▸MUSIC
▸MICROS
▸MIDI
▸MULTI-
TRACK
and more!

Electronic MUSICIAN

NOVEMBER 1986

U.S. $2.50
CANADA $3.50

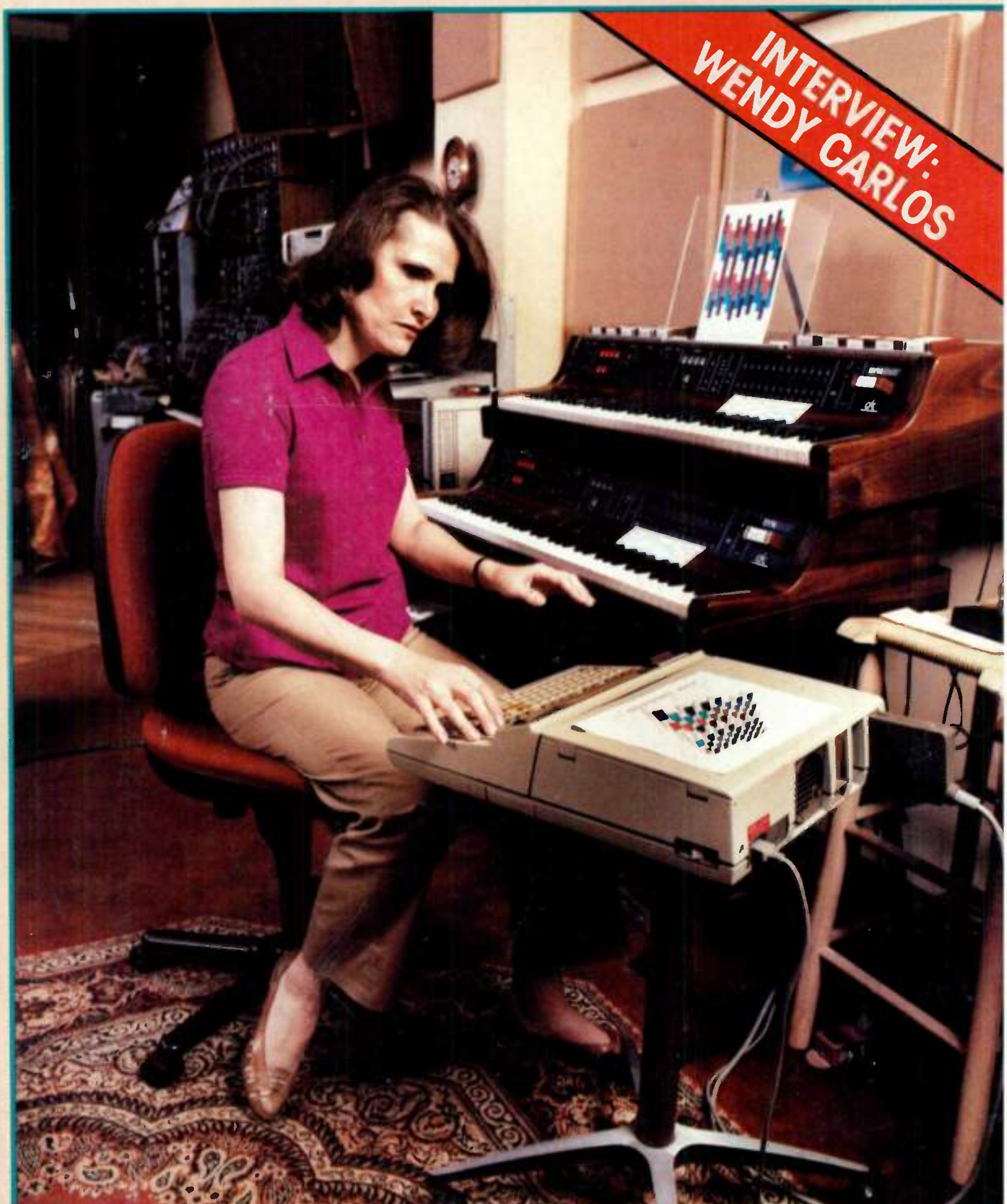
Alternate Tunings
he newest old wave
n composition—what
t is, why it is, and how
can you coax these
new sounds out of your
electronic instruments

Careers
You can do it—be a
freelance electronic
musician or a music
software company

Build an
AC Line Filter
Protect your gear from
minor surges and spikes

MIDI Switch Boxes
Learn the ins and outs of
these handy accessories

Reviews:
Alesis MIDIverb and MIDIfex, Yamaha FB-01



A MIX PUBLICATION

Yamaha has been hearing voices again.

And you can hear all 240 of them for only $345.*

Presenting the Yamaha FB-01 FM Sound Generator. A surprisingly compact black box containing the largest selection of Yamaha digital FM voices since the introduction of the DX synthesizer.

Its incredible affordability is even more dramatic when you consider that in addition to 240 pre-programmed voices, the FB-01 accommodates 96 user voices. For a total of 336 voices at the unheard of price of only $1.02* each.

ROM 1 (BANK 3)	ROM 2 (BANK 4)	ROM 3 (BANK 5)	ROM 4 (BANK 6)	ROM 5 (BANK 7)
1. Brass	1. Up Piano	1. Horn 2	1. Fnk Syn 2	1. JOrgan 1
2. Horn	2. SPiano	2. Horn 3	2. Fnk Syn 3	2. JOrgan 2
3. Trumpet	3. Piano 2	3. Horns	3. SynOrgan	3. COrgan 1
4. Lo strig	4. Piano 3	4. Flugelh	4. Syn Feed	4. COrgan 2
5. Strings	5. Piano 4	5. Trombon	5. Syn Harm	5. EOrgan 3
6. Piano	6. Piano 5	6. Trumpet 2	6. Syn Clar	6. EOrgan 4
7. New EP	7. Ph Grand	7. Brass 2	7. Syn Lead	7. EOrgan 5
8. EGrand	8. Grand	8. Brass 3	8. Huff Tak	8. EOrgan 6
9. Jazz Gt	9. Dp Grand	9. Hard Br 1	9. So Heavy	9. EOrgan 7
10. EBass	10. LPiano 1	10. Hard Br 2	10. Hollow	10. EOrgan 8
11. Wod Bass	11. LPiano 2	11. Hard Br 3	11. Schmooh	11. Sml Pipe
12. EOrgan 1	12. EGrand 2	12. Hard Br 4	12. Mono Syn	12. Mid Pipe
13. EOrgan 2	13. Honkey 1	13. Huff Brs	13. Cheeky	13. Big Pipe
14. POrgan 1	14. Honkey 2	14. Perc Br 1	14. Syn Bell	14. Sft Pipe
15. POrgan 2	15. Pf Bell	15. Perc Br 2	15. Syn Pluk	15. Organ
16. Flute	16. Pf Vibe	16. String 1	16. EBass 3	16. Guitar
17. Piccolo	17. New EP 2	17. String 2	17. Rub Bass	17. Folk Gt
18. Oboe	18. New EP 3	18. String 3	18. Sol Bass	18. Pluck Gt
19. Clarine	19. New EP 4	19. String 4	19. Pluk Bas	19. Brite Gt
20. Glocken	20. New EP 5	20. Solo Vio	20. Uprt Bas	20. Fuzz Gt
21. Vibes	21. EPiano 1	21. Rich St 1	21. Fretles	21. Zither 2
22. Xylophn	22. EPiano 2	22. Rich St 2	22. Flap Bas	22. Lute
23. Koto	23. EPiano 3	23. Rich St 3	23. Mono Bas	23. Banjo
24. Zither	24. EPiano 4	24. Rich St 4	24. Syn Bas 1	24. Sft Harp
25. Clav	25. EPiano 5	25. Cello 1	25. Syn Bas 2	25. Harp 2
26. Harpsic	26. High Tin	26. Cello 2	26. Syn Bas 3	26. Harp 3
27. Bells	27. Hart Tin	27. Lo Strg 3	27. Syn Bas 4	27. Sft Koto
28. Harp	28. Perc Pf	28. Lo Strg 4	28. Syn Bas 5	28. Hit Koto
29. SmadSyn	29. Wood Pf	29. Lo Strg 5	29. Syn Bas 6	29. Sitar 1
30. Harmoni	30. EP String	30. Orchest	30. Syn Bas 7	30. Sitar 2
31. Steel Dr	31. EP Brass	31. 5th Str	31. Marimb 2	31. Huff Syn
32. Timpani	32. Clav 2	32. Pizzic 1	32. Marimb 3	32. Fantasy
33. Lo Strg 2	33. Clav 3	33. Pizzic 2	33. Xyloph 2	33. Synvoice
34. Horn Lo	34. Clav 4	34. Flute 2	34. Vibe 2	34. M. Voice
35. Whistle	35. Fuzz Clv	35. Flute 3	35. Vibe 3	35. VSAR
36. Zing Plp	36. Mute Clv	36. Flute 4	36. Glockn 2	36. Racing
37. Metal	37. Mute Cl 2	37. Pan Flt	37. Tube Bel	37. Water
38. Heavy	38. Syn Clv 1	38. Slow Flt	38. Tube Be 2	38. Wild War
39. Funk Syn	39. Syn Clv 2	39. 5th Flt	39. Bells 2	39. Ghostie
40. Voices	40. Syn Clv 3	40. Oboe 2	40. Temple G	40. Wave
41. Marimba	41. Syn Clv 4	41. Bassoon	41. Steel Dr	41. Space 1
42. EBass 2	42. Harpsi 2	42. Reed	42. Elect Dr	42. Sp Chime
43. Snare Dr	43. Harpsi 3	43. Harmon 2	43. Hand Dr	43. Sp Talk
44. RD Cymb	44. Harpsi 4	44. Harmon 3	44. Syn Timp	44. Winds
45. Tom Tom	45. Harpsi 5	45. Harmon 4	45. Clock	45. Smash
46. Mars to	46. Circust	46. Mono Sax	46. Heifer	46. Alarm
47. Storm	47. Celeste	47. Sax 1	47. Snare Dr	47. Helicop
48. Windbel	48. Squeeze	48. Sax 2	48. Snare Dr	48. Sin Wave

Banks 1 and 2 can be used for storage of 48 original voices each.

But what is even more incredible is the amazing versatility the FB-01 affords the amateur and the professional musician alike.

Each natural acoustic instrument or synthesizer voice features independently programmable functions such as pitch bend, detuning, octave transpose, and up to eight 4-operator digital voices simultaneously.

Plus four preset configurations that enable the FB-01 to be used as a single-voice 8-note polyphonic sound source, as well as a split sound source and dual sound source. And a Mono-8 mode offers monophonic performance of up to 8 voices simultaneously.

You can also create your own configurations and then store them in one of the FB-01's 16 user memories.

A lit LCD exhibits all performance data, system set-up, and voice names with dozens of operations carried out via a simple key layout on the front panel. The FB-01 is designed for ease of operation by any musician, even those without any detailed knowledge of MIDI or computers.

Its exceptional adaptability makes it well suited for MIDI applications ranging from live performance to computer music systems, MIDI recorder and sequencer systems, and MIDI studio systems.

Weighing in at a slight 4.6 lbs., the Yamaha FB-01 provides left and right stereo outputs and is also capable of microtonal tunings by computer.

All the more reason for you to stop by an authorized Yamaha Digital Musical Instrument dealer today for a complete demonstration. So you too can soon be hearing voices.

Yamaha International Corporation, Digital Musical Instrument Division, P.O. Box 6600, Buena Park, CA 90622. In Canada, Yamaha Canada Music Ltd., 135 Milner Avenue, Scarborough, Ontario M1S 3R1. *USA suggested retail price subject to change without prior notice. Canadian price will vary.

YAMAHA®

Electronic MUSICIAN

A MIX PUBLICATION

DEPARTMENTS

COVER

Wendy Carlos, the pioneer who turned the music world around in the late '60s with *Switched-on Bach*, is now exploring the world of alternate tunings and temperaments. At the time this picture was taken, she was in her home studio putting the finishing touches on her latest album, *Beauty in the Beast*. Photo by Vernon L. Smith.

Electronic Musician is published at 2608 Ninth Street, Berkeley, CA 94710 and is © 1986 by Mix Publications, Inc. This is Volume Two, Number Eleven, November 1986. *Electronic Musician* (ISSN: 0884-4720) is published monthly. Second Class postage paid at Berkeley, CA and additional mailing offices. All rights reserved. This publication may not be reproduced, quoted in whole or in part by mimeograph or any other manner without written permission of the publishers.

Subscriptions are available for $22.00 per year (12 issues). Single or back issue price is $3.00. Subscription rates outside the U.S. are $34.00 per year.

Send subscription applications, subscription inquiries and changes of address to *Electronic Musician*, 5615 W. Cermak Road, Cicero, IL 60650 or call (312) 762-2193.

Address all other correspondence to *Electronic Musician*, 2608 Ninth Street, Berkeley, CA 94710, (415) 843-7901.

We are interested in receiving unsolicited manuscripts but cannot be responsible for them and cannot return them unless they are accompanied by a stamped, self-addressed envelope. We urge you to send for our "How to Write for EM" guidelines.

Display advertising rates, specs and closing dates are available upon request.

To the best of our knowledge the information contained herein is correct. However, Mix Publications, Inc., its editors and writers cannot be held responsible for the use of the information or any damages which may result.

ARTICLES

Editor's Note

One of the main ideals of this magazine is to encourage musicians to be creative, and to strive to make music that is as state-of-the-art and innovative as the gear on which it is played. So, it's only fitting that this month's focus is on alternate tunings.

I guess this is sort of our "back to the future" issue. The 12 tone even-tempered scale is, historically speaking, a comparatively recent development (not too long ago, *it* was the alternate tuning). The main reason for its widespread adoption was pragmatism, not tuning accuracy, since with pre-electronic instruments the ability to modulate from key to key was practical only with even-tempered tuning.

However, we now have computers that can create scales with purer tuning than the 12 tone even-tempered scale, and can also handle the chore of proper modulation. Some instruments already allow for alternate tuning, but as you'll see in this issue, even keyboards such as the DX7, Six-Trak, CZ-101, Xpander, and others can be tuned to alternate scales. Once the concept of alternate tunings becomes more fully accepted (re-discovered?), surely more instruments will provide capabilities to handle these new tunings.

Why bother to experiment with alternate tunings? First, because it's fascinating. Just as major and minor scales produce different psychological effects, so do other scales—and this is almost virgin territory in Western cultures, for what could be useful research. Second, most intervals produced by the standard 12 tone scale are inherently out-of-tune; a truly consonant scale, where all intervals are in tune with each other, *sounds different.* If you find the lack of "beating" too bland-sounding, spice it up with some chorusing or digital delay—the effect is quite different compared to chorusing an even-tempered signal.

My first hands-on experience with just intonation occurred over a decade ago when someone brought by a custom IC that produced a just-intoned scale. Though the chip was never produced, I could hear that just intonation sounded different from what I was used to. My first real experience with microtonal tunings was courtesy of Ivor Darreg, a gentleman in Southern California who showed me his collection of re-tuned guitars, megalyras, and other instruments. It was a treat to play a 17-tone guitar and hear some of the wonderful intervals that resulted. Ivor has been crusading to make people aware of alternate tunings for decades, and it looks like his persistence in sending out tapes, information, and lively letters to virtually anyone who has asked him for advice or assistance on the subject is producing results. And Wendy Carlos, a sonic pioneer if there ever was one, is exploring new paths with an album that is the culmination of years of work with alternate tunings.

Kraftwerk once said something to the effect that although we have sophisticated global TV technology, we use it to show reruns of old westerns. They have a very good point. We now have instruments that could launch us into a whole new world of tonalities—one that opens musical possibilities and offers new challenges. Will we continue to play the musical equivalent of old westerns?

NATIONAL EDITORIAL, ADVERTISING and BUSINESS OFFICES
2608 Ninth St., Berkeley, CA 94710
(415) 843-7901
SOUTHERN CALIFORNIA ADVERTISING OFFICES
(818) 709-4662

Sound Experience

Kawai's SOUND experience and excellence in building innovative electronic products has resulted in the creation of the K3 synthesizer system. The foundation of the system, the K3 Digital Wave Memory Synthesizer, is so advanced it has set higher standards of quality in the industry for affordably priced digital synthesizers. The advanced technology featured in the K3 provides an incredibly wide spectrum of useful voice programs created from a broad base of 32 digitally sampled waveforms. The K3's keyboard is carefully crafted to be the finest playing keyboard of any synthesizer and features both velocity and pressure response. 100 on board tone patches, "live" editing of patch parameters and full MIDI implementation give the K3 a true performance edge over the competition. Performance features on the K3 are designed to enhance — not hinder — your personal style. The user friendly programming system together with its programmable digital wave form makes creating and storing your sounds easier than ever before.

The K3 sound experience continues with the new K3M Module. The Kawai K3M is not a mere keyboard clone, but is specifically designed to enhance the performance of any Midi synthesizer. With the K3M you can add the crystal-clear sounds of Kawai's digital wavememory technology to your existing keyboard set-up. When Midi'd to the K3 (or any other synthesizer equipped with Midi Local Control) the K3M provides true Keyboard Split and Range assignment, and Midi Spillover (useful for 12-voice polyphonic performance on the K3). Like the K3, the K3M features 100 on board tone programs, full patch editing functions, 2 user programmable digital waveform settings, and 32 pre-sampled digital waveforms.

The K3 System

Now, for what most other manufacturers charge for a single keyboard, you can have a complete digital music system featuring both the K3 and the K3M! Also, Kawai has taken advantage of the open architecture of the K3 system by introducing a complete computer support system based on the Atari 130XE computer. Jointly developed with Hybrid Arts, the K3 Computer System includes a Librarian for organizing and storing hundreds of tone patches to disk, and a Wave Table Editor for creating and storing to disk hundreds of user programmed digital Waveforms and tone patches. The K3 computer system also features the Midi-Track III, a 16 track, 10,000 note Midi music sequencer.

