel audio format first appeared on the Alesis ADAT recorder, which can record eight tracks of digital audio on an S-VHS tape. Thanks to the extreme popularity of the ADAT, Lightpipe interfaces are now showing up on everything from sound cards to mixers to synthesizers. The Lightpipe connector is physically identical to a Toslink connector, and several interfaces, such as the Sonorus StudI/O and Alesis's own ADAT/PCR card, can be configured in software to transmit or receive 2-channel S/PDIF audio through the connector.

The Lightpipe format can handle up to 24-bit, 48 kHz resolution. The standard plastic fiber-optic cables are inexpensive and can be run up to 33 feet; longer runs are possible with high-quality glass cable. Optical cables are more fragile than wire ones, but they eliminate the threat of EMI and ground loops.

TDIF. When Tascam rolled out the DA-88, its answer to the ADAT, it also unleashed TDIF (pronounced "tee-diff"), the Tascam Digital Interface Format. Like Lightpipe, it carries eight channels of digital audio, but it uses electrical DB-25 connectors on a 25-conductor cable (see **Fig. 4**). While other interfaces use two cables, one for transmitting and one for receiving, TDIF can do both on a single cable. However, the cables are expensive: a 3-foot length costs about $110. TDIF has a maximum resolution of 24 bits.

Studio Setup #3

The scenario shown in **Figure 5** combines some of the best features of analog and digital recording. Instruments and vocals are recorded to the ADAT through the mixer's bus outputs, digitally transferred into the computer via a Lightpipe interface such as the Frontier Dakota, edited, and then dumped back into the ADAT. (A Tascam DA-series recorder and a TDIF computer interface could also be used.)

Next, the edited ADAT tracks are played back and mixed through outboard effects to a DAT recorder. If the Lightpipe interface can be switched to S/PDIF, the stereo mix can then be digitally transferred back into the computer for mastering and burning onto CD. Although this setup forces the audio to pass through two sets of analog-to-digital conversions, it allows you to record and mix with actual faders, knobs, and high-quality outboard effects. Furthermore, it doesn't require a very powerful computer.

Adding a MIDI interface and synchronizer, such as a MOTU MIDI Timepiece AV or an Opcode Studio 64 XTC, greatly expands the power of this setup. Connect an ADAT sync cable, and you can synchronize MIDI sequencer software with the ADAT, building up dozens of "virtual" MIDI tracks that play along with the tape. At mixdown, you can feed both synthesizer audio and ADAT audio through the mixer.