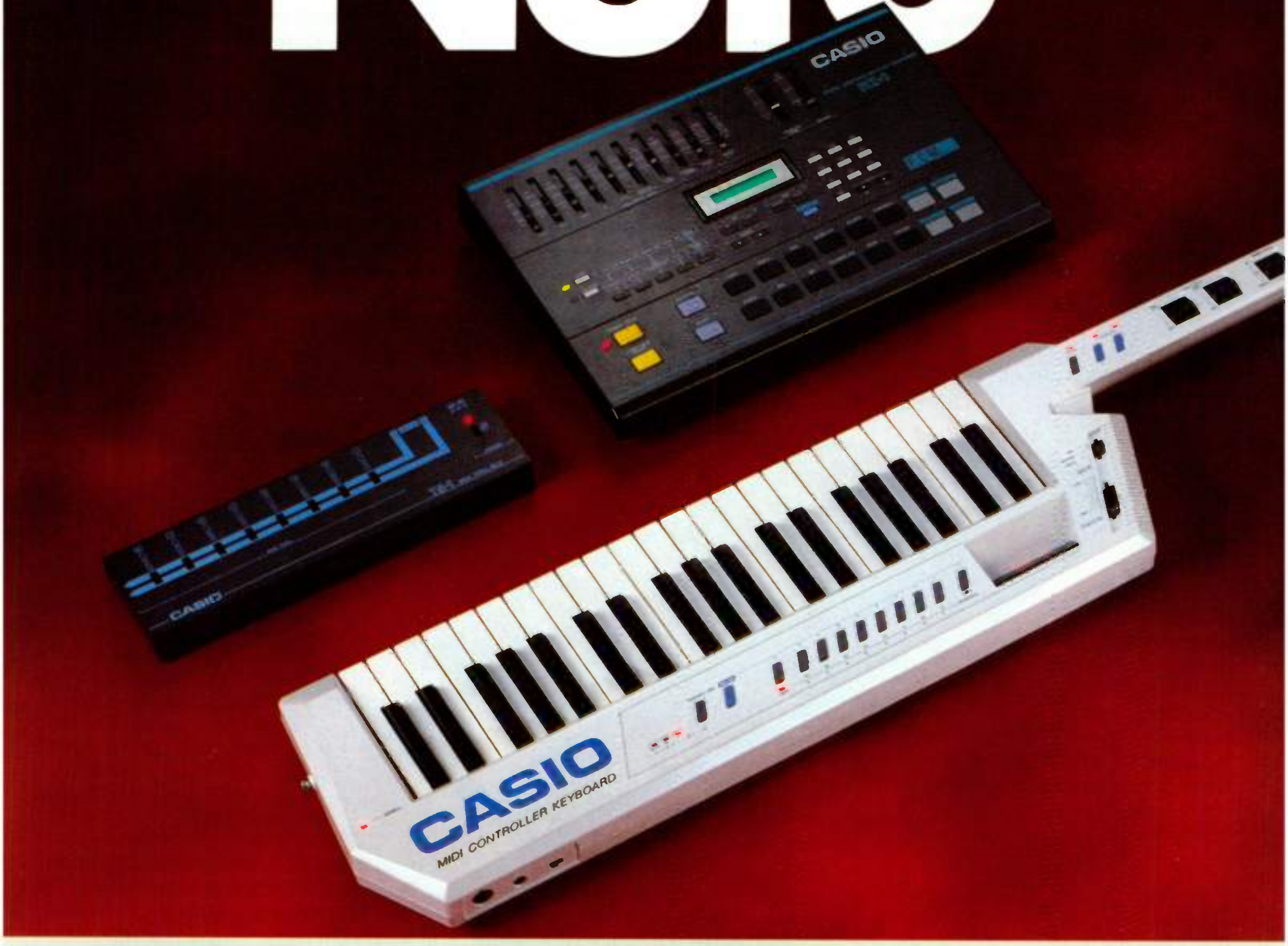
Conclusions

Before you invest money in a digital synthesizer, take our SOUND advice ... check out the SOUND EXPERIENCE of the Kawai K3 and K3M Module at your local Kawai dealer!

Kawai America Corporation
Department EM
P.O. Box 0438
24200 S. Vermont Ave.
Harbor City, CA 90710-0438

KAWAI
The Master Builder

Note



Introducing a touch-sensitive system that's not out of reach.

You haven't gotten this far in your career by making compromises. That's the whole idea behind Casio's new line of professional products—uncompromising performance. It's also why we created a whole new division to help you get the most out of it.

And there's a lot to get. Our **CZ-1 ($1,399)** is a full-size, 61-key synthesizer with programmable touch sensitivity. Initial touch, or velocity, can be programmed to control pitch, timbre and volume; while after touch can be adjusted to control modulation depth and volume.

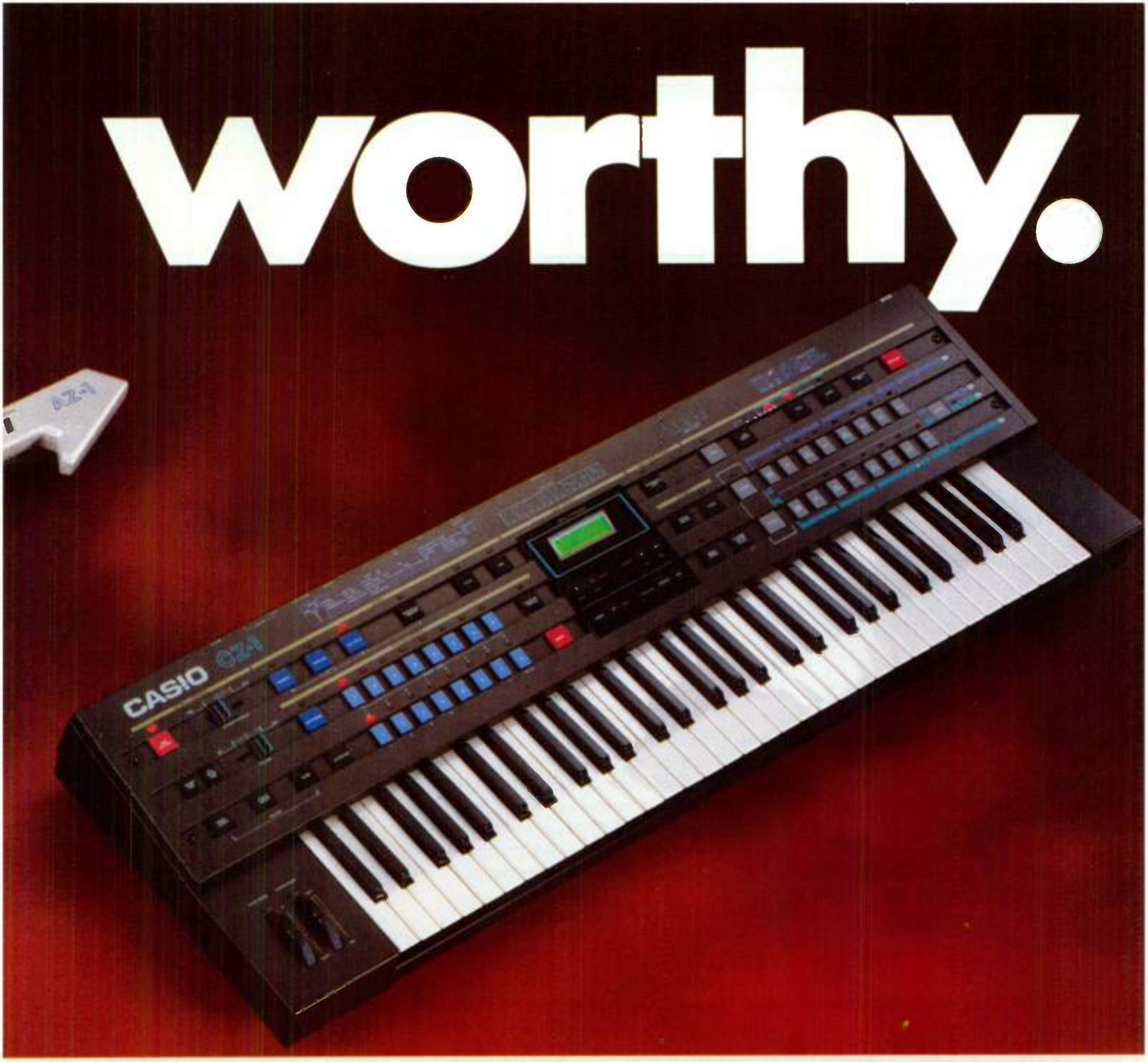
It has 64 RAM memories which are loaded at the factory with a powerful assortment of PD sounds, or can hold the same number of sounds of your own creation. (You can still recall any of the factory presets at the touch of a button—even if you have written over them.) Our optional RA-6 cartridge ($89.95) can immediately access another 64 sounds, for a total of 192 sounds in all!

In addition, the CZ-1 has a new Operation Memory, which holds 64 key-splits, tone mixes and other combinations for instant recall in the heat of performing. The key-splits and tone mixes themselves now have added features to give you more flexibility, such as separate stereo outputs, independent detuning and octave shifts.

Of course the CZ-1's MIDI is advanced to the max—an 8-note polyphonic, multi-timbral system, which allows you to assign the 8 voices in any combination over the 16 channels of MIDI for all your sequencing needs.

And so you can easily keep track of all your sounds, the CZ-1 lets you name them yourself and shows you which ones you're using on its bright, back-lit alpha-numeric display.

Strapping on our **AZ-1 ($549)** 41-key, full-size MIDI keyboard con-


worthy.
AZ-1
CASIO
CZ-1

Addresses, please...

On page 19 of the August '86 issue of **EM** you list R.M.D. & Associates, as a manufacturer of a MIDI interface for the Radio Shack Model 100 portable computer. Unfortunately no address was given. Could you please help me locate this company?

Walter Aldrich
Port Richey, FL 33568

Walter—R.M.D. is at 5265 Grandview Ave., Yorba Linda, CA 92686; tel. 714/777-3180. And for those of you who asked for a couple of other addresses, Hinton Instruments is at 168 Abingdon Rd., Oxford, OX1 4RA, England; tel. Oxford (0865) 721731. Intercomp Sound is at 129 Loyalist Ave., Rochester, NY 14624; tel. 716/247-8056.

Who's unbalanced?

After reading Glenn Flood's article about a Low Z to High Z adapter in the May '86 **EM**, I wondered what it would take to convert this unbalanced high Z output to a balanced high Z output? Thanks to Glenn Flood and all at **EM**.

Mark Zifcak
Putnam, CT 06260

Mark—First, thanks for also pointing out an error on the schematic's legend (see Error Log below). To answer your question, simply lift the other end of the output winding off ground, and ground the center tap. You will have in-phase and out-of-phase signals, referenced to ground, at the transformer output.

Professional resentment?

Having read your publications of letters from **EM** worshippers, I felt compelled to submit my own. I am 15 and have a fair amount of musical experience. When I received two complimentary issues of the magazine, although I considered the subscription price a little high, I knew I had no choice—the magazine was just too wonderful! I hope no professionals are resentful of a kid reading the same magazine as they, for I have dedicated my life to music, MIDI, and **EM**. You're my kind of magazine!

Spencer Gary
Dallas, TX

Spencer—First, thanks for the kind words. But more importantly, I think most professionals are delighted, *not resentful, to see more people getting into the field that they*

love. Besides, current topics like MIDI are new no matter whether you're 15 or in in your 60s (like some other readers we have), and so on one level we're all beginners. Music cuts across all age groups, philosophies, races, and other "labels"—welcome to one of the world's most non-exclusive groups.

MIDI For Musicians error

Your book *MIDI For Musicians* was excellent for me, even though I am much more a computer scientist than a musician. Your discussion of the MIDI protocol was thorough and generous.

I think you may want to know of a bug in your keyboard note on/off scanning program in pp. 18-19. Line three should read "If no key is down, skip to Step 5." The way it's written in the book, the program will not know that a key has been released *until* a key is down, but the program should keep looping for both events.

Thanks for a good book.

Ruben J. Kleiman
Bedford, MA

Back to basics...

Okay! You've impressed me enough to send in my subscription card—but—I'm a drummer who's just breaking into this field. I'm planning on getting a Yamaha DX100 and Oberheim DX and to put things quite frankly, I don't really understand a lot of your articles although I'm trying to learn. I'd like to see more features on the basics of this music field and its devices.

Bo Eder
West Covina, CA

Bo—We certainly sympathize, and know how hard it is to jump headfirst into a whole new field. But keep reading and experimenting, as that will help things to fall into place. Also, our game plan has always been to retain our technical orientation, and as the page count increases (which it has been), to add more basic articles for those just getting started. Expect to see more articles of this nature starting in January. Meanwhile, if you have some specific ideas for topics you'd like covered, drop us a postcard—many articles are the result of specific reader suggestions.

Dolby has the right idea...

In the Thomas Dolby interview (June '86 **EM**), Dolby says his passport lists him as an inventor. Igor Stravinsky's passport listed him as a composer. However, during the war he told a French border guard that he was an inventor of music. The guard hassled Stravinsky, pointing out that he was listed as a composer. Stravinsky explained, "The expression 'inventor of music' fits my profession more exactly than the term applied to me in the documents authorizing me to cross borders." Dolby has the right idea.

Reed Maxson
Airfield Music
Davis, CA

Error Log

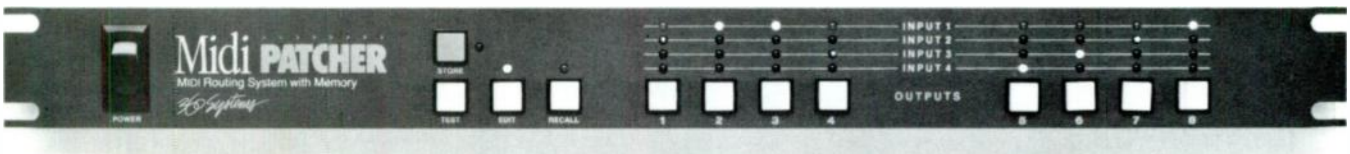
In "Low Impedance Balanced Line to High Impedance Unbalanced Line Adapter" schematic (page 64, **EM** May '86), "High Z balanced output" should read "High Z unbalanced output."

In "Budget Modems" (page 37, **EM** September '86), when describing the Model 100's built-in software, an editorial mix-up inserted the word "compiler" after BASIC. Only a version of BASIC, not a BASIC compiler, is included in the Model 100.

To **David Gilden:** We know you requested a copy of "How To Write For EM" but have no record of your address. Please let us know where we can contact you.

EM

Link your Midi instruments



$295.

with MIDI PATCHER—a 4 in, 8 out Midi routing system *with memory*

IF you could connect your master keyboards to different Midi sound sources, at different times—you would have the power to create musical arrangements never before possible. Now, every important link can be remembered, recalled, changed and instantly compared to others.

Midi Patcher does more than organize your wiring—it displays every connection on its front panel with four-color LED's. It even changes routing while you play, either from the front panel or by Midi.

With Midi Patcher, the complexity of large systems becomes manageable under intelligent micro-computer control. Available rack mount or stand-alone, at high-tech keyboard stores everywhere.

360 Systems

18730 Oxnard Street • Tarzana, California 91356

Hear the MIDI BASS sampled sounds on this new cassette

At $399, Midi Bass adds a real bass player to Midi keyboards, guitars, pedals, and sequencers. Now multi-sample digital recordings can be part of your performance. Each sound is a perfect copy of a real bass. Midi Bass even copies dynamics and pitch bends.

NEW ALTERNATE SOUNDS

We've added the best of Rock, Tech-Pop, Funk, and Country to our expanding library. Get the Midi Bass cassette and hear the entire collection of alternate sounds from this remarkable bass player. Each sound is performed by itself, and again with a rhythm section. Included with each cassette is a detailed description of every sound, and a complete library list/order form.

Get the Midi Bass cassette from your dealer, or send $5 cash or money order to 360 Systems, 18730 Oxnard Street, #214, Tarzana, CA 91356.

360 Systems

$399 MIDI BASS with two sounds

AES Booths 922-924

Send me the Midi Bass Cassette

Enclosed is $5 for each tape
(Outside U.S. add $1.)

Name ______________________

Street ______________________

City/State/Zip ______________________

Please check the boxes that apply:

☐ I own a Midi Bass. I use it for ☐ recording ☐ live.
☐ I don't have one yet. Send info

360 Systems • 18730 Oxnard St. #214, Tarzana, CA 91356

Operation Help

Operation Help *is dedicated to helping musicians help each other. If you need technical assistance, a schematic for some old piece of gear, or just want to connect with people having similar interests, send your name, address, phone number (optional), and nature of your request to Operation Help,* Electronic Musician, *2608 Ninth St., Berkeley, CA 94710. There is no charge for this service, but we cannot guarantee that all requests will be published.*

Oberheim Mods: Does anyone have any useful mods for the Oberheim OB-SX Synthesizer (programmer, custom EPROMs, MIDI or computer port applications, etc.)? I have come up with some I would like to share. Gordon Bland, Webster Groves, MO 63119.

MIDI Trident: I currently own a Korg Trident synthesizer and Ensoniq Mirage sampling keyboard. My problem is that the Korg is not built for MIDI. I would like to explore the MIDI functions of the Mirage but at this point cannot. Is there any MIDI retrofit for the Korg Trident? Can anyone give me advice on this problem? Tim Daniels, P.O. Box 403, Chester, VA 23831.

P/V, ARP Avatar Schematic: Does anyone have a good pitch-to-voltage converter schematic, or even an ARP Avatar schematic they could photocopy or sell? Michael Hambrick, 2614 Meadows St., NW Roanoke, VA 24012.

Turn A Prophet: I am a happy owner of a very early Prophet 5 (rev 2.0, I believe; it has an edit button and the knobs are in absolute position when in edit), serial #666. I also own a DX7 and Casio CZ5000. Obviously I would love to get my Prophet MIDIed, but I have not been able to hook up with anybody who can do this. I read about people with MIDIed Oberheim modular polyphonics and Moog model 15s; someone must be able to MIDI an early model Prophet. I was told that J.L. Cooper's tech division could do the job, but they haven't responded to my messages, so I presume they cannot. I really dig the sound of my old Prophet and it has no memory dump facilities so I would also not want to lose my patches. If anyone knows of any outfits that can help me, please let me know. Francis Manzella, 36 W. 37th St., New York, NY 10018.

Ensoniq User Group: I am interested in starting or joining a user group for the Ensoniq ESQ-1. If there is anyone out there interested in trading patches, sequences and tips, contact me. Bob Wham, 4900 Joe Ramsey Blvd. #1303, Greenville, TX 75401; tel 214/454-6792.

Moog Schematic: I am really desperate to obtain a schematic for the Moog Prodigy. Doug c/o Space Station Studio, 479 5th Ave., Brooklyn, NY 11215. EM

There's no telling what a drummer might do with a Mirage . . .

If you're a keyboard player, don't ever let a drummer borrow your Mirage . . . you might never get it back. If you're a drummer, ask a keyboard playing friend to lend you his Mirage . . . "for a while." In either case, if you're into percussion, there's a score of good reasons to get your hands on a Mirage.

The buzz on the buzzword

"Sampled Percussion" is a pretty catchy buzzword. Some high-end electronic percussion systems offer sampling as a creative option. Others offer a selection of sampled sounds on ROM's that plug into the system.

The Mirage can sample any sound in the percussion family — or any other family, for that matter. There's also a wide range of percussion sounds on 3.5" diskettes in the Ensoniq Sound Library, from acoustic and electronic drums to kalimba and Fu Yin gong.

The Ensoniq Percussion Library

Sound Disk	Sound
4	Acoustic Drums, Electronic Drums, Orchestral Percussion
10	Tabla & Bayan Drums
11	Rack Bell, Kalimba, Wind Gong, Slit Drum
14	Cup Gongs, Che Cymbal, Crotales Orchestral Bells
16	Latin Percussion
18	Fu Yin Gong, Opera Gong
20	Ambient Drums

MIDI makes the magic

Now that we've gotten all these great percussion sounds into a Mirage, how do we get them out? Naturally, all the sounds can be played in real time from the keyboard. Since the Mirage can hold up to 16 samples, you can play a full drum set or complete percussion at any one time.

You can use the on-board sequencer to build up patterns, or use an external MIDI sequencer to create and edit complete songs. Just play the part on the keyboard or, if your sequencer has step editing, write the appropriate MIDI note number on the right beat and lock in a solid groove.

How to become an Octaman

Most drummers will argue that playing percussion is no fun unless you get to hit something. We agree. MIDI features that can put you in touch with a Mirage are showing up on electronic drum kits. And our friends at Roland have come up with a MIDI percussion item that's simple and inexpensive — the Octapad*.

As the name implies, the Octapad gives you 8 pads to hit and each pad can be assigned a MIDI channel and MIDI note number. Add a Mirage, a MIDI cable and a pair of drum sticks and you've got a potent percussion instrument.

Let's start by creating an electronic drum kit. Connect the MIDI out of the Octapad to the MIDI in of the Mirage and load Sound 2 (Electronic Drums) from Sound Disk 4. The Mirage now has 12 distinct electronic percussion sounds ready to go, including full octaves of toms, ride cymbals and flanged crash cymbals.

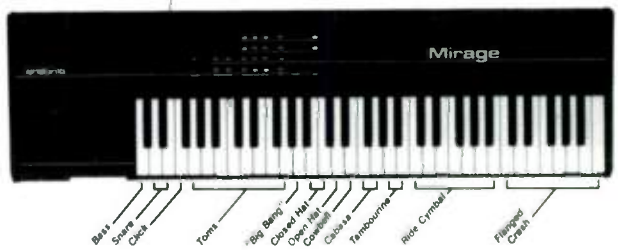
Set the Octapad and Mirage to the same MIDI channel and choose any 8 sounds by entering the MIDI note number into the Octapad for each sound. The keyboard map shown here will give you a guide. You've now got an 8-piece electronic drum kit that's ready to record, sequence or play live.

Mirage means melodic percussion

You can follow the above procedure to use any of the Mirage percussion sounds with the Octapad — but why stop there. One of the strongest advantages of the Mirage/Octapad combo is the ability to play percussion using any sound in the Ensoniq Library.

By selecting MIDI note numbers you can easily program scales into the Octapad to use with Mirage steel drum, marimba, hammered piano, bass, harp, vibes or whatever. Because the Octapads are velocity sensitive, you'll be able to control the dynamics just as you would any acoustic percussion instrument.

If you want to get a bit more outside, try playing brass and orchestra hits, guitar power chords, sound effects and pipe organ through the Octapads — there are over 300 sounds in the



Ensoniq Library just waiting to get pounded.

All this and a keyboard, too

As you can see, the Mirage isn't just a great keyboard, but a versatile drum machine, too. With some additional MIDI gear, it can be downright amazing. Visit your authorized Ensoniq dealer for a full demonstration. There's no telling where a Mirage and your imagination can take you.

ENSONIQ Corp.: 263 Great Valley Parkway, Malvern, PA 19355 ■ Canada: 6969 Trans Canada Hwy., Suite 123, St. Laurent, Que. H4T 1V8 ■ ENSONIQ Europe: 65 Ave de Stalingrad, 1000 Brussels ■ Japan: Sakata Shokai, Ltd., Minami Morimachi, Chu-O Building • 6-2 Higashi-Tenma, 2-Chome • Kita-ku Osaka, 530

ensoniq®

*Octapad is a trademark of RolandCorp. Mirage is a tramemark of ENSONIQ Corp. The hollow log is not covered under any U.S. or international patents — yet. The Mirage Sampling Keyboard retails for $1695 — the Mirage Multi-Sampler for $1395.

BY ROBERT CARLBERG

Send records, tapes and videos for review to Robert Carlberg, P.O. Box 16211, Seattle, WA 98116.

Steve Joliffe, *Japanese Butterfly* (Nada Pulse 012). Flautist/keyboardist Jolliffe (ex-T. Dream) is a lot more New Age on his second solo outing, employing mournful flutes, piano, and digital synthesizers in low energy mood pieces. Nearest equivalents: Emerald Web or Lucia Hwong. $10 from EUROCK Distribution, P.O. Box 13718, Portland, OR 97213.

Bluetoy, *Berserker* (cassette). Keyboardists don't often make good percussionists, but Christopher Laird Simmons is the exception. The dominant force on this tape is a very accomplished sounding Linn 9000, with relatively minor keyboard chords, trills and fills holding it together musically. Like Neal, he doesn't confine himself to drumkit sounds, making his percussion a joy to listen to. This and five previous tapes available for $6 each from S.U. Productions, Box 7000-822, Redondo Beach, CA 90277.

Sandy Simpson, *The Passing of the Dark* (cassette). Christian artist Simpson appeared with Jeff Johnson on Meadowlark's *No Shadow of Turning* (reviewed 4/86). Here he sings his own subtly-praising lyrics accompanying himself on guitar, piano, and synthesizers. The result is very professional for his solo debut. Outrigger Records, P.O. Box 682, Newberg, OR 97132.

Brian Eno, *More Blank Than Frank* (Editions EG LP65, LP); ***Desert Island Selection*** (Editions EG CD65, Compact Disc). Compilations from Eno's four "rock" albums; *Warm Jets* (1973), *Tiger Mountain* (1974), *Another Green World* (1975), and *Before and After Science* (1977). Chosen by Eno himself, the tracks are a good cross section of this period of his work, though by no means a "best of." The CD is slightly different than the LP, sharing six of the latter's ten tracks but inserting four different ones plus a track from his Ambient period. Why the difference? You might as well ask why the original albums haven't been released on CD.

Robert Slap, *Search for Utopia* (Valley of the Sun AM131; cassette). "Progressive" New Age music, which means that in addition to the usual pentatonic keyboard noodles, Slap also slips in some synthesizer white noise effects, some David Gilmour electric guitar strums, and a few power chords as befits his rock and roll past. This and three previous tapes can be had for $8.98 from VotS at P.O. Box 2010, Malibu, CA 90265.

Iasos, *Wave #2: "Elixir"* (W2-CD; cassette). In New Age circles, Iasos (pronounced ya-sos) is near-legend. He has in the last dozen years released a score of spiritual-evolution cassettes, emphasizing the therapeutic effect of tranquil music. His music consists primarily of airy synthesizer drones with a lot of depth to them, but zither, steel guitar and flute also pop up. Iasos is more successful than most of his imitators in creating music that transcends the world of notes and sounds. $12 from Inter-Dimensional Music, Box 594 Waldo Pt., Sausalito, CA 94965.

Klaus Dinger, *Neondian* (Teldec 6.26019). As one half of the group Neu! (see May '86 column), Dinger was responsible for some of the best German progressive music of the '70s. Sporting a punk Mohawk and using digital drums, Dinger still sounds remarkably like his last transmission five years ago, *Individuellos*, by La Dusseldorf. Reportedly he's putting Neu! back together again with Michael Rother, which sounds fine to me. Imported by EUROCK Distribution, P.O. Box 13718, Portland, OR 97213, $10.

Indra Lesmana, *For Heaven and Earth* (MCA Zebra 5709). An Indonesian keyboard prodigy, 20-year-old Lesmana has populated his second solo album with L.A.'s top session musicians and recorded at Chick Corea's Mad Hatter Studios. As you might expect, it's slick, quick "corporate jazz."

Tangerine Dream, *Green Desert* (Relativity 8072). The "lost" T.D. album from 1973, which puts it between *Atem* and *Phaedra*. It turned up earlier this year as part of the *In The Beginning* boxed set, and is now available (on compact disc) on its own. Musically, Froese was in his guitar-hero period and technologically the disc is mostly Moog modular and string ensemble. The total lack of any liner notes is disappointing, and somewhat misleading, but *Phaedra* fans will enjoy the additional chapter.

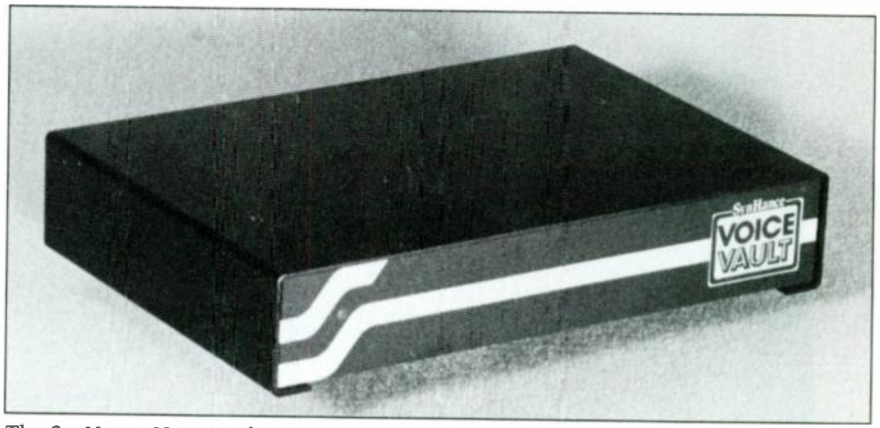
XYL, *Nuclear Winter* (cassette). The 14-minute title track is an invocation of its subject using backwards and forwards wind chimes, gongs, and synthesizers. Like Wendy Carlos' "Winter" off *Sonic Seasonings*, it makes the whole room seem freezing. The three other shorter tracks range from T. Dreamish sequencer pieces (Peter Gulch assists on this tape) to a piece based on the post nuclear film *Testament*. Despite the heavy inspirations, this tape is a pleasurable journey. $4 from Charles Van Zyl, 322 Margate Road, Upper Darby, PA 19082. EM

__Robert Carlberg__ is the national service manager for audio Environments Inc., a nationwide supplier of original-artist music for restaurants and fashion stores. His hobbies are electronics and music, and particularly electronic music.

ACCESSORIES

▶The **SynHance Voice Vault** ($229 for 192 patches, $399 for 512) rack-mount memory expander stores DX7 patches in battery-backed up RAM. The 512 patch model also includes 128 "songs" (pre-sequenced groups of patches, available for easy recall while playing live).

Harmony Systems
4405 International Blvd., Suite B-113
Norcross, GA 30093
404/923-2121



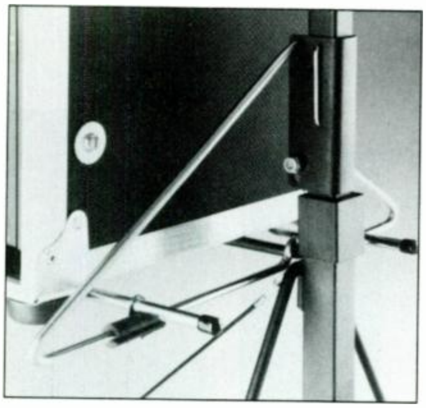
The SynHance Voice Vault

▶The **Model 877** ($450 plus installation) memory expansion kit increases single-disk drive Prophet 2000 memory to 512K, thus doubling the available sampling time. The **Model 878** ($300 plus installation) doubles memory in double-disk drive Prophet 2000s and the Prophet 2002.

Sequential
3051 N. First St.
San Jose, CA 95134
408/946-5240

▶The **MIDI Shelf Kit** ($59) includes adapters and rack supports to hold rack gear below keyboards on Invisible Products' KB series stands.

Invisible Products
Box 341
Accord, MA 02018-0341
617/871-4787



Invisible Stands MIDI Shelf Kit

▶The **FilteRing** ($39.95) steel-framed pop filtering system mounts on any microphone stand; the **NS-TENuator** ($15/pair) holds the filtering material of your choice in place against an NS-10M tweeter.

MASA
4928 Maytime Lane
Culver City, CA 90230-5055
213/836-4524

The FilteRing

▶**ProPhiles** acoustic foam ($89.95 per box; covers 13.3 sq. ft.), a Sonex product, controls room acoustics in home listening environments.

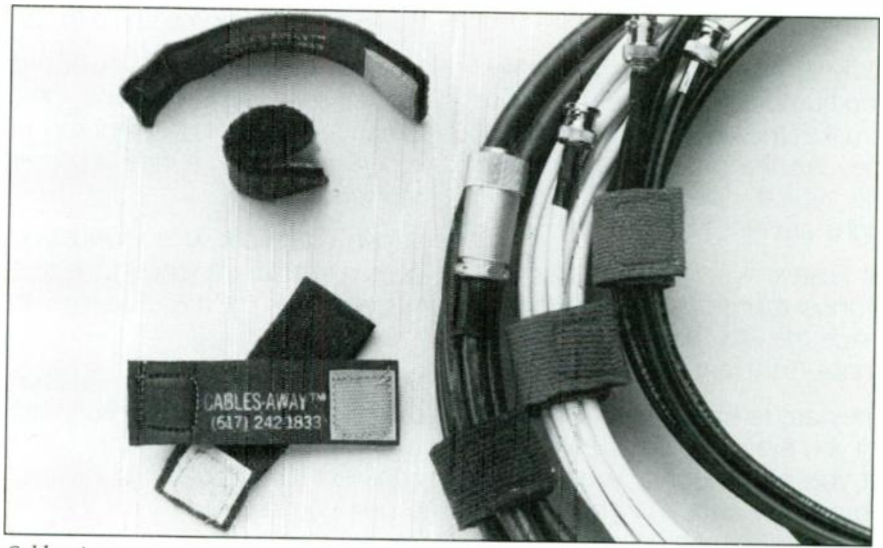
Illbruck
3800 Washington Ave. North
Minneapolis, MN 55412
612/521-3555

▶A velcro strap cable tie, **Cables-Away**, stretches to fit any size cable.

Playback
3504 Eighth St.
Charlestown, MA 02129
617/242-1833

COMPONENTS

▶A precision dual op amp, the **RC4227** (under $1 in quantities of 100), features a



Cables Away

2.7 V/μs slew rate, 3 nV/root Hz noise figure, and input offset voltage of 20 μV typical.

Raytheon
350 Ellis St.
Mountain View, CA 94042
415/968-9211

COMPUTERS

▶The **Music Power Station** ($3,199) comprises an Apple Macintosh, 4 megabytes of RAM, and software to switch between multiple functions. Expandable 2 Megabyte and 1 Megabyte versions are available for $2,799 and $2,599 respectively. Prices good through October. Existing systems can also be upgraded to Power Station specs.

Julian Music Systems
4345 Fairwood Dr.
Concord, CA 94521
415/686-4400

▶The **1018-PC** board ($495) allows the IBM-PC to monitor/control up to 128 digital lines or devices via simple PC programming commands. Plug-in options include opto-isolation, high-current drives, and digital-to-analog outputs for VCA control.

Industrial Computer Designs
31264 La Baya Dr.
Westlake Village, CA 91362
818/889-3179

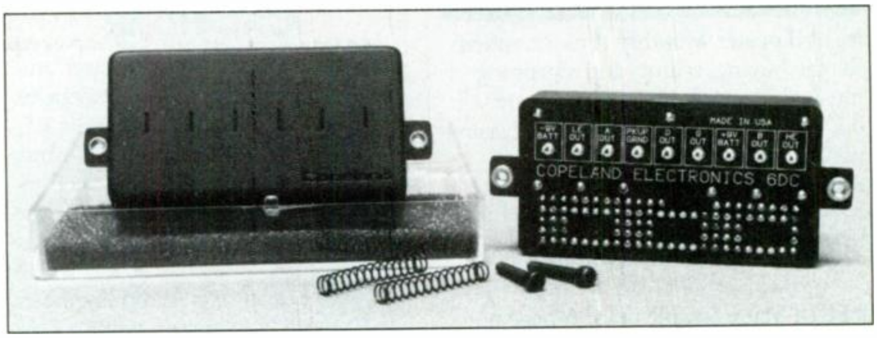
▶The **EPROM Burner** ($139.95 for Atari ST, $199.95 for IBM PC and Amiga) accommodates 2764, 27128, 27256, and 27512 type EPROMs; files can be read or written in binary, Intel, or Motorola formats.

Hippopotamus Software
985 University Ave., Suite #12
Los Gatos, CA 95030
408/395-3190

EDUCATION

▶Musication has opened a MIDI Center in New York. Services include a MIDI production facility, music software demonstrations, seminars and classes, sound library, special events, and sales of preconfigured music systems.

Musication
1600 Broadway (48th St.), Suite 1000A
New York, NY 10019
212/957-9100



Copeland hex guitar pickup

ELECTRONIC GUITAR

▶The **6sc** ($139.95) and **6dc** ($149.95) hex guitar pickups are single and dual-coil humbucking pickup designs respectively. Also available: the **6csm** companion mixer.

Copeland
4007 Seaport Blvd.
W. Sacramento, CA 95691

▶The **Takamine GTM6** acoustic guitar (from $2,095 to $2,395; one nylon string and four steel string models are available) uses piezo-electric pickups and provides polyphonic pitch-to-MIDI conversion. Includes on-board sequencer, hold, transposition, etc.

Kaman Music Distributors
P.O. Box 507
Bloomfield, CT 06002
203/243-7888

ELECTRONIC PERCUSSION

▶The **EDR-1** Electronic Drum Rack, made of sturdy, lightweight rectangular aluminum, is optimized for use with electronic as well as acoustic drums. It includes the normal front bar/legs section, two side rails and legs, five PC-2 pipe clamps and one Tone Unit holder.

Pearl International
P.O. Box 111240
Nashville, TN 37222-1240
615/833-4477

▶Owners of products from **Linn Electronics** can obtain repairs, modifications (memory expansion, disk drive option, extra trigger inputs for LM1, etc.), custom sounds, and other services from Linn's former service technicians at:

Forat Electronics
11514 Ventura Blvd.
Studio City, CA 91604
818/763-3007

▶The **Drum Bug** ($50) can trigger drum synths as well as provide a standard acoustic output.

J.T. Enterprises
6924 W. Arrowhead
Kennewick, WA 99336
509/735-7430

▶The **Klone Trigger System** ($699) includes five self-adhesive drum sensors, the Klone "brain" (analog sound generator /interface), cables, and manual.

Paul Real Sales
745 Oak Knoll Circle
Pasadena, CA
818/792-6847


Klone Trigger System

MICROPHONES

▶Two new microphones, the **PE10D-LC** ($64; optimized for instrumental sound reinforcement) and **PE15D-LC** ($84; optimized for vocals) provide switchable high impedance or low impedance outputs.

Shure Brothers
Customer Services Dept.
222 Hartrey Ave.
Evanston, IL 60202-3696

PUBLICATIONS

▶The **Locater Monthly** runs classifieds for the buying, selling, and swapping of musical gear. Ads are free for private sellers. A one-year subscription is $12; sample issues are $1.

Locater Network
2265 Westwood Blvd. Penthouse 494
Los Angeles, CA 90064
800/331-0741 (in CA 213/477-9222)

▶**MIDI Made Simple** is a 106-page nontechnical primer on MIDI. Available for $12.95 (plus $2 p/h) from:

MIDI Made Simple
65 Meetinghouse Ridge
Meriden, CT 06450
203/235-3452

▶The 86-page **Directory of Computer Assisted Research in Musicology** ($5) includes a news section with a list of relevant dissertations in progress under the auspices of several academic disciplines, a substantial article on music printing via computer, and a listing of current and recent computer applications with an address list.

Center for Computer Assisted Research in the Humanities
525 Middlefield Rd., Suite 120
Menlo Park, CA 94025
415/322-7050

▶The **Yellow Pages of Rock** ($80), a 500-page, three-volume set, includes a who's who of professionals involved in contemporary music and media, luxury business travel services, and a pocket-size travel version.

Album Network
8265 Sunset Blvd.
Hollywood, CA 90046

—page 24

CALENDAR

Musicom '86, the premiere electronic music convention for the Benelux countries, will be held November 7, 8, and 9 in the Netherlands. For further information, contact Synton Electronics B.V. at Zandpad 46, Breukelen, the Netherlands; tel. 03462-63499, telex 40541.

The 81st annual **Audio Engineering Society** convention will be held November 12-16 at the Los Angeles Convention Center. Stan Cornyn will be the keynote speaker, and Firesign Theater will perform at the Awards Banquet. Contact the AES at 60 East 42nd St., New York, NY 10165; tel. 212/661-2355 or 661-8528.

Industry Trends

BY STEVE SAGMAN

When I wrote about the MIDI software market last spring, I described the just-beginning shakeout of a number of software companies. Back then, I depicted a market that was truly small compared even to other narrowly-defined vertical market segments. I suggested that too many products from too many producers were appearing, all designed to serve the same needs of the same musicians. With that scenario, it seemed there could only be more of the business dropouts that were just starting to occur and, in fact, a few more software vendors did close down. But that was several months ago, and in a business as fast-moving as the musical electronics industry, a lot of changes can happen in a couple of months.

A few dark clouds hung over the software market at last June's NAMM show, but there were also signs of sunnier days to come over the next half-year (six months or so seems to be the usual interval you can expect to wait before seeing the next batch of products in the stores—it usually takes a few months before products that debut at the January and June NAMM shows are completed and shipped from the factory). Industry observers were often walking around trying to remember who had been at the previous event in January and were now missing. I can understand why some one-product companies may have dropped out and, no doubt, their failure was painful to the individual entrepreneurs involved. But the herd that leaves behind its weakest members has a better chance of surviving. In the long run, the attrition of frail companies is in the best interest of the market. Obviously, less competition for consumers' dollars makes the going easier for software authors, but there are other benefits. Sometimes, small upstarts act like guerilla marketers. They strike the market and stir things up, leaving consumers confused—and sometimes angry at having been exploited. A few of these companies have employed unethical sales tactics and others, while they are earnest in their efforts, can't deliver the products they promise or properly support the goods they provide. A few consumers get burned and many more are disillusioned. We are likely to see less of these kinds of problems now.