With a digital audio sequencer and a second set of audio outputs, you could

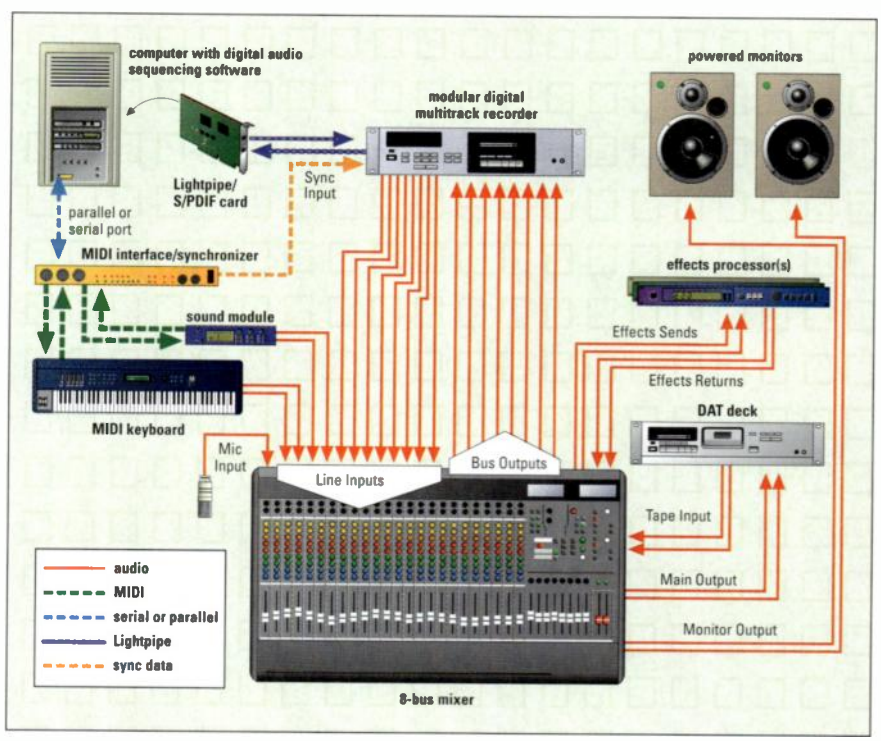

FIG. 5: By connecting a digital tape recorder to a computer and an 8-bus mixer, you can record and edit digitally but mix in the analog domain.

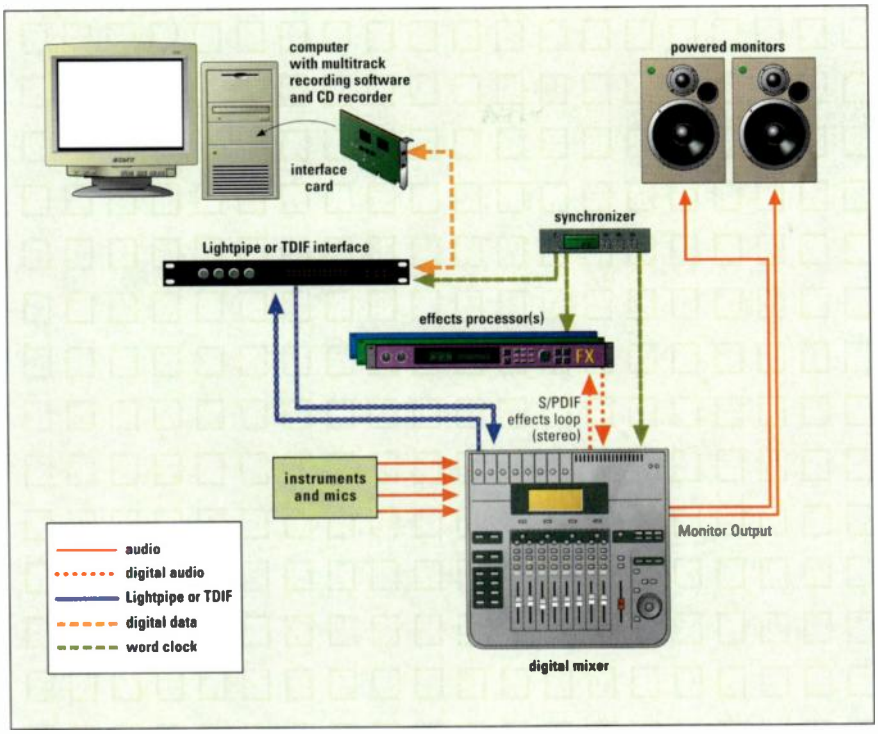

FIG. 6: Thanks to 8-channel digital audio interfaces, this powerful setup is a snap to hook up.

run both ADAT and computer audio tracks simultaneously, producing a huge number of tracks. Additional ADATs could also be synched up. Alternatively, you could transfer all the ADAT tracks directly into the digital audio sequencer and not mess with sync at all.

Word Clock Demystified

In the next setup, we'll make even more digital audio connections, so let's pause for an explanation of *word clock*, the glue that binds them.

For digital audio signals to combine without producing nasty clicks and pops, their sample rates must match exactly. Although all digital gear contains highly accurate clock circuitry that controls the sample rate, no two clocks run at precisely the same speed. When transferring digital audio, you'll need to make sure that one device provides the master clock signal and that all the others are set to slave to it, ignoring their own internal clocks.

AES/EBU, S/PDIF, Lightpipe, and TDIF digital audio signals all carry the necessary synching information within them, and digital devices will usually lock to it. In some instances, however, you will need to manually set your digital equipment to slave mode.

Many digital audio devices can also sync to a separate word-clock signal, a square-wave signal that carries clock information but no audio. The most reliable results come from connecting a master clock source (such as an Aardvark AardSync II) to the word-clock input of each device in your setup—assuming that it has one. This input is a bayonet-style connector that accepts a 75Ω coaxial video cable. As with S/PDIF, keep the cable length under 20 feet if possible.