There has been another business advancement that looks hopeful—the development of several music software companies in the pattern of more conventional publishing houses. These organizations, like Passport Designs and Dr. T, are software producers who have seen the economic advantages of adding smaller organizations' products to their lines. These struggling, entrepreneurial companies, often only one or two programmer/musicians large, are delighted to be relieved of the considerable marketing expenses of packaging, sales, advertising and after-sale support. The relationship benefits all sides with consumers getting better availability, support, and, sometimes, pricing of software with the economies the new publishers find in having a whole catalog of products to sell. Of any recent development in the software market, I feel the advent of a publishing model in MIDI software marketing is the most significant.

Another encouraging trend is the cooperation that is starting to blossom between hardware companies and software producers. . . but that's a story for another time. See you then! EM

Color your music

With Advanced MIDI Products From . . .

SONUS

Sequencers, Commodore 64/128: Super Sequencer 64/128 · GlassTracks 64
Yamaha Software Products, Commodore 64/128: DX-TX 216/816 Double Banked Programmer Librarian
DX-TX 18 Banks of Sounds · DX7/TX7 Support · DX21, 100, 27, 7 Support · RX11/21 Librarian **MIDI Event Editors:**
MIDI Processor 64/128 **Programs for Casio Synthesizers:** Casio Programmer Librarian (CZ101, 1000, 5000) · Casio Sound Disk
Visual Editing Software (sampling) Commodore 64/128: Sonic Editor for the Ensoniq Mirage · Sonic Editor for the Sequential 2000
Hardware for the Commodore 64/128: Commodore MIDI Interface · Commodore MIDI Interface With Tape Sync **Apple IIe:** Super Sequencer
128 **Atari 520st/1040st:** Super Sequencer 520/1040 **IBM/Compatibles:** Super Sequencer for IBM **MIDI Accessories:** A/B Selectable 2 in 8 Out
Thru Box · MDM 80 MIDI to FSK Tape Sync

21430 Strathern Street · Suite H · Canoga Park, California 91304 · (818) 702-0992 · Telex: 650-297-9928

Art Direction & Design: Julie Munro & Jane Masterson

For a limited edition fine art print of this ad, send $15.00 to Sonus.

Percussion at NAMM

BY GEORGE PETERSEN

The 1986 Summer NAMM show offered, quite literally, something for everyone in the realm of electronic percussion. Certainly the big news was the wealth of new MIDI controllers, ranging from percussion bodysuits to MIDI "maracas," with a good selection of electronic kits and drum machines also making their debut.

Yamaha perhaps made the biggest splash by unveiling their long-awaited Electronic Percussion System, consisting of the PMC1 rack-mount pad-to-MIDI converter and any combination of up to eight snare/tom or bass drum pads. The system doesn't generate sounds—it's strictly a MIDI controller—but when configured as Yamaha's "recommended system" (triggering an RX11 drum machine and TX816 tone module rack) the results were truly impressive, although this setup would make for a rather expensive system.

A lot of thought must have been given to the Yamaha pad design, which has somewhat of an H.R. Giger-esque appearance. These pads utilize a unique ball joint angle adjustment for precise positioning, and the XLR outputs are located at the ends of the pad's stems, which keeps cables out of the way—another nice touch.

George Petersen has written over 150 articles for numerous motion picture, music, and recording publications. A staff editor for Mix *magazine, he resides, with his wife and two musical dogs, in a 100-year-old Victorian house on an island in San Francisco Bay.*

PHOTO GEORGE PETERSEN

L.A. studio drummer Hugh Wright demonstrates the Dynacord ADD-one system.

ddrum, the Swedish electronics manufacturer (now with a U.S. office in North Palm Beach, FL) showed their modular drum kit and library of over 100 available interchangeable drum cartridges. Up to eight modules (one for each drum) can be fitted into a rack/power supply unit; each module has adjustments for cartridge select (choice of four), pitch, sensitivity, treble, and bass. The snare pad has both rim and drumhead trigger outputs for rim shot effects. A basic five-piece kit is $3,960.

Another new entry in the field of sampling kits is the 512 system from **Walker Manufacturing** of Norman, OK. The basic $1,683 kit includes four tom/snare pads, bass drum pad, mounting hardware, and single-space rack-mount electronics unit. A library of interchangeable voices on EPROMs are available, starting at $25, and the company has announced plans to market an EPROM blaster (for writing chips for the Walker, Sequential, or Oberheim systems) by the end of the year.

The **Simmons** booth was packed with attendees checking out the under-$1,000 SDS1000 drums, TMI trigger-to-MIDI interface, SDC200 percussion amplifier, and their popular SDS9 and SDS7 kits, but the display of the Simmons SDE MIDI expander made a significant statement. The SDE with its tuned percussion sounds (vibes, marimba, glocks, bells, gongs, and effects) was shown with pads set up in a semicircular array for stand-up drumming—another non-traditional approach from one of the pioneers of electronic percussion.

At $1,595, **Premier**'s five-piece Powerpack kit features analog sounds and a built-in click track to the unit's headphone jack, a useful addition. The model exhibited is not MIDI yet, although a blank space left on the back panel for a "multi-pin connector" certainly left me wondering whether some familiar-looking DIN jacks would show up in the next version.

Europa Technology provided some dazzling demonstrations of the Dynacord Advanced Digital Drums (ADD-one) system by L.A. studio drummer Hugh Wright. And advanced is absolutely the right word to describe the system's capabilities, the power of which would make most synth players green with envy. The ADD-one features 128 programmable drum sets; multiple sample triggering from single pads; programmable routing of the eight pad channel inputs; and individual programmable control over volume, panning, digital delay, pitch, pitch bend, filter characteristics, and dynamics—for each channel—as well as full MIDI implementation. The Dynacord Power Pads have an oblique, four-sided shape that allows either horizontal or vertical placement, while the optional Drum Caddy mounting system gives a clean, uncluttered look.

Syncussion-X is a total percussion system from **Pearl,** and goes far beyond any of the their previous electronic drum kits. An SC-40 percussion synthesizer forms the heart of the system: it's an eight-input programmer/controller that uses digital wave analog processing for tone generation, and with an optional PE-8 expander, a total of 16 pads can be brought into the system. Pads range from the usual tom/snare and bass pads to cymbals, open/close hi-hat, and a four-in-one quad pad, which allows for a wide variety of set configurations. Other features include cassette dump for program storage, MIDI in/out, and note assign for chromatic playing.

—page 22

Aria exhibited a prototype of the PDX-8, a five-piece programmable drum set that uses a simplified programming system based on moving eight front panel sliders (each also has an LED indicator) to modify the sound, and then pushing a single button to store those parameters. Pricing and shipment dates were unavailable at press time.

And now it's time for a prediction: I expect **Casio** will make a major push into electronic percussion in the next year. They unveiled their DZ-1 MIDI drum translator, an eight input pad-to-MIDI converter that includes a ninth input for an open/close hi-hat switch. Casio also expects to be introducing a line of drum pads in the near future (which is no surprise, since they've been marketing their DP-1 dual hexagonal, yellow pad controllers for their consumer synth line for some time), and when you put together the new pads, a DZ-1, and the RZ-1 digital sampling rhythm composer, you've got quite a system.

Speaking of digital sampling rhythm machines, **Korg** introduced the DDD-1 Digital Dynamic Drums, which offers touch sensitivity dynamics control plus programmable tuning, decay, rolls, and real time or step mode rhythm pattern editing. Pattern sequences can be stored on tape, Korg RAM cards, or MIDIed out to an external sequencer. Sounds can be selected from a number of available ROM cards, or an optional sampling board can be plugged into the DDD-1 for user sampling.

Roland showed the CR-1000, a digital preset rhythm machine, with 24 basic rhythm patterns from rock to rhumba. Fills, intros, and endings can be added for more variations, and shuffle, tempo, and accent controls are provided. Also on display were two new versions of Dr. Rhythm, everybody's favorite low-cost, programmable rhythm machine. The DR-220A features acoustic drum sounds, while the DR-220E includes electronic percussion effects; each can store up to eight songs (each up to 128 measures in length) and a chain function allows two songs to be linked.

An all-too-frequent complaint about MIDI instruments and controllers is that they don't feel like or respond as well as the real thing. Happily, matters are improving all the time. In fact, the KAT MIDI mallet percussion controller (from **KAT**, Longmeadow, MA) actually provides an excellent feel, and its full-scale rubber key pads are quite resilient, for faster playing than actual vibes or marimba. The KAT controller system consists of a one-octave master unit which contains mode display, patch change footswitch jacks, LCD status display, MIDI In/Out jacks, and three outputs for connecting up to three additional octaves of expansion units. Features include programmable keyboard split (anywhere on the keyboard), and a tuning access range of ten octaves. The master unit is priced at $1,095; expanders are $595 each.


PHOTO GEORGE PETERSEN

Spyro Gyra's Dave Samuels checks out the KAT mallet-to-MIDI controller.

Airdrums from **Palmtree Instruments**, La Jolla, CA, is a MIDI percussion controller system based on rotational accelerometers located in clave-sized, handheld tubes. Thus hand movements can be translated into MIDI events. The system's electronics package includes full note/patch assignment capability, and each control tube can generate six triggers as it is shaken in six separate directions, with full velocity sensitivity. Airdrums is priced at $1,895.

Dynacord's Rhythm Stick, another alternate controller (shown in the August '86 **EM**, page 16), is a stand-up controller that gets the drummer out from behind a kit. The strap-on Rhythm Stick looks vaguely like a guitar, but has no strings attached—instead, pressing eight trigger selectors (placed up the "neck") decides which voices of the attached MIDI instrument are played upon touching the two slap sensors. Two playing modes, two editing modes, and 256 programs can be selected. This instrument is definitely a lot of fun.

Also in the fun department is the MIDI percussion controller suit demonstrated by Brock Seiler of **Brocktron-X**, of New York City. The Brocktron-X device includes right and left foot stomp sensors, thigh "tom" pads, and a clear waist-level "hi-hat" sensor. The net effect of seeing Brock dance away, while putting down a thundering rhythm groove in his black leather jumpsuit, helmet, and futuristic glasses, was nothing short of amazing. I'll have to check one out myself one day. . . as soon as they are available in a 48-long size!

UNIQUELY QUALIFIED

Create your DIGITAL AUDIO WORKSTATION with ATARI

To transform musical inspiration into realization you need powerful technology. Technology that is accessable and affordable. Technology that's Atari.

Always on the technical edge

Atari has championed digital music technology ever since MIDI debuted. With the introduction of the amazing 520ST and 1040ST computers, stage, studio and non-professional musicians have access to the world's only 16/32 bit computer with MIDI built-in. The ST with its 68000 CPU running at 8 mhz is faster than any of it competitors. The ST with either 512K or 1 megabyte is more powerful, able to store thousands more MIDI events. And price-wise -- to put it bluntly, the 520ST and 1040ST beat the stuffing out of all competitors.

Always a choice

For progressive musicians on an even tighter budget the ATARI 130XE with Hybrid Arts MidiTrack III is the affordable choice. Professional MIDI implementation... increased memory... boosted processor speed... all combine to offer stage, studio and non-professional artists with a high-performance system. The same system that Kawai America selected to introduce with their new K3 synthesizer.

Hybrid Arts, Inc.™

All ways committed

Software? Of course. Support hardware? Absolutely. Companies like Nilford Labs, Dr. T's music software, Hybrid Arts and many others are committed to creating high-end MIDI products for the 520ST and 1040ST. That includes Hybrid Arts' new 16 bit Analog Digtal Audio Processor (ADAP) with stereo sampling and MIDI capability, Dr. T's CZ Patch and a growing library from other manufactures. On the ATARI 130XE Hybrid Arts offers patch librarians, editors and sample editing software for top selling brands of synthesizers.

ATARI. Accessible. Affordable. Always the answer to transforming musical inspiration into musical reality.

ATARI®

Power Without the Price™

—from page 18, WHAT'S NEW

RECORDING

▶A new multi-track cassette/six input mixer, the **Model 260** ($995), runs at 3.75 ips and includes Dolby C noise reduction.

Fostex
15431 Blackburn Ave.
Norwalk, CA 90650
213/921-1112

▶The **MR-30** ($299) is a 4-track cassette recorder featuring Dolby B noise reduction, integral mixer, and 1-7/8 ips tape speed.

Vesta Fire
10 McLaren, Bldg. E
Irvine, CA 92718
714/380-7314

SIGNAL PROCESSORS

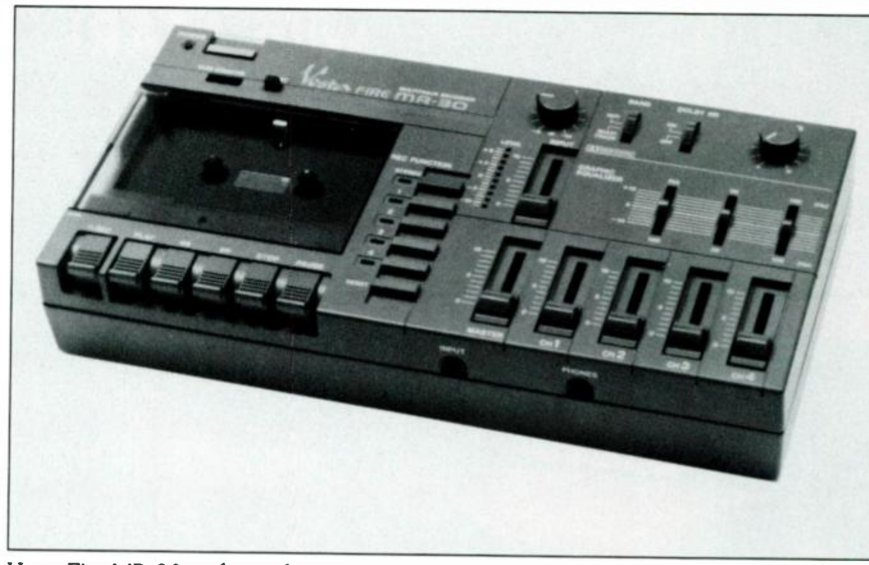
▶The **FX 35 Octoplus** ($89.95) is an octave divider with octave level, tone, and direct level controls. Also, the **PDS 20/20** ($279.95) is a full-bandwidth digital delay pedal with time variable from 1.2 ms to 2 seconds, six controls, and two footswitch pads (infinite repeat and in/out).

DOD Electronics
5639 S. Riley Lane
Salt Lake City, UT 84107
801/268-8400

DOD FX 35 Octoplus

▶The **V4X** four-way electronic crossover (also handles two-way and three-way systems) includes balanced XLR and ¼-inch inputs, transformer balanced XLR outputs for all four passbands, and selectable 40 Hz high pass and 20 kHz lowpass filters.

Peavey Electronics
711 A St.
Meridian, MI 39301
601/483-5365



Vesta Fire MR-30 multi-track cassette

Peavey V4X electronic four-way crossover

Boss RPQ-10 preamp/parametric equalizer

▶The **RPQ-10** ($195) preamp/parametric equalizer features variable input gain and two-band parametric equalization with individual frequency, Q, and output levels for each band.

Roland
7200 Dominion Circle
Los Angeles, CA 90040-3647
213/685-5141

SOFTWARE

▶**Super Sequencer,** a comprehensive sequencer program already available for the Commodore 64 and 128, is now available for the Apple IIe (program cost $275.95) and includes a built-in MIDI system-exclusive librarian. **DX/TX Support** ($149.95 DX7/TX7; $139.95 DX21, 27, 100/TX7)

MIDIFEX

63 Sound effects. From the obviously necessary to the quite bizarre. Pre-packaged and MIDI selectable. Single and multi-tapped delays… with filtering and reverb ambient outputs: Perfect for vocals and instruments. Stereo effects that get attention. Reverb effects that don't exist on the plane of current reverb understanding. Interested? We call it MIDIFEX. And to get the effect of MIDIFEX without one, you'd need a very capable digital reverb, a few dozen digital delays, a couple of parametric equalizers and quite a few extra channels on your mixing board. By presetting the variables, we programmed the MIDIFEX to produce these effects at instant recall…at the front panel or through MIDI patch change. The polished sound You could work hours to get is now here. And like MIDIVERB…The best part is the price…

…suggested list price

$399.00

ALESIS
STUDIO ELECTRONICS

for the C-64/128 features separate pages for function parameters, operator values, and graphic display of envelope shape as well as re-calculation of values. Also available: **Casio Programmer Librarian** ($129.95; for CZ101, 1000, 5000).

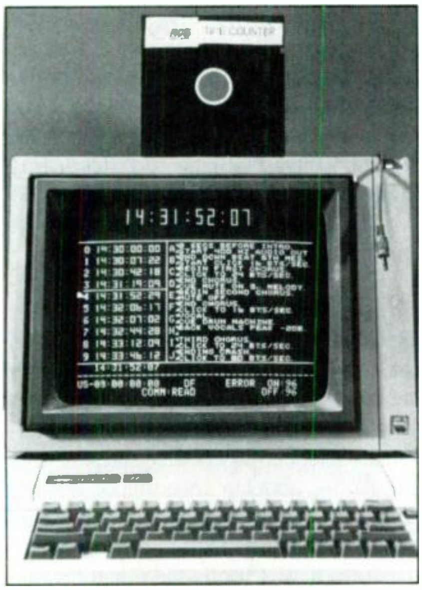
Sonus
21430 Strathern, Suite H
Canoga Park, CA 91304
818/702-0992

▶The **Prolib** universal MIDI librarian ($99.95), for the IBM PC with Roland MPU-401, now supports the E-mu SP-12 drum machine (samples and segments) and LinnDrums equipped with the new JL Cooper MIDI retrofit.

Club MIDI Software
P.O. Box 93895
Hollywood, CA 90093
213/876-6725

▶**Time Counter** ($140) turns a 64K Apple II into a time-based machine controller that can be programmed to perform up to 20 events. It syncs to SMPTE or EBU longitudinal clocks. **Time Generator** ($74) is a simple time code generator for the Apple II.

ROS Software
P.O. Box 7321
New York, NY 10116
212/594-6573



ROS Software Time Counter

▶**The Music System** for the Commodore 64 or 128 comes in two versions. The standard version ($39.95) gives full access to the internal SID chip and includes a sequencer. The advanced version ($79.95) adds MIDI capabilities when used with a SIEL or Passport Designs interface, and also provides music printing, sequence linking, and other features.

Firebird
P.O. Box 49
Ramsey, NJ 07446
201/934-7373

▶A new Mac/Kurzweil 250 interface program, **QLS**, allows for loading 256,000 samples from hard disk into the K250 in 15 seconds—a six fold speed increase over the previous interface. QLS ($495) consists of a cable, Mac disk, and printed circuit board that installs in the K250.

Kurzweil
411 Waverly Oaks Rd.
Waltham, MA 02154
617/893-5900

▶The **DX7 Sound Patch Library** ($39.95) is a 214-page spiral bound book with 757 different sounds (includes algorithm, alphabetical, and group index). These sounds are also available on disk or cassette. A **Rhythm Pattern Library** data tape ($29.95) contains 100 different patterns for the RX11, 15, 21, and TR707 drum machines.

Valhala Music
P.O. Box 20157
Ferndale, MI 48220
313/548-9360

▶The **Digital Sampling Sound Cassette** ($17.95) includes 125 audio sounds on chrome cassette suitable for recording into any sampling machine. Also, six rhythm track data cassettes for the TR-707 (rock, jazz, latin, electro-pop, etc.) are available for $16.95 each ($14.95 each for three or more), and plans for a D.I.Y. MIDI switching box are $3.

MIDIMouse Music
Box 272
Rhododendron, OR 97049
503/622-5451

▶The **DX7 Voice Library** ($29.95), programmed by EM author and former Youngbloods member Lowell Levinger, contains 64 of his best voices developed over the three years. Voices are available on disk (specify computer and format), loaded into RAM, or as hard copy.

Paramount Music
314 A 5th St.
Petaluma, CA 94952

▶Forty programs of **just intoned scales** ($25) are now available for the rev. 3 Prophet 5. These include all major and minor keys, thus allowing for accurate intervals when transposing. Also includes seven ancient Greek scales. Disk or cassette; cassette also contains computer generated audio reference frequencies.

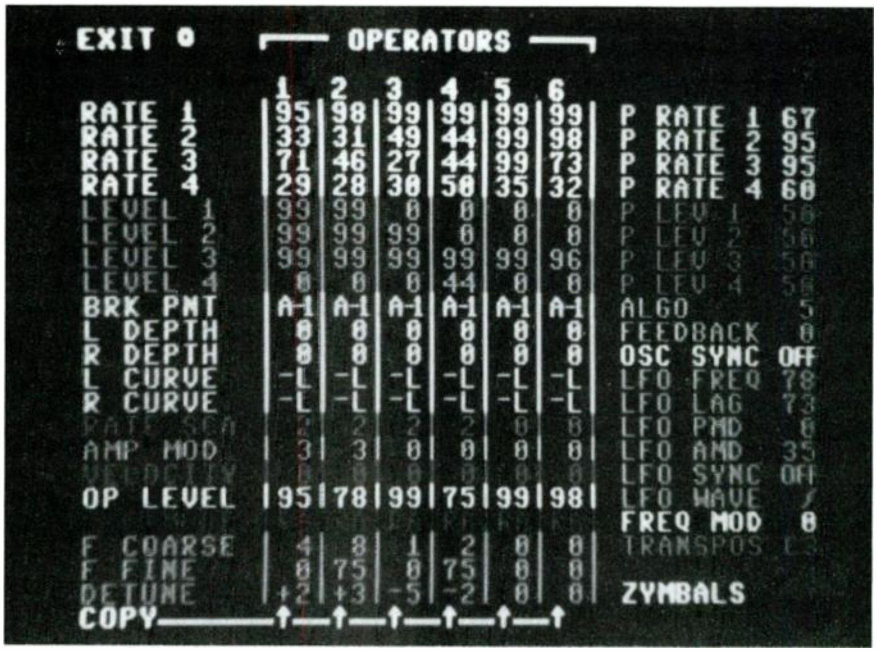
Soundscape Productions
P.O. Box 8891
Stanford, CA 94305

▶**Design! JX-8P** ($89.95), a full-featured JX-8P Voice Librarian for the Atari ST, includes full graphic editing or panel display, a 20,000 note polyphonic real-time recorder, RAM disk option, demo sequences and example presets, and utilizes the full GEM desktop.

Beam Team
6100 Adeline St.
Oakland, CA 94608
415/658-3208

▶**Autopilot** ($49.95), for the C-64 or 128, is a DX7 voice librarian and editor that also features random patch generation algorithms.

Ultimate Media
275 Magnolia Ave.
Larkspur, CA 94939
800/334-2447, (800/228-6244 or 415/924-3644 in CA)



Auto Pilot screen display

TELECOMMUNICATIONS

▶**Microsearch**, the world's largest database devoted exclusively to microcomputer products, is now available on-line via CompuServe as well as on The Source and ORBIT.

Microsearch
1725 K St., NW
Washington, DC 20006
202/833-1174

VIDEO

▶The **MacVideo** adapter allows Macs to connect to a "standard" video monitor or VCR; a hardware zoom/pan capability provides, among other uses, help for those with impaired vision. The **DVA Composite Video Adapter** ($99.95) connects Macs to high resolution monitors and projectors.

Julian Music Systems
4345 Fairwood Dr.
Concord, CA 94521
415/686-4400

OTHER NEWS

S.1739, the audio recording equipment royalty tax, is lining up considerable opposition. U. S. Commissioner of Patents and Trademarks Donald J. Quigg called the proposed tax scheme "arbitrary" and told the Senate Judiciary Committee that "the Administration would oppose S.1739 as presently drafted." Also, Tandy's chairman of the board John Roach told the Committee that the legislation is "unnecessary, unfair, and unworkable," and added that "the recording industry (should) look to the marketplace rather than to the Congress for its profits." For more information on how to oppose S.1739, contact the Audio Recording Rights Coalition, P.O. Box 33705, 1145 19th St., N.W., Washington, DC 20033; tel. 800/282-TAPE.

The advent of the first consumer digital audio tape recorder (DAT), originally expected for this fall, now may be pushed back at least until next spring—partly because Phillips and recording firms seem to feel the new product would adversely affect compact disc sales. A story circulating about a meeting of leading consumer electronics firms (including Matsushita, Hitachi, and Sony) says that the opinion was expressed that introducing the DAT before the end of the year was "untimely." While the vendors are not bound by the opinion, they are nonetheless expected to delay introduction.

All prices are suggested retail prices, as supplied by the manufacturers. All prices and specifications are subject to change without notice. EM

User Groups

Attention User Groups! *To be listed in* **EM**, *simply describe who and what you are: name, address, phone, areas of interest, membership dues and qualifications (if applicable), and services offered to members. Notice of specific, dated events must arrive at* **EM**'s *offices three months prior to the cover date. (For example, we would need to know by November 1 about any meetings planned for February.)*

To be listed every month, you must notify us every month that you're still active. Sorry to put you to the extra effort, but otherwise we have no idea of which groups are still around. Send info to User Group Listings, **EM**, *2608 Ninth St., Berkeley CA 94710. There is no charge for this service.*

Note: **EM** cannot check the legitimacy of these organizations. Call or write first for additional information (or go to a meeting) before sending any money to any users group.

▶**AMUG, the American MIDI Users Group,** sponsors monthly meetings, is building a database of MIDI information, and publishes a monthly newsletter. On-line communications with AMUG are handled through the Dallas MIDI Users Group (DMUG) BBS (Bulletin Board Service) at 214/276-8902. Membership is free to composers, music publishers, MIDI-oriented stores, studios, manufacturers, and publishers of MIDI-related books and periodicals. For a membership application, write:

AMUG
4306 Pineridge Dr.
Garland, TX 75042
214/272-0963 or 214/987-2940

▶**AMuse**, the New York City Amiga Users Group, is a non-profit organization dedicated to the support of users of the Amiga personal computer in the New York City area. Regular meetings are held twice a month, and cover all aspects of the Amiga. AMuse publishes a bi-monthly newsletter, maintains the first New York Amiga music Special Interest Group (AMusic), and runs a bulletin board at 212/269-4879 that features several message bases; also, over 300 software files are available for downloading. The AMuse bulletin board is on line from 5 a.m. to 3 a.m. every day. AMuse meets every other Tuesday night at 7:30 p.m., in the School of Visual Arts amphitheatre (3rd floor, 209 East 23rd St, between Second and Third Avenues). Meetings are open to everyone. For more information, call 212/460-8067

▶**Casio CZ Users International** (CZUI) encourages open dialog among both entry level and professional users of CZ series synthesizers worldwide through its bimonthly newsletter, *Cozmosynth*. This features tutorials, hardware and software reviews, tips and modifications, an ample CZ patch section, advanced applications, and general discussions relating to getting the most out of CZ synthesizers and associated gear. **CZUI** membership is $18/yr. and includes a subscription to the newsletter. Personal or group listings in the newsletter for CZ users who want to contact other users are free to members upon request. For more information or a sample issue of *Cozmosynth* ($3) write to:

Dream Machines Inc.
P.O. Box 1033
Grover City, CA 93433

▶**Champaign/Urbana MIDI Users Group** meets on the third Thursday of every month at 7:30 p.m. at C. V. Lloyd Sound System Products, 102 S. Neil, Champaign, IL 61820. Discussions include applications, problems, and the future of MIDI. We have new product demos every month. As of now, there is no membership fee; all are welcome. For more information call 217/352-7031.

▶**Canadian MIDI Users Group** (CMUG) publishes a newsletter that includes articles, news, and a classified and contact section for members only. Annual dues are $20 (Canada) and $25 (all others). For more information write:

Box 1043
Belleville, Ontario, Canada K8N 5B6
613/962-0549 or 613/962-0603

▶**CX5-US Users Group** maintains a 1,200+ voice library, available upon joining, for the CX5M. A number of public domain games, utilities, and programs are also in the library. Monthly meetings are held the first Tuesday of each month at the address below at 8 p.m. Kevin Bierl, a Telephone Service Representative with Yamaha, is generally present to answer questions. A newsletter is also distributed on an irregular basis. Membership fee is $20/yr. Contact Mike Dwyer at:

5218 Scott St.
Torrance, CA 90503
213/540-3758

▶**The Digidesign BBS** provides technical support and user tips for registered owners of Digidesign software, as well as general news about the music biz, computers and music, etc. Sound Designer format sound files (for use with *Sound Designer* and *Burner*, Digidesign's EPROM programmer) are on-line for downloading, and users are encouraged to upload sounds. Parameter files for Digidesign's new Softsynth program will also be on file for up/downloading. The BBS is on line 24 hours a day, seven days a week, and supports 300 and 1,200 Baud communications (auto selected by the BBS). Set your modem for 8 bits, one stop bit, no parity. 415/494-0264.

▶**DJ/VJ Information Network:** Club Disc Jockeys, Studio Remixers, and Mobile DJs (not radio DJs!) can log on to our computer using their personal computers to learn more about music, computers, and how they affect our segment of the business. Guest artists are welcome for online conferencing; contact our offices during normal working hours for consideration and log on time. There is a small yearly maintenance fee of $50. The network telecommunications protocol is 7 data bits, 1 stop bit (or 8 data bits, 1 stop bit) and either odd or no parity. It supports all popular XMODEM protocols, at either 300 or 1,200 Baud. Contact:

George B. Tselentis
Electronic Products Inc.
5078 So 108th St.
Omaha, NE 68137
402/339-5803

▶**The DX User** is a user group for the DX7 synthesizer. A newsletter is published on an irregular schedule, and members trade original voices for the DX7. The newsletter includes tips on hardware, software reviews, patches, opinions, and so on. Patches are available on paper, and in a variety of disk formats. For more information and a sample issue describing the group and its functions, send three 22 cent stamps to:

The DX User
P.O. Box 209
Woods Hole, MA 02543

▶**MIDI Applications Group** shares information concerning current uses of hardware and software systems. Meetings are held the first Saturday of each month. This group focuses primarily on "state of the art" applications rather than strictly theory or topic reviews. Forums for information exchange include a newsletter, monthly meetings, seminars, and featured audio selections (available on cassettes). A mailing list of interested individuals and groups will be assembled and the premier issue of the newsletter *MIDI Milieu* will be available soon. There is a $5 yearly sign-up fee for individuals, and $20 for groups. For more information, please contact:

John or Gay Komenlic
c/o The "M ROOM"
1411 Tenth Avenue
Oakland, CA 94606
415/465-6216

▶**New York CX5M Users Group** has an extensive program and patch library and holds regular meetings. For more information, write to:

551 Central Ave. (Suite 22B)
Cedarhurst, NY 11516
516/295-1427 or 718/461-8057

▶**Northwest Electronic Musicians (NEMUS)** is open to anyone interested in any kind of electronic music from tape techniques and musique concrete to analog, digital, hybrid and sampling synthesis. They also address peripheral topics such as signal processing and the uses of PCM recording. There are no dues, but a monthly newsletter is available for $8 per year. Meetings are the first Tuesday of each month at the Dutchman Studios, 101 S. Spokane, Seattle, WA 98134. Contact members Steve Ditore 206/632-2103, Gary Mula 206/343-9001, or Daryl Schultz 206/644-7237 for more information, or write to the above address. Or, if you happen to be in town on the first Tuesday of the month, drop on by.

▶**Xpander Users Group** is an informal forum for the exchange of patches, interface hardware and software, troubleshooting hints, and other useful information relating to the Oberheim Xpander. An irregularly published newsletter is planned. Contact:

Mike Metlay
Mys-Tech Productions
P.O. Box 81175
Pittsburgh, PA 15217

EM

She re-defined the concept of timbre with 1968's Switched-On Bach. *Now she's exploring the world of alternate tunings—and perhaps once more, our music will change because of her explorations.*

Tuning in to Wendy Carlos

BY FREFF

Should you ever meet her, do not tell Wendy Carlos she changed your life. Even if it's true. Her good honest Rhode Islander reserve won't let her stand still to enjoy your equally good and honest compliment: instead it'll be duck and run, and miss the point, and let's talk about anything else, shall we?

So let's talk about something else! For now, carefully ignore that 18 years ago Wendy Carlos, in a mind-boggling display of focus, virtuousity, and sheer physical endurance, created a record called Switched-On Bach *and changed all our lives. It didn't happen; it never existed; and you and this magazine are face to face because synthesizers have been a part of human pop culture since way back in the early MIDIzoic, when shambling proto-Californians discovered the microprocessor and bandwidthed together to defend themselves from vicious sawtoothed tigers. (Facts are just facts, as Professor Peter Schickele is fond of pointing out; can't argue with facts.) Instead of debating whether the field's debt to Wendy is vast or merely gigantic, let us focus on some of the things about her that you* don't *know, that you couldn't possibly know, because no one has ever come right out and said them in print. Little things, true, but telling. Wendy is an avid astronomer who has traveled all over the globe pursuing solar eclipses; in fact, along with her partner Annemarie Franklin, she has produced some of the best eclipse photos ever taken. She's a big fan of Carl Barks, the comic book artist who chronicled the adventures of Donald Duck. Much of her recording gear is self-designed and self-built or so thoroughly modified as to blur original distinctions (the Olde English lettering on her mixing board is a dead giveaway). She loves hard science fiction as practiced by masters like Arthur C. Clarke, but has little taste for fantasy. To recuperate after an auto accident, she took to inventing brand-new map projections of the globe . . . and then wrote her own plotter-driver software to print them out. She loves theatre organs. She hates (conceptually) yuppies. She loves garlic. A sheriff in Texas once proposed to her by mail. She lets her three Siamese cats drape themselves decorously over her outboard gear; never mind the fur. She has a phenomenal capacity for attention to detail and, like most visionaries, little patience with the limitations of the world. Her tape editing is sharp enough to get a razor in between a hic and a cup. She paints and draws, a little. And even more than never telling her she's changed your life you must never, never ever ever, get her started on puns and Monty Python routines. Not unless you do that kind of thing too. And have no pressing engagements. For days.*

In short, Wendy Carlos is a fascinating and diverse person. That she's a brilliant composer whose newest (so far unreleased) music promises to do for tuning what her first record did for timbre . . . hey. Gravy.

Freff lives in Brooklyn with three friends, three cats, seven computers, and a recording studio. Aside from drowning in article deadlines, he writes documentation for synths and software, is the American reporter for a BBC show about computers, and is working on various book and record projects.

Wendy is one of the few people I've met whom I have no qualms about calling a genius, with all the pluses and minuses automatically attendant upon the term. Genius is a mixture of qualities combined in such a way that the genius pulls things out of the world that are A) starkly obvious when you know where to look and B) completely hidden until the genius shows you how to look. Usually by example.

In 1968, Wendy did it with Switched-On Bach. *It went platinum, the first classical record ever to do so, and whether people bought it for love or novelty matters not one whit. All that matters is the door was opened. Glenn Gould called it the "album of the decade"; I'd go further and call it one of the ten seminal recordings of the century.*

It is also the worst thing that could possibly have happened to her career.

Think about it. SOB *was a step, not an end in itself. Wendy was exploring possibilities. Her point was to conquer a demanding, finicky, fragile collection of wire and knobs and patch points called a modular Moog synthesizer, demonstrating along the way that synthesis and electronic music were good for real art as well as in-grown academic exercises. This the record did, making much money for CBS . . . a fact CBS executives seem to have misunderstood, supposing the secret was in Bach and the synth, rather than the synth-player.*

They weren't alone. A wave of "Switched On Thus-and-Such" spread locust-like through record stores (even today we aren't free, as witness such derivative efforts as the recent Bachbusters *CD). But the real problem for Wendy was not incompetent competition: it was confusion of identity in the one place no recording artist can afford, her own record company. I feel Wendy's catalog since 1968 is virtually a case study in artist mismanagement, with her strengths downplayed and her weakness—repetition, which she simply has no talent for—accentuated. This is not to say that her original work has not seen release. But just try and find her two-record environmental sound piece,* Sonic Seasonings; *her scores for* Tron *and* Clockwork Orange; *her* By Request *(which is something of an historical hodgepodge, marred by some more—gasp—Bach; but to be treasured nevertheless for the riveting snap of "Geodesic Dance" and the intricate musical joke called "Pompous Circumstances"). And if you find any of these, send me a note* *because my copies are long since worn out and I hanker to hear Wendy's music clean.*

Despite these marketplace frustrations, Wendy has never stopped pioneering. Each of her records, including the Bach ones, have pushed at the boundaries of available technology and technique.

*Case in point, her last album—*Digital Moonscapes. *It's been out for a year or so, but don't be surprised if you've never heard it: this marvel of original electronic music was dropped into the American marketplace with little or no fanfare, promotion, or advertising, and on a classical label (CBS Masterworks) to boot. What makes* Digital Moonscapes *special above all else is that it marks the culmination of two years of intense research into recreating orchestral sounds through digital synthesis. Using the GDS digital synthesizer system she got towards the end of work on* Tron, *and a couple of its Synergy offspring, Wendy crafted what she refers to as the "LSI Philharmonic Orchestra:" a collection of several hundred simulations good enough to stand with pride against the yardstick of the real thing. (Designers and collectors of myriad DX7 patches, take note: listen to this album and see how it* should *be done.)*

The only place to go when you've gotten this far is farther. Wendy's newest project, Beauty in the Beast, *takes digital synthesis beyond timbral recreation into extrapolative invention. More importantly, it casts off the leg-irons of the equal-tempered scale.*

Some of you know what that last part implies. Some of you don't. Those that don't shouldn't be ashamed, because the standard 12-note octave is so deeply a part of modern Western music that even talented, well-trained musicians take it for granted. But it's not Holy Writ. It's a so-so bargain between the physics of sound and the physical limitations of acoustic instruments, a 300-year-old compromise designed so that every note, in every key, is equally not quite in tune. In other words, you can get by with it. It'll do. But it's a long way from perfect, and there have always been a few hardy (foolhardy?) souls trying to find their way to a better, more musically consonant system. Unfortunately, the same laws and limits that forced the compromise in the first place have not been repealed, and alternate tunings have so far proven both esoteric and impractical.

Enter the computer. And the computer-based instrument. Although there are still massive hardware problems to solve, largely in the areas of controllers (taking one example, how do you physically play *a scale with 31 notes to the octave?), it is finally possible to up anchor, sail off on the sea of tuning, and navigate to safe harbor in new countries of sound.*

Exploring. That's what Wendy's new album is all about. But best to let the traveller tell the tale.

EM: *What led you in this radical a direction?*

WC: For a long time—since the early '70s—I felt I had to get away from the compartmentalization of sounds; we had rich acoustic sounds on one hand and impoverished synthesizer sounds on the other. The analog synths of the time, and even the newer digital machines, just didn't have sophisticated enough control over sound, and the timbres they produced quickly became very boring—to

PHOTO: VERNON L. SMITH

my ears, at least. That's the reason for the orchestrational style I developed from the first record on, in which I jump from timbre to timbre to timbre so quickly that by slight of hand it gives the impression of considerably greater timbral resources than really existed within the instruments. There are possibly half a dozen *basic* sounds you can get out of an analog machine, short of some very silly things. They're like little islands that sound good floating in an ocean of possibility. There's a percussive envelope/filter thing you can do on a bright wave, and it doesn't matter much what kind of bright wave; there's a slow attack filter that's more like an imitation of a brass instrument; there are nice, simple, dull waves like triangles and sines that you can put together with either soft or hard attacks; tuned noise, delayed vibrato, and a few others. . . just these categories and a few others, and *that's it.* It's a little like drawing in pen and ink. You can make solid shapes, you can do cross-hatching, you can do little dots, you can have outlines. . . but it's all pen and ink, and everything else you get is from juxtaposing these in more or less intricate, clever ways that give the eye the impression more is happening than really is.