Studio Setup #4

Although the all-digital studio shown in **Figure 6** is even more powerful than the elaborate one in **Figure 5,** it uses far fewer cables. Thanks to 8-channel digital audio connectors, routing signals is easy. Instruments and mics are fed into the digital mixer; enhanced with the mixer's onboard compressors, limiters, and EQ; and recorded by the computer's multitrack software.

After editing, you could loop the tracks back through the mixer (and the digitally connected effects processor) for mixdown, or mix them in the computer using plug-in effects software. If the mixer is the master clock source, the external word-clock generator isn't necessary, but some people can hear the difference in detail and clarity that a high-quality clock makes.

Final Connections

The setups presented here are just examples; yours is probably different. How can you do something right now to improve your setup? Here are two places to start.

Plan out. Draw a diagram that shows each piece of gear, each connection, and each type of cable in your studio. This will help you lay out your connections and equipment so that you can make the best use of your existing cables for the quietest and most versatile setup. Remember to bundle the power cables separately from instrument and speaker cables to reduce interference.

Hook up. Use your soldering skills to custom-fit your current cables to the lengths you need. (You'll probably end up with extra cables, as many of your existing ones will be way too long.) Connectors can be purchased from many local music stores, as well as from electronics-supply houses and the granddaddy of connector stores, Radio Shack. If you plan to do this type of studio upgrade, I highly recommend that you first get racks for all rack-mountable gear and patch bays for both audio and MIDI. You'll be very glad you invested in them, especially when you integrate new equipment in the future.

Very few people build complete studios all at once, so deciding on the best layout usually involves working with the gear that you have. Play to your strengths: if you have a weak computer but a fabulous collection of outboard gear, lean more on your mixer. If you have a powerful PC and lots of audio plug-ins, do more in the computer. Just remember to keep your cables short, your equipment properly grounded, and your eye on the (word) clock, and you'll be calm, cool, and connected. ◆

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Why use Digital Performer's effects automation?

MOTU

1. **Beat/tempo-based automation.**
Automate plug-in effects in perfect time with your music, from filter sweeps that land on downbeats to multitap delays that echo in triplet 8ths. Your beat-based effects always stay in rhythm, even through meter and tempo changes. You'll never waste time wondering things like, "how many milliseconds is a 16th note at 126 bpm, anyway?" Rhythmic effects are now just a few clicks away.

2. **Sample-accurate ramp automation.**
Digital Performer's plug-in automation isn't a kludge — it calculates true ramps in 32-bit floating point glory. And it's sample-accurate, not quantized to buffer boundaries, so you'll never hear weird artifacts or zipper noise in your audio. Instead, your moves will be as smooth as silk...

3. **Discrete events and stair-step automation.**
Some effect changes are discrete events, like changing an LFO from a sine wave to a square wave. Others require a stair-step approach. Digital Performer has all three: ramps, events and steps.

4. **Graphic editing.**
View all automation data directly on the audio waveform. Work fast with descriptive icons and convenient control points.

5. **View all automation data at one time.**
Clearly view all automation data at one time. Easily control the interaction of multiple FX parameters.

6. **Units of measurement that actually make sense.**
Digital Performer's automation data is always displayed in the correct unit (like milliseconds or percent), instead of arbitrary number ranges like other programs. (0-127, yipee!)

7. **Five advanced automation modes.**
Tweak your heart out with advanced automation modes like Touch, Latch, Overwrite, Trim Touch and Trim Latch. Want to bypass the effect? You can automate that, too.

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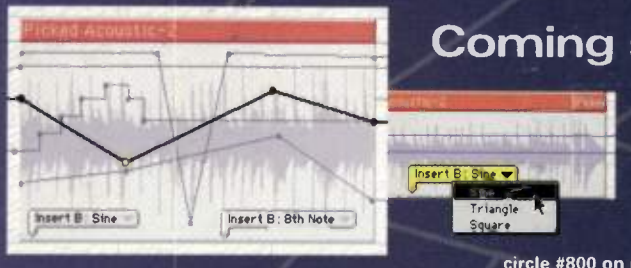

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