EM: *Limited or no, you got a lot out of that repertoire of sound—*

WC: My earlier pieces worked well in spite of the repertoire of available sounds, rather than because of them. So by the late '70s I was trying to find new and different generation techniques, and exploring digital synthesis, when I met Stoney Stockell and Tom Piggott and the folks behind the GDS and Synergy. They wanted me to get involved in their products, and Disney's *Tron* provided the opportunity. The Synergy looked like the only commercial instrument that would do the kinds of things that I wanted to do, so after *Tron* I began to learn how, by developing acoustic replicas on it. After doing 300 voices of the orchestra, I'd pretty much tamed the instrument, and decided to record *Digital Moonscapes* as a waystation from the old analog world into what the future promised. It was a way of saying "Hey look, we can get *very, very* close to the orchestra now. That's a big step from where we used to be! And with the ambience techniques now possible through digital time-processing and reverberation, you see we've joined the worlds of acoustic and electronic. . . that's what's possible now, and on the *next* record we'll see where it can lead."

EM: *What about the way you've jettisoned standard scales?*

WC: About the time I began the current record Stoney finally unbuttoned the frequency tables in the Synergy, so I wrote a bunch of custom control software that made it possible to retune the instrument. That's something I've wanted to do for a long time. A digital instrument is a natural for microtonal tuning because you can be precise to any degree you need and also *repeatable.* It's idiotic that Western music has remained such a slave to a tempering system which evolved 300 years ago as a satisfactory compromise. We don't need the compromise anymore. We can begin to work in areas that up to now have been forbidden because we only had the equal-tempered scale. Where these steps may lead is anyone's guess. How important these new areas will be I don't know. We'll have to find out. I do feel they have become very important areas to explore, and that their implications transcend me as a human being and a composer and an artist. They're bigger than any one person. These ideas *have* to be disseminated. They mustn't become a quaint personal system, like Harry Partch's, but must get taken as much for granted as people now take synth work and multi-track recording. These areas are so rich with possibilities, they are an ideal way to get pop, classical, jazz and contemporary music out of the *cul-de-sacs* they're all in, that I feel I could easily become so filled with messianic zeal I'd probably hate myself.

EM: *With all possible timbres, and all possible tunings, where do you begin?*

WC: When you're given all possibilities, you're in a worse position than you were before. It's a perfect way to drown. In fact, you've really chosen to drown in the middle of a very large ocean. Several oceans. And there's not even a floating log nearby; you've discarded all that. But there just isn't any way art can work outside of a discipline. . . Stravinsky's wonderful comment when people asked him how he felt about working on a ballet with Balanchine, because the form was rather restrictive, was "I love exact specifications." That's how it is with all art. It works best when there *are* limits. Quite probably my earlier records were aided greatly by the fact that they were done while working within *very* narrow regions of possibility. But in late 1984, I found myself swamped by the anarchy of total possibility, so I began making choices. I chose to limit myself to some small, selected regions of the palette of "everything." In timbre, I decided to see what would happen if I took orchestral instruments that I understood and began combining selected properties of two or three, creating hybrids. That's a fairly small cast of the line. . . it's not nearly what the hardware allows, but it's a good way to learn the limits in a disciplined manner. I was mainly concerned with learning what rich things could be developed from models of past good instruments: the best Stradivarius overtone structure merged with the best Steinway action. . . what does *that* do? Does it sound good? And the answer is yes, it does, it sounds delightful. There are in fact several ways of doing it, and they *all* sound wonderful. Or take a good Boehm clarinet and merge it with a Guarneri cello, or. . . you find a lot of fascinating sounds this way, because you are standing on the shoulders of giants of the past of timbre, and yet they are genuinely new sounds, subtly or wildly unlike anything ever heard before.

EM: *And tuning? There's even less to stand on, outside what we're all used to.*

WC: I cast my sights: what happens if we move out only into the realm of tunings from other cultures? Cultures like those of Bali, Java, India, Africa, or the Middle East. . . let's explore what they've found rich for many years. And let's also explore things that are fascinating mathematically, like variations in the overtone series and scales built with different numbers of equal-sized steps in an octave. Let's find what those sound like, doing only a few of them, and use those few as a guide. Everything might be possible hardware-wise, but *I'm* not capable of that, so while I have taken big steps in tuning and timbre they are not the biggest steps imaginable: just the biggest steps I could take *while keeping control.*

> **". . . your conditioning and learning, the things you've developed —your strengths, in other words— can be crippling when you're trying to take new steps"**

EM: *In retrospect, how do you feel about taking these steps?*

WC: As I stand here a little bit away from the coastline, the ocean seems far bigger and far more profound than I imagined it could be. It seems to me in hindsight that this was the right thing to do. A wise step. But I didn't know it was wise when I took it; I was just working from instinct. There is no one tuning to the album, no single timbre. Each selection is an essay that explores one or two ideas fairly deeply, rather than a lot of them superficially. I'm like a blind person in a room, poking a long stick in several places to make *sure* there's an elephant in here, instead of taking a sharp pencil, poking in lots of shallow places, and deciding there's nothing in the room after all.

EM: *Did you find yourself having to fight not to think in old, familiar ways?*

WC: Constantly. I also found that your conditioning and learning, the things you've developed—your strengths, in other words—can be crippling when you're trying to take new steps, because you keep falling back into habit patterns. Although it's self-conscious, you've got to deliberately break your habit patterns. For example, the last album was totally notated first, written out just like any orchestral composition, and then played. This is an approach I know very well, because of all the Bach records. It's a safe way to work; not much risk. So on this new album I chose to work in a *scary* way. I composed directly on tape, relying on sketches and improvisations which were edited many, many times and re-improvised and re-edited until they grew into compositions. . . working that way, things happened that I didn't *know* how to write down. And I had to hold it all in my memory, which is scary for me because I've always had the same crutch Stravinksy had: he used to say he didn't compose except when he was at the drawing board with the manuscript paper right in front of him.

EM: *You mentioned you'd been interested in alternate tunings for a long time. When did you first start?*

WC: Oh, way back in my teens, probably from reading some magazine articles. When I was 16, I bought a piano-tuning hammer and wedges and began retuning my parent's spinet piano in all manner of unorthodox tunings, trying to find out what some of these things I'd read about sounded like (you couldn't then find records with these things on them). In college I got involved in *musique concrete* pieces with retuned pianos and arbitrarily tuned sine waves and stuff like that. Nothing very profound. But I got inspired to put together a series of special reference tapes with a physicist friend. We had access to several very expensive audio oscillators in a Brown University laboratory, test devices worth several thousand dollars, and we'd go in and tune one to a 440 Hz reference signal broadcast by short-wave radio station WWV, then tune another against it until an oscilloscope pattern told us we'd reached the particular ratio of our choice. Then we'd tape that. We ended up with a library of something under 100 pitches in an octave, all of which were derived from pure thirds and fifths. Most of the pro tape machines of the day tended to run at pretty much the same speed all the time—if they did vary from day to day it was within the limits of our precision—so we spliced some leader ahead of the recorded strips, labeled them, and from then on whenever we wanted to do any precise intervals or ratios we would use the strips as tuning references. The technology was never intended for this purpose, but there was just no other way to make the empirical tests necessary to take intellectual ideas about tuning and turn them into something that might have practical and pragmatic value. Even then I knew that you have to have a practical application. If there's no way to use something in a real musical context, who cares?

EM: *After that?*

WC: Well, I read just about every book on the subject, but after college it wasn't until 1984 that I started experimenting with tunings again. I did have other things going. But when I came back to tuning it was as a gleeful child in a candy store. After *Moonscapes* I listened to a lot of ethnic records, deciding what direction I wanted to take the new album. I'd sit and try to play along with some of the different scales, but the equal-tempered scale didn't fit very well. It was driving me crazy. I tried minor variations. I even explored quarter-tone scales, but these were even less musically useful than equal-temperment and I'm amazed that so many musicians have bothered to explore them.

Anyway, in July 1984, bingo, Stoney presented us with some new chips and said look-in-there-at-byte-so-and-so, perform a write-read, and you'll get the pitch table. At the time, I didn't have any idea what it did, but I pulled out all the numbers, dumped them into the Hewlett-Packard 9825, and fiddled around with them until I figured out how to do some things. There was a small section of 12 × 2 byte values that the Synergy actually used for tuning, with all the values for all the other octaves derived from those through 2:1 (octave) ratios. I found the way to convert those from Hertz into cents, wrote a piece of software that slowly grew and grew and grew but finally made it possible, after much hassle and lots of math and tricks, to move the notes individually with a resolution of about 1.5 cents. It made it very easy to set up all kinds of WHAT-IF situations. For example, one piece on the new album, "Just Imaginings," was based on asking WHAT-IF all the notes of the scale were tuned to represent the *closest natural harmonic overtones from a single fundamental.* That means you have to store the overtone series for every key-note with which you want to work. I wound up with an array of 12 times 12 (144) different pitches in the octave, each of which represents a pattern of the 12 closest-fit partials to a particular fundamental. You play the piece by starting in one key and then as you move along to another, you hit a reference key on a special little keyboard and it instantly retunes the whole instrument.

The last part of this track ends by going through the entire cycle of 12 pitches—the "circle of fifths," if you will—except all in perfect tuning. That's one of the things you aren't supposed to be able to do, which is exactly why I did it! The nice thing about this Harmonic Scale, as I call it, as opposed to normal just intonation, is that you can put down a cluster, just play anything, like a three-year-old kid, and it will always be in tune. The accompaniment at the end is a continuous cluster. Every note remains down, but from moment to moment all the notes are slightly retuned to match whatever note the melody and bass is playing, so the same cluster always harmonizes the melody perfectly.

EM: *What about the other tracks? You've got an African-inspired piece, a gamelan-inspired piece. . .*

WC: In 1983, chasing an eclipse, we spent some time in Bali and fell in love with the place. I had to write music "about" the experience. "Poem For Bali" is in authentic tunings taken from cassette recordings I made and bought when I was there, and also on a few records I've found since. (The tunings aren't based on any textbook descriptions—it turns out there are a lot of discrepancies between what's in print and what's really used.) The piece has ten sections written wholly in several varieties of *Pelog* (and one *Slendro*) tunings used by Balinese gamelans. Near the very end is a dance which I turn into a concerto for gamelan with symphony orchestra. That's a stunt that can't be done in real life because of tuning differences, but when you hear it here you'll wish it could be, because it's a really great stunt. The funny thing about gamelans is that their scales sound pretty horrible on our western instruments, but are really damned good scales on theirs. And it isn't because they are somehow quaint savages or primitives who only have five notes—you know, that condescending "hey, maybe someday they'll get to seven" attitude Western music takes—but because they found a way that empirically fits the overtone structure of their instruments. And their tunings work *well* there. Ours don't. In fact, our pure octave—commandment number 1, "though shalt not use anything but 2:1 for an octave"—sounds pretty awful on their instruments. It sounds flat.

EM: *If each step of exploration is built on the previous one, I expect the last track you finished must have been pretty unusual. Which one was it?*

WC: "Beauty in the Beast." It's sort of a rondo-like form, with two main themes that come round and round again, always in motion. This track could only be written for the electronic medium. It's built on two scales I discovered. One uses 78 cents per step, which is what you get if you split a pure minor third into four equal parts; it happens that if you do that you have virtually perfect triads, but no octaves, creating beautiful harmonies and very exotic melodies, because the steps are so strange. Motion from chord to chord is unlike anything you've ever heard, and yet the arrival points are so *perfectly* in tune that you know it's something very natural to us, for all its wildness, something distant and strange and yet at home and peaceful. The other scale is derived very much the same way, but from a a perfect fourth broken into four equal steps of about 125 cents, and then splitting each of these in half. We have a hard time describing a split fourth melody because we've never heard that in Western music. But it works! And the track as a whole is kind of a whimsical blending of two different quasi-grotesque ideas in the very best "Ballet Ruse" style.

EM: *You actually started dispensing with the octave entirely, then?*

WC: After the album was recorded I started exploring tunings in a more analytical fashion, using the Hewlett-Packard 9825 and some programs I wrote to plot the "fit" of different intervals as you change the number or size of equal steps in an octave. Twelve steps in an octave happens to hit the fifth well, as we know. It doesn't do as good a job on the thirds; sixths are a little better. The next good fit occurs as we move on to 15 steps. That one actually misses the fifth, the third, and the minor third by being a little too small, but it is also equally a little too large for the fourths and the sixths. . . .not bad, but kind of equally out all the way around.

Nineteen steps fits the minor third almost exactly, but is less good on the major third and the fifth. After that it isn't until 31 steps that things start to get interesting: the minor third is not quite perfect, but the rest all group together very high in consonance. That includes the seventh harmonic. There's an oddly near-perfect group near 34 steps, but the next most useful is perhaps at 53 steps—it sits really nicely on a crest—and another one that sits a little less well occurs at 65 steps in the octave. And so on, to an infinite number of steps! But if we take away the restriction of having only scales which form an octave, if we *throw out the octave completely,* use the *hardware* to get our octaves through 16′, 8′, 4′, and so on, and say okay, just within one octave let us make equal step divisions, because equal steps are lovely: they allow you to modulate conveniently and linearly all over the place . . . whooptedoo! We start finding some really remarkable configurations, including the tunings I used in "Beauty in the Beast." I hadn't plotted and figured these out when I composed that piece, but afterwards I wanted to know why it worked so well, and here it is. And since this is virgin territory, like Christopher Columbus I hereby christen these three peaks in the plot Carlos Alpha, Beta, and Gamma. Alpha is the temperment that "Beauty in the Beast" is written in, the equal splitting of the minor third. Beta is the interlude that starts it, the divided fourth. Notice that these things, in cents, are simple numbers. Alpha has steps of 78 cents . . . but that's equivalent to something like 15-and-a-third steps in an octave, which makes no sense. How do you put a *third* of a step in an octave? Build in scales with hiccups? It has to be treated as a special case. But throw out this one unorthodox quality by handling it with the hardware, leaving only the harmonic point of view, and it's a great tuning. With an approach like this, we can get very close to just intonation without any of the problems that prompted people to say "oh, just intonation simply doesn't work." Well, in a practical world, here it is.

EM: *What about Gamma? Worked with that one yet?*

WC: No, I'm waiting for Stoney to get me a way to play more than 12 notes meaningfully at one time. Gamma has something like 34.5 steps per octave, and arranged on a normal keyboard even someone with huge hands simply couldn't physically span more than a third. A fourth would be out of the question.

EM: *Of course, these things can always be explored with multi-track recording.*

WC: For final performances, sure! But for composing and gaining familiarity it isn't an easy way to work. I'm a composer who very much believes in the Debussy dictum: "do whatever please the ear, and the rules be damned." There have been a lot of proposed tuning variations in the last 200 years, different kinds of keyboards and controllers, but nothing has actually changed. The number of people using any of these alternative systems has always been appallingly small. The feedback I'm getting now suggests that a sizable number of people are getting interested in alternative tunings, but will a real majority adopt it? Probably not. There's one very good reason, laziness. In these areas, most musicians you encounter, and most musical theoreticians for that matter, are just very lazy. It's a human foible we all share. I can tell you that after doing the perfect tunings piece, "Just Imaginings," in which there was a passage of only two measures that took over 12 *hours* to compose six chords, I'm not so sure I won't flee to their side very soon! In some ways it's preposterous that the difficulty of using these things is so great. But that's the price of admission. You're not going to find anyone looking for a fast dollar coming into this at all. Those who do will run in and run right back out again. On the other hand, with Alpha—and maybe even Beta—and a practical keyboard, you could become an empirical musician. You could just comp on it and start finding things that sound good to your ear, then put them in your MIDI sequencer or what have you . . . it would actually allow you to

> **". . . a sizable number of people are getting interested in alternative tunings, but will a real majority adopt it?"**

write music in these tunings without quite knowing what you're doing, which is how I went about "Beauty in the Beast."

EM: *Sequencers would be ideal for just slinging experiments around, for editing later.*

WC: Even so, I find I like the idea of not having anything stored rigidly, because as I move from tuning to tuning the way the melody wants to move is different for me. It's less interesting to take some existing tune and move it around from one temperment to another. That might be useful as an exercise, as an etude, as a quick way of getting some results out. But I think that if you're going to really explore the depth of these things, you've got to allow the implications of the particular tuning to steer you. You can't be dogmatic. You can't go in with preconceptions, or you'll just be overlooking the true beauty and power of the particular scale.

EM: *What about the next generation of instrument technology? Could it knock down enough barriers to attract a lot of people to new tunings?*

WC: It might. *If* the manufacturers get feedback from people who want to cut with their cutting edges, instead of sloughing. Me, I'm very impatient. I'm discovering how different timbres *demand* different tunings, such as the Balinese examples. You can put together any kind of sound and hear what sorts of tuning it cries out for (literally). In this arena, tuning and timbre are really kind of the same thing: overlapping and combining overtones in a pleasing way. It's a very exciting place to be, but also very frustrating, because the support hardware, new keyboards and the rest, are not at all in place and it will require the expenditure of much time and money to get there.

EM: *You are on the way, though.*

WC: If, as it often seems, everybody else wants to waste these new tools doing diatonic new age equal-tempered tunes and triads, fine. Let them. But before I die I want to find out what lies beyond all these new horizons. And I'm doing it for the best motive in the world: I'm curious.

ADDENDUM

Beauty in the Beast is currently scheduled for a November release through JEM records. Wendy's contract with CBS concludes with a "lecture-with-musical-examples" record tentatively called *Wendy Carlos' Guide To Electronic Orchestration,* after which Wendy, like all good explorers, will be moving on. EM

Just the facts about Just Intonation . . . definitions, a brief history, what to read, what to listen to, and other resources on the subject.

What is Just Intonation?

BY DAVID DOTY

Technically, Just Intonation is defined as any system of tuning in which all of the intervals can be represented by ratios of whole numbers, with a strongly implied preference for the smallest numbers compatible with a particular musical purpose. Unfortunately, this definition, while concise and accurate, doesn't convey much to those who are not already familiar with the art of tuning. The aesthetic experience of Just Intonation, however, is quite unmistakable to anyone whose hearing functions properly.

The human auditory system recognizes as consonant the simple-ratio intervals upon which Just Intonation is based, provided that it ever encounters them in a musical context. These intervals are the foundation of melody and harmony, and their importance has been recognized by musicians worldwide for at least 5,000 years.

Just Intonation is neither a particular scale, nor is it a musical style. It is, rather, a set of principles that can be used to generate a virtually infinite variety of scales and chords which are applicable to any type of tonal music, regardless of style, or of historical or ethnic provenance.

Why then isn't Just Intonation in general use? This sorry state of affairs is a result of compromises made by composers in previous centuries. Rather than confront the difficulties raised by applying the principles of Just Intonation to complex harmonic music, the majority of composers of the 18th and 19th centuries opted for equal temperament (the tuning system in general use today), compromising the purity of all intervals except the octave, in order to facilitate modulation and harmonic progression.

> **"Equal temperament didn't find favor because it sounded better"**

Equal temperament didn't find favor because it sounded better. The composers and theorists who designed and implemented equal temperament knew that it would have been better to have all intervals in perfect tune (what we now call Just Intonation), were it possible to do so with the technology at their disposal. Had it been possible, in the 17th century, to build a keyboard instrument that could retune itself instantaneously, it is safe to assume that 12-tone equal temperament would never have been invented.

We now possess the technical capability to design and build such instruments. Indeed, that has been the case for several years. With a few exceptions, however, the electronic music industry has been slow to build instruments that support alternate tunings. Thus, applying the principles of Just Intonation, even on electronic instruments, usually requires special techniques (see the articles by Robert Rich and Alan Campbell). There is no instrument commercially available today on which you can simply press the "Just Intonation" button and have all of your music played truly in tune. Further, to use Just Intonation successfully, one must learn to make aesthetic decisions about tuning—a subject of which most musicians, conditioned by equal temperament, are blissfully ignorant.

A question which most readers, especially those who have never heard Just Intonation, are likely to ask at this point is: is it worth the effort? Why should we go to all of the trouble of learning new techniques and mastering new tuning systems, when we have a perfectly workable system available that is clearly capable of producing great music? There is no single answer to this question, for the many musicians who have decided to pursue Just Intonation have done so for a host of different reasons. Harry Partch, who more than any other composer is responsible for the current revival of interest in Just Intonation, was seeking a scale with sufficient subtlety to mirror the inflections of American speech. Many, like Lou Harrison, Terry Riley, and La Monte Young, were led in the direction of Just Intonation by the tunings used in various non-Western musics. Most Just Intonation aficionados, like most early electronic musicians, are pioneers at heart, preferring exploration of the unknown to exploitation of the familiar. In addition, many, myself included, feel that the adoption of equal temperament has stifled musical evolution and that the time is ripe to get get things back on the right track. Whatever their reasons and motives, all users of Just Intonation recognize the greater clarity and increased evocative power which familiar consonant intervals and chords acquire when they are properly tuned.

If you find all of these reasons a little obscure or abstract, consider the following questions. How much of the electronic music that you have heard of late consists of well-worn harmonies, melodies,

David Doty *is a composer, performer, instrument builder and theorist, and a founding member of the experimental ensemble* Other Music. *His compositions can be heard on Other Music's two LPs,* Prime Numbers *and* Incidents Out of Context. *He is currently the editor of* 1/1, *the quarterly journal for the Just Intonation Network.*

and rhythms dressed up in new electronic timbres? When was the last time that your heard a chord that you had never heard before? Not just a cluster or an aggregate, not just a bunch of tones that happen to be sounding at the same time, but a real chord? What would it be like if you could have access to new intervals, chords, and progressions that you had never heard before, but which were logical extensions of the existing musical vocabulary? If this prospect interests you, there are many resources for more information on Just Intonation . . . read on.

BOOKS

Harrison, Lou. *Lou Harrison's Music Primer*. C. F. Peters Corp., 1971 (Miscellaneous tips on tuning, composing, and musical life in general)

Helmholtz, Herman. *On the Sensations of Tone*. Dover, 1954. (Extensive exposition on the fundamentals of acoustics and psychoacoustics, by the 19th century scientist who laid the foundations of both fields)

Partch, Harry. *Genesis of a Music*. Da Capo Press, 1974. (The most detailed explanation of Just Intonation currently in print, by the composer/instrument builder/philosopher largely responsible for current interest in the subject)

PERIODICALS

Interval/Exploring the Sonic Spectrum (irregular publication schedule). 4195 Norfolk Terrace, San Diego, CA 92116. An approximately equal mix of Just and other microtonal material.

1/1 (The Journal of the Just Intonation Network; quarterly). 535 Stevenson St., San Francisco, CA 94103. This publication, which I edit, is devoted strictly to Just Intonation. Sample copy on request.

Pitch: for the International Microtonalist. 211 W. 108th St., New York, NY 10025. Sample copy on request.

Xenharmonikon (bi-annual). 23A Park Pl., Middletown, CT 06457. An informal journal of experimental music; recently revived after long dormancy. Previously had strong emphasis on alternative tuning—current focus uncertain.

SELECTED DISCOGRAPHY

Glen Branca, *Symphony Number Three (Gloria)* (Neutral N4).

Lou Harrison, *Double Concerto for Violin and Cello with Javanese Gamelan* (TRC-109); ***Three Pieces for Gamelan with Soloists; String Quartet Set*** (CRI 455).

Ralph David Hill, *The Sounds of Just Intonation* (see sidebar).

Other Music, *Incidents out of Context* (Flying Fish FF302).

Harry Partch, *The World of Harry Partch* (Columbia Masterworks MS 7202); ***And on the Seventh Day Petals fell in Petaluma*** (CRI 213); ***Delusion of the Fury*** (CBS M230576).

Terry Riley, *The Harp of New Albion* (Celestial Harmonies 7869); ***Songs for the Ten Voices of Two Prophets*** (Kuckuck 067).

Various Artists, *Tellus #14* (A sampler of 16 works by 16 different composers, edited by the Just Intonation Network; Distributed by Harvestworks, 16 W. 22nd Street, #902, New York, NY 10010.

EM

Cassette Introduction to Just Intonation

The Just Intonation Network distributes Ralph David Hill's lecture/demonstration tape, *The Sounds of Just Intonation*. Performed on the Quadvox, Hill's custom four-voice digital synthesizer, this three-hour presentation consists of a detailed step-by-step exposition of the intervals and chords of Just Intonation, followed by a concert of justly-tuned classical and new music. The audio portion of the program, issued on two hi-bias CrO2 cassettes, is accompanied by 64 pages of documentation, including scores of all musical examples.

In the past, learning about Just Intonation could be difficult since information on the subject is often the product of learned composers and psychoacousticians writing for their peers. However, Hill's exposition is clear and straightforward, and easily grasped by any musician with a basic understanding of music theory. Every concept is supported by musical examples, the meaning of which will be aurally obvious. The *Sounds of Just Intonation* is available at a cost of $25 to the general public, or $20 to members of the Just Intonation Network. Contact Henry S. Rosenthal, c/o The Just Intonation Network, 535 Stevenson St., San Francisco, CA 94103; tel. 415/864-8123.

TUBECRAFT
HOLBROOK, NY 11741
(516) 567-8588

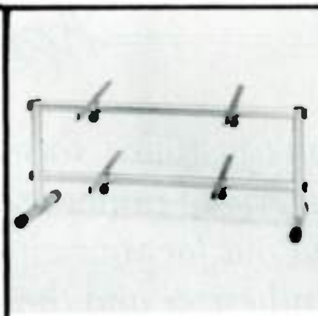
ORDER NOW AND SAVE

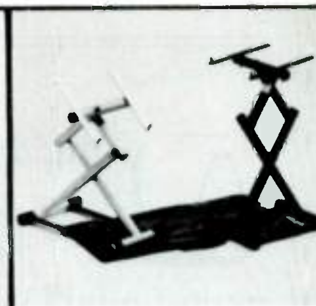
Dealer Inquiries Welcome

- SUFFIXES (S=SINGLE, D=DOUBLE, T=TRIPLE, U=UNDERDESK SHELF, M=MONITOR SHELF
- BLACK FINISH ADD 10%
- CASTERS ADD $42.00

ITEM #	DESCRIPTION	RETAIL	OUR PRICE
	TUBE RACKS		
TR-06	6 SP (10.5") TUBE RACK	110.00	77.00
TR 08	8 SP (14") TUBE RACK	118.00	83.00
TR-10	10 SP (17.5") TUBE RACK	124.00	87.00
TR-12	12 SP (21") TUBE RACK	164.00	115.00
TR-14	14 SP (24.5") TUBE RACK	172.00	121.00
TR-16	16 SP (28") TUBE RACK	180.00	126.00
TR-18	18 SP (31.5") TUBE RACK	190.00	133.00
TR 22	22 SP (38.5") TUBE RACK	202.00	142.00
TR 27	27 SP (47.25") TUBE RACK	218.00	153.00
TR 41	41 SP (71.25") TUBE RACK	268.00	188.00
	KEYBOARD RACKS		
LK 36S	36" LARGE KEYBOARD RACK (INC 1 TIER)	158.00	111.00
LK 42S	42" LARGE KEYBOARD RACK (INC 1 TIER)	160.00	112.00
LK-48S	48" LARGE KEYBOARD RACK (INC 1 TIER)	162.00	114.00
LK-54S	54" LARGE KEYBOARD RACK (INC 1 TIER)	164.00	115.00
SK-36S	36" SMALL KEYBOARD RACK (INC 1 TIER)	158.00	111.00
SK-48S	48" SMALL KEYBOARD RACK (INC 1 TIER)	162.00	114.00
SK-54S	54" SMALL KEYBOARD RACK (INC 1 TIER)	164.00	115.00
AT-36	36" ADDITIONAL TIER	38.00	27.00
AT-42	42" ADDITIONAL TIER	40.00	28.00
AT-48	48" ADDITIONAL TIER	42.00	30.00
AT-54	54" ADDITIONAL TIER	44.00	31.00
ET 36B	36" ECONOMY TRIPLE RACK (BLK.)	194.00	136.00
ET 42B	42" ECONOMY TRIPLE RACK (BLK.)	206.00	145.00
ET-48B	48" ECONOMY TRIPLE RACK (BLK.)*SPECIAL PRICE!	178.00	125.00
ET-54B	54" ECONOMY TRIPLE RACK (BLK.)	230.00	161.00
ED-36B	36" ECONOMY DOUBLE (BLK.)	174.00	122.00
ED 42B	42" ECONOMY DOUBLE (BLK.)	186.00	131.00
ED-48B	48" ECONOMY DOUBLE (BLK.) *SPECIAL PRICE!	158.00	111.00
ED 54B	54" ECONOMY DOUBLE (BLK.)	210.00	147.00
ER 04	4 SP EXPANSION RACK 48" WIDTH)	120.00	84.00
ER 08	8 SP EXPANSION RACK-48" WIDTH)	140.00	98.00
PB 10	PIGGY BACK RACK (TIERS NOT INC.)	30.00	21.00
MS-10	MINI SCISSOR STAND	80.00	56.00
MT 30B	MIC STAND TIER + MIC STAND + MUSIC RACK (BLK.)	60.00	42.00
	X STANDS		
SX 30	SM X STAND	66.00	47.00
MX 32	MED X STAND	78.00	55.00
LX 36	LG X STAND	88.00	62.00
DX 32	DOUBLE X	138.00	97.00
BX 10	BILEVEL X	118.00	83.00
	ACOUSTIC DIVIDERS (GO-BO)		
GB-39	(W39" × H48") GO-BO (BLU, RED, YEL, GREY)	130.00	91.00
GB-52	(W52" × H48") GO BO (BLU, RED, YEL, GREY)	150.00	105.00
	PORTABLE WORKSTANDS & TABLES		
PW 28	(28 × 18 × 30) PORTABLE WORKSTAND	90.00	63.00
PW 36	(36 × 20 × 30) PORTABLE WORKSTAND	110.00	77.00
PT 28	(28 × 18 × 30) PORTABLE TABLE	140.00	98.00
PT 36	(36 × 20 × 30) PORTABLE TABLE	160.00	112.00
UT 30	SM UTILITY TABLE	96.00	68.00
UT-36	LG UTILITY TABLE	116.00	82.00
	DJ STANDS		
DJ 30	SMALL DJ STAND	90.00	63.00
DJ 36	LARGE DJ STAND	110.00	77.00
DB 36	DJ BOOTH (INC. SNAP ON SKIRT)	500.00	350.00
	RACKING CONSOLES		
RC 10C	RACKING CONSOLE/CASTERS	250.00	175.00
RS-10C	RACKING CONSOLE/SHELF/CASTERS	280.00	196.00
	PARTS		
PCA 10	LOCKING CASTERS (SET OF FOUR)	60.00	42.00
PKA 10	KEYBOARD ARMS (SILVER)	22.00	16.00
PER-10	ECONOMY KEYBOARD ARMS (BLK.)	12.00	9.00
	PORTABLE BIN SCAFFOLDS		
BS 05	(18 × 18 × 60) BIN SCAFFOLD/1.5" DIA. TUBE	124.00	87.00
BS 06	(18 × 18 × 72) BIN SCAFFOLD/1.5" DIA. TUBE	130.00	91.00
BS 15	(22 × 22 × 60) BIN SCAFFOLD/2" DIA. TUBE	180.00	126.00
BS 16	(22 × 22 × 60) BIN SCAFFOLD/2" DIA. TUBE	190.00	133.00
	NEW PRODUCTS		
HR 06	6 FT. HEAVY DUTY ELECTRONICS RACK (BLK. ONLY)	550.00	385.00
MC 48	MIXING CONSOLE STAND (W48 × D30 × H26) OTHER SIZES CALL	250.00	175.00
	WORKSTATIONS		
WS 42	WORKSTATION 42 × 28 × 26	196.00	138.00
WS 42M	WORKSTATION 42 × 28 × 26/MONITOR SHELF	230.00	161.00
WS 42MU	WORKSTATION 42 × 28 × 26/MONITOR & UNDERDESK SHELF	258.00	181.00
WS 42U	WORKSTATION 42 × 28 × 26/UNDERDESK SHELF	218.00	153.00

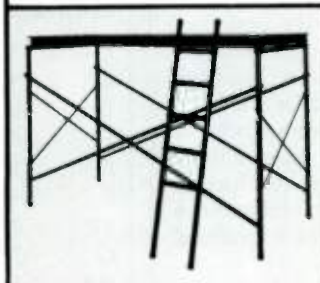
ALSO IN 36" WIDTH & 48" WIDTH CALL!
—WS TABLETOPS: ALMOND, BLK., OAK, WALNUT-SPECIFY
—WS SERIES AVAILABLE WITH LOCKING CASTERS (#PCR 10)
—TR, PW, PT, DJ, & DB SERIES AVAILABLE WITH CASTERS


Piggyback Rack

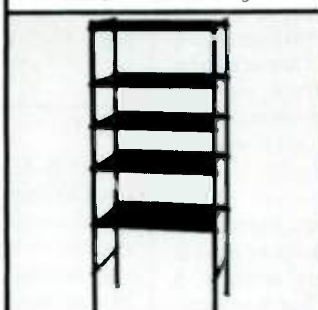

Mini-Scissor


DJ Stand


DJ Booth


Custom Steel Scaffolding


Multipurpose Mini Stand


Custom Display Rack


Custom Display Rack

Send Coupon and List of Items Desired To:

FM TUBECRAFT SUPPORT SYSTEMS INC.
1121-26 Lincoln Avenue, Dept. EM, Holbrook, NY 11741

List Items ____________________
____
____

Name ____________________

Address ____________________

City __________ State __________ Zip __________

Telephone ____________________

CHECK FORM OF PAYMENT: ☐ VISA ☐ MasterCard ☐ Personal Check ☐ Certified Check ☐ Money Order

Card No. __________ Exp. Date __________

ALL SHIPPING CHARGES ARE FREIGHT COLLECT

PERSONAL CHECKS: Allow 3 weeks to clear
PRICES SUBJECT TO CHANGE WITHOUT NOTICE
All Returns Must Have a Return Authorization Number

You don't just have to speculate about what alternate tunings sound like—you can find out for yourself if you have a multi-timbral synthesizer and the right sequencer.

Just Intonation for MIDI Synthesizers

BY ROBERT RICH

Few synthesizers offer the option of redefinable tuning. Those that do include Sequential's Prophet 5 and T-8, the alphaSyntauri, Serge modular, and high-end systems such as those from Synclavier and Buchla. Unfortunately, most of these instruments are either expensive, hard to find, or discontinued. Many old organs can also be retuned, but their sonic potential leaves a lot to be desired.

However, there is an alternative for people dedicated to retuning their electronic instruments. If you are willing to give up some real time control, any programmable MIDI synthesizer can play in *any* scale you want when used in conjunction with the right kind of sequencer. The method discussed here is pretty crude, but it works.

THE METHOD

With this method, each note (interval) in your intonational system fills up a program location in the synthesizer's memory. A single timbre is duplicated, but it is transposed interval-by-interval, one transposition per program location. A MIDI synthesizer then plays the synthesizer, but the sequences do not consist of note changes—they consist of *program* changes. More on this later.

To make retuning easier, a *multi-timbral* synthesizer is the instrument of choice. Multi-timbral means that each synthesizer voice can be assigned to its own MIDI channel, and also, each voice can be programmed with a different patch (program) if desired. Usually this feature is used to provide several different timbres simultaneously but we will use it to create notes with separate and different "detuning" settings, in order to access pitches beyond the confines of the standard even-tempered scale. The Oberheim Xpander, Sequential Six-Trak, and Casio CZ series synths are all multi-timbral. Anything capable of a keyboard split is also multi-timbral (well, at least duo-timbral). Using the tuning system described here, a multi-timbral synthesizer lets you play polyphonically up to the number of voices in the instrument; with non-multi-timbral instruments, you would need a separate instrument for each voice in the composition. In general, you can play as many parts in harmony as you have MIDI channels.

INTERVALLIC RATIOS

C	1/1	unison
C#	16/15	minor second
D	9/8	minor third
D#	6/5	minor third
E	5/4	major third
F	4/3	fourth
F#	7/5	tritone
G	3/2	fifth
G#	8/5	minor sixth
A	5/3	major sixth
A#	9/5	minor seventh
B	15/8	major seventh
C	2/1	octave

Fig. 1

This article will focus on the two least expensive, most common multi-timbral synthesizers, the Sequential Six-Trak and Casio CZ-101. As for MIDI sequencers, the ability to edit individual note events is crucial. For this purpose, I highly recommend Dr. T's *Keyboard-Controlled Sequencer*, which is available for Apple II, Commodore 64/128, and Atari ST computers. Very few other sequencers have comparable capabilities, and those that do tend to cost a lot more.

SIX-TRAK PARAMETERS

note	*coarse freq*	*fine freq*
C	27	5
C#	28	7
D	29	6
D#	30	10
E	31	0
F	32	4
F#	33	0
G	34	6
G#	35	9
A	36	0
A#	37	11
B	38	1

Fig. 2

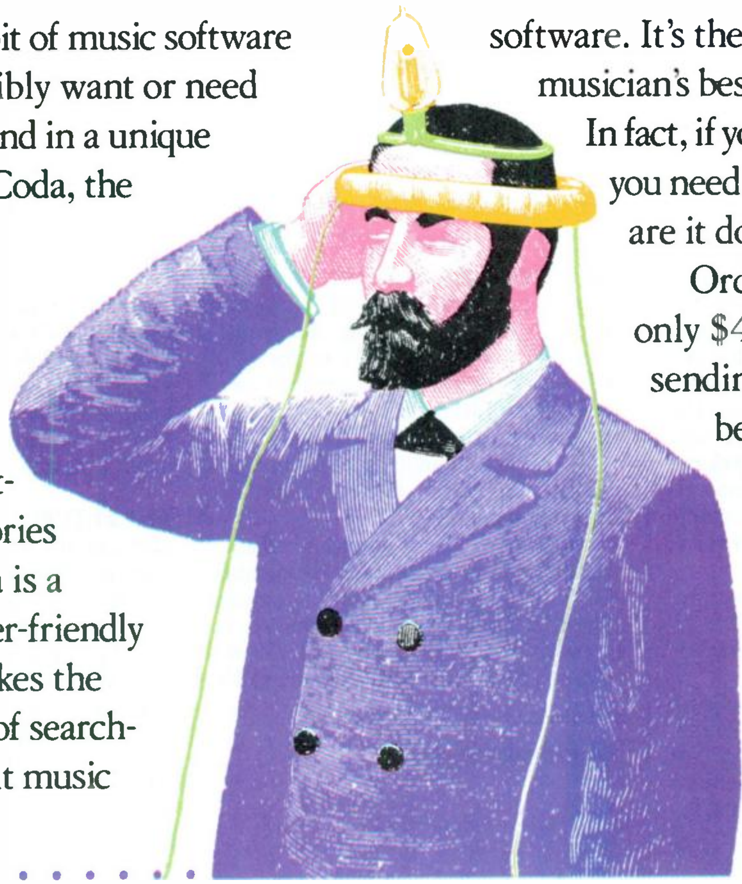
TUNING: GENERAL PROCEDURE

Copy the "source" program (patch) into as many program locations as there are intervals in one octave of your scale. If you use non-repeating octaves, you need extra locations for each unique non-octave-related interval. Next, choose the keyboard key that will serve as the scale's reference pitch. I use A-440 because it is the easiest standard of comparison. Then, holding down that reference note, tune each interval (one per program) to whatever frequency it corresponds in your scale. (With synthesizers that use quantized main tuning controls, there is often some kind of detune or offset control, whose setting is also memorized with the program, which can serve to "tweak" the interval's tuning.)

Six-Trak: For the C scale shown in **Fig. 1**, the coarse and fine tuning values in **Fig. 2** should come very close to providing the proper intervals. These values should work for Sequential's Max and Multi-Trak synthesizers as well.

Robert Rich is an electronic musician who has used alternate tunings for many years. A member of the Just Intonation Network, he has released five cassettes and a new LP, created tuning programs for the Prophet 5, and helps with research at Stanford University in his spare time.

If you feel like a lost soul when it comes to music software, get the bible.



Almost every bit of music software you could possibly want or need can now be found in a unique single source: Coda, the bible of music software.

Detailing over 500 items which range from software to accessories to books, Coda is a remarkably user-friendly catalog that takes the confusion out of searching for the right music software. It's the computer-using musician's best resource today. In fact, if you can't find what you need in Coda, chances are it doesn't exist.

Order Coda today for only $4.00 by simply sending in the coupon below. It's not only inspirational. It's divine guidance. Or call **1-800-843-1337.**

All major credit cards accepted. Or call collect 1-507-451-1951.

Please send me ____ copies of Coda at $4.00 each.

Name ____________________

Address ____________________

City __________ State ______ Zip ______

Phone ____________________

Signature ____________________

Payment enclosed $________

☐ check ☐ money order

☐ Visa ☐ Mastercard

☐ American Express

Card No. ____________

Expiration date ____________

Mail to:

Wenger Corp.

555 Park Drive, Dept. E2

Owatonna, MN 55060

Coda.

Line Select: 1 + 2				
Vibrato: Wave = 1, Delay = 49, Rate = 53, Depth = 21				
Octave: Range = 1				
Line 1 Key Follow (DCW, DCA): 0				
Line 1 DCO, DCW, DCA Envelopes:				
Step	1			
Rate	0			
Level	0			
Sus/End	End			
Line 2 Key Follow (DCW, DCA): 0				
Line 2 DCO and DCW Envelopes:				
Step	1			
Rate	0			
Level	0			
Sus/End	End			
DCA 2 Envelope:				
Step	1	2	3	4
Rate	85	55	31	31
Level	99	89	65	0
Sus/End	***	***	Sus	End

Fig. 3 *Simple CZ-101 piano program*

CZ101: The CZ is a bit annoying, because there is no programmable tuning adjustment that affects both oscillators (unfortunately, the DCO frequency envelope is too coarse for our purposes; its resolution is about 12 cents). Therefore, only DCO 2 can be easily used for sound generation. Use the *detune* control to set the interval, and mute DCO 1 by setting its DCA envelopes to 0. **Fig. 3** shows an ultra-simple example program for a smooth electric piano sound. **Fig. 4** shows the detune values for the C scale in **Fig. 1**.

This method of retuning does compromise some of the sonic versatility of the CZ, but I have yet to find an easier or better way to do it.

Another minor annoyance with the CZ involves a note cut-off problem. Whenever the sequencer sends a program change over a specific MIDI channel, the CZ sends a momentary note-off over that channel before changing the program. Luckily, it does not seem to respond with an all-notes-off command, so the other channels will still make sound while this glitch occurs. The next section mentions some ways to avoid this problem.

Sequencing Techniques

In general, the sequence's note list consists of a single note—the reference note—transposed by different octaves to cover different ranges. The actual *frequencies* are determined by program changes. For example, suppose Program 10 is tuned to A and Program 5 is tuned to the E below A. If you wanted to play A followed by E, you would start with the synthesizer set on Program 10 and tell it to play A. To play the E, the sequencer would first send a program change command to change the synthesizer to Program 5, then tell it to play A. Of course, since Program 5 was retuned to play an E, you will hear an E even though the sequencer is telling the synthesizer to play A. For playing harmonies, different MIDI channels can carry different individual notes in a harmony.

If you have access to enough simultaneous voices, you can minimize the number of required program changes by assigning individual notes to individual channels. In an extreme case, for example, if you are sending a pentatonic scale sequence to the Six-Trak, you can assign one note to each of five MIDI channels, thereby never having to make a program change (unless you want octaves to repeat within a chord). In this case, then, the MIDI channel and octave for each event in the sequence define its frequency.

CZ-101 PARAMETERS

Interval	*oct*	*Detune note*	*fine*
C	+0	3	9
C#	+0	4	12
D	+0	5	12
D#	+0	6	18
E	+0	7	1
F	+0	8	8
F#	+0	8	59
G	+0	10	12
G#	+0	11	16
A	+1	0	0
A#	+1	1	21
B	+1	2	3

Fig. 4

Because of the CZ's note-off glitch, this technique is the only apparent means of playing fast tempos, or high note densities on the Casio synths. In other words, if you don't want rests between successive notes, you have to overlap them on different MIDI channels. Combining two CZ-101s or using one of Casio's 8/16 voice synths (i.e. CZ-3000) would allow for playing a major or minor just-intoned scale without any program changes. In most cases, since not every voice will be used at once, careful channel assignment and program change timing can minimize program change glitches.

Some new devices entering the market may free this tuning technique from the tyranny of sequencers. The devices are called "MIDI mappers," and their sole purpose is to convert one MIDI message to another. Conceivably, with a sophisticated enough mapper, keyboard note values could be translated by the mapper into different MIDI channels. Note on-off commands could thus be separated from note values, and the new just-intoned notes could be played by multi-timbral slave synths. It sounds a bit cumbersome, but it might just work.

The Future...

Alas, I am still searching for a more elegant generalized retuning procedure than the one described here. Two other possibilities have arisen. The first involves sending calibrated pitch-bend messages for each note in a sequence. The problem with this technique is that many, if not most, multi-timbral synthesizers apply a single pitch-bend message to all voices simultaneously. This is the case for both the Six-Trak and the CZ (I think the CZ applies pitch bend to the basic channel only); the Oberheim Xpander is an exception to the rule. Another drawback is that editing sequences is a pain using this method! A second alternative involves sending system-exclusive program retuning messages through the sequencer. *Dr. T* can supposedly send system-exclusive bytes, but I have yet to get this working.

The one-note-per-program method of retuning has the real benefit that it works on most any MIDI synthesizer and is easy to use—so now you don't just have to read about just intonation, you can hear for yourself what it does. The advantage to any such retuning method is that it frees us from the 12 note per octave scale! EM

CMC 24* MK II — FEEL THE POWER!

$7200 PUTS YOU** IN COMMAND

The **COMPUTER AIDED ROUTING SYSTEM**

***C.A.R.S.**

with 32 banks of internal memory, gives instant recall of 16 track bus assignment and muting information (24 input channels and 16 monitor/input channels) through the onboard microprocessor.

Comprehensive monitoring and talkback systems keep you in command. A separate cue system, in addition to the 6 auxiliary Mix buses, allows simplified control of musicians headphone mixes. Improved electronic and mechanical construction offer new levels of performance over previous designs.

In addition, with optional Computer Interface/Sequencers, the CMC-24 may be controlled by an external source such as Keyboard, Drum Computer or Tape Track. Anyway enough talk, we believe the Excitement is in the Driving. . .We know you're ready!

For More detailed information on how the new CMC Series can bring your Mixing Capabilities into the Computer Age, contact your local authorized AHB dealer today.

***Includes: MPS Power Supply.*
Prices & Specifications subject to change without notice.

AHB

Mixing **ART** With **SCIENCE**

Allen & Heath Brenell (USA) Ltd.
Five Connair Road
Orange, Ct. 06477 / (203)795-3594

Allen & Heath Brenell Ltd.
69 Ship Street, Brighton, BN1 1AE England
Telephone: (0273) 24928/ Telex 878235

Here's how to tap the potential for alternate tunings hidden inside some of today's—and yesterday's—electronic keyboards.

Just and Mean Tone Tuning for Electronic Keyboards

BY ALAN GARY CAMPBELL

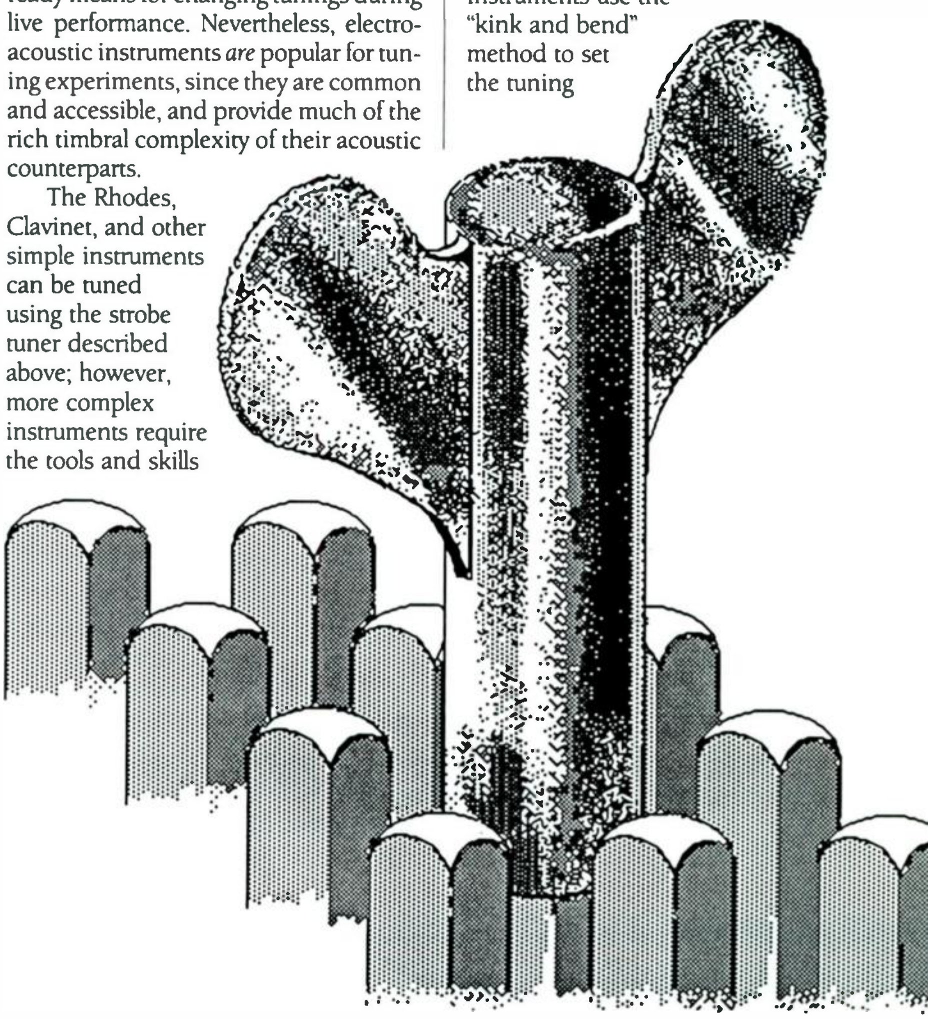
In search of new harmonies, or merely seeking a major chord that sounds more perfectly "in tune," many keyboardists and composers are experimenting with just and mean tone tunings. Indeed, alternate tunings are enjoying a renaissance.

Many contemporary instruments can only produce equal temperament, but a surprising number *can* produce just, mean tone, and even microtonal scales. Retuning some is as simple as selecting the proper software routine, but others require instrument service skills and correct pitch references. Often, a strobe tuner is used for this, but such tuners are calibrated for *equal temperament*. However, top-of-the-line tuners (such as the Peterson Model 450) provide a direct display of the pitch deviation from equal temperament, in cents (1 cent=1/100th of a semitone). The difference in cents between just or mean tone note-frequency and that of equal temperament can be calculated or derived from tables, and the instrument then strobe-tuned accordingly.

ELECTRO-ACOUSTIC KEYBOARDS

Electro-acoustic keyboards, such as the Fender Rhodes, Yamaha CP-series pianos, Kawai pianos, and the Hohner Clavinet and Pianet, can be tuned to just or mean tone scales. However, their effectiveness is limited by their inherent tuning instability, and often by the skill of the person performing the tuning. In addition, such instruments can be quite time-consuming to tune, and offer no ready means for changing tunings during live performance. Nevertheless, electro-acoustic instruments *are* popular for tuning experiments, since they are common and accessible, and provide much of the rich timbral complexity of their acoustic counterparts.

The Rhodes, Clavinet, and other simple instruments can be tuned using the strobe tuner described above; however, more complex instruments require the tools and skills of a piano technician. Even basic tuning calls for some technical skill—it's not as simple as just turning the tuning peg with the appropriate tool. For example, many instruments use the "kink and bend" method to set the tuning



Alan Gary Campbell is owner of Musitech,™ a consulting firm specializing in electronic music products.

of each string; otherwise, they will drift horribly out of tune when played. A tunings experimenter, not familiar with such requirements, could reduce the tuning stability of even the best instrument to zero. But, alternate tunings are by nature experimental, and one can hardly afford to pay a piano tuner for countless hours of tinkering. Thankfully, many schools, correspondence courses, and textbooks teach the necessary techniques; and occasionally a local piano technician will offer private lessons. Also, an instrument service manual is a helpful reference. Tuning techniques can be difficult to learn. However, once mastered, they provide the student with greatly enhanced do-it-yourself service skills, *and* an optional source of income (i.e., from piano tuning), in addition to gaining access to alternate tunings.

The Clavinet, with only a single string per key, is probably the easiest of the listed instruments to tune; the overtone series is very uniform, making it easy to detect the fundamental. The Rhodes is more difficult, since the tines can, depending upon the adjustment of the action, produce a rather bell-like sound containing numerous noninteger harmonics that obscure the fundamental. Electric grands can be troublesome, too, especially in the lower register. The large, stiff bass strings act, mathematically speaking, more like rods, and produce a harmonic series that is roughly in tune with itself, but sharp relative to the fundamental. Thus, whether the piano sounds in tune or not depends upon any equalization applied to the instrument and the room response, since these factors determine whether one hears the *actual* fundamental or the psycho-acoustically-perceived fundamental implied by the harmonics. Truly, tuning electro-acoustic instruments can be more of an art than a science!

Discrete-Oscillator Keyboards

Many electronic organs incorporate a free-running discrete oscillator for each chromatic note of the standard 12 tone, even-tempered scale. Each oscillator then drives cascaded *flip-flops,* which successively divide the oscillator pitch by two, four, eight, etc. to generate the required suboctaves. Some well-known examples of discrete-oscillator technology are the Vox Continental organ, and various console organs manufactured by Schober and Devtronix.

Generally, discrete oscillators are tuned by adjusting a variable inductor with a TV-type alignment tool. Such oscillator designs use analog circuits, but are highly stable; while an analog *synthesizer* will rarely ever produce a stable strobe-tuner display, a discrete-oscillator-output display is "rock steady." Retuning is easy for any given scale. However, modifying a discrete-oscillator instrument to select alternate tunings quickly can amount to a major job of re-engineering.

Top-Octave-Divider Keyboards

Top-octave-divider instruments use a single high-frequency square wave (this can be as high as 1 or 2 MHz) and a series of digital dividers to derive the desired notes of a scale from this single square wave. For example, dividing a 2.00024 MHz signal by 239 produces C=8,369 Hz, dividing by 253 gives B=7,906 Hz, and so on. Flip-flops or similar circuits then derive the suboctaves, as with discrete-oscillator keyboards. The divider circuits that generate the scale are designed for equal-temperament, and generally cannot be changed.

However, it is possible to bypass the divider circuitry with an external circuit designed to produce the note-frequencies required for alternate tunings. At least one such device is available commercially: PAiA Electronics offers the EK-10 Just Intonation Generator retrofit for their *Strings'n'Things* and *Organtua* keyboards. This kit also works with other instruments based on the 50240 top octave generator IC (the circuit is described in detail in the February '84 issue of *Polyphony*; see Bibliography). The board connects easily to the host instrument via a DIP header cable that plugs into the top-octave divider chip socket.

Korg PS-3000 Series

The PS-3000-series keyboards are offshoots of top-octave-divider technology. Each of the three instruments in the series features full (48-note) polyphony, with a separate voltage-controlled filter (VCF) and associated envelope generator (EG) for *each key*, and a quasi-modular design (*modular* in the sense of a Moog Modular analog system) where modulation and control routings can be selected via front-panel jacks and patch cords. *And*, the tuning of each chromatic note may be adjusted directly via 12 panel controls. The 3000-series is thus very straightforward to retune, and offers excellent tuning stability.

The PS-3100 has a single rank of top-octave tone generators—with adjustable tuning—and associated output circuitry. The PS-3200 has two ranks of top-octave generators, each with individually-adjustable temperament, that share a common output stage; the unit is programmable (excluding temperament). The PS-3300 has *three* ranks of top-octave generators, *each* with individually-adjustable temperament, and each with its own independent output stage; therefore, up to three different temperaments, each with a different timbre, can be produced simultaneously (the 3300 is not progammable). The 3000-series instruments were in many ways ahead of their time, and still offer considerable sonic potential, though they are limited by having only a single output VCA and associated EG.

AlphaSyntauri & Soundchaser

Syntauri Corporation's *alphaSyntauri* and Passport Designs' *Soundchaser* are peripherals that, used in conjunction with Mountain Computer's *Music System* components, turn an Apple II or compatible computer into the equivalent of an 8-bit digital music synthesizer. (For more information on Apple II music peripherals, see "The Musical Apple II" in the October '86 EM.) Both the alphaSyntauri and Soundchaser provide disk-based software utilities for alternate tunings. For example, the Soundchaser system has a "Tunings & Waveforms" disk, containing routines for just, mean tone, and microtonal tunings (*and* a selection of common periodic waveforms). To create a just scale, the user simply specifies the base key, and the software calculates the correct note-frequencies (microtonal scales are specified similarly). To create a mean tone scale, the user specifies the mean comma *and* the base key, and the software does the rest. Alternate tunings thus created can be saved or loaded to and from disk in moments. Such fast access to tunings files makes experimenting much more practical.

> **"Truly, tuning electro-acoustic instruments can be more of an art than a science"**

SCI Prophet-5

A hidden *scale mode* function allows the Prophet-5 to create alternate tunings, and store these as "patches." To access scale mode, press the BANK SELECT and TUNE switches simultaneously; then, the 12 knobs in the middle row of the front panel (i.e., LFO FREQUENCY through AMP RELEASE) can adjust the note-frequencies of the 12 semitones, over a range of ±1/4 tone (±50 cents). These techniques are covered in detail in the Prophet-5 *Operation Manual*, and in an excellent article in Volume 1, Number 4 of *1/1* (this issue is devoted entirely to alternate tunings on keyboard instruments; see Bibliography). Once in scale mode, the Prophet-5 can select alternate tunings virtually instantaneously, just like patch programs—and the tuning stability is quite good. The only trade-off is that saving a tunings program will "overwrite" the patch program in that location. In other words, a given program location can hold a patch *or* an alternate tuning, but not both.

Yamaha DX7

The DX7 can use MIDI pitch-bend data to offset particular notes from even-temperament, and thus create alternate tunings. A computer program (compatible with the IBM PC and Roland MPU-401 interface) for generating monophonic just intonation appeared in the February '86 issue of *Keyboard* (see Bibliography).

DX7s incorporating a Revision 2 *E!* retrofit (see May '86 EM) can have user-defined temperament with a pitch accuracy of approximately 1/3 cent. Up to 16 just, mean tone, and macrotonal or microtonal scales can be created and saved via the keyboard presets—a special software routine allows note-frequency adjustment via the data entry slider. Mapped and inverted keyboard configurations are also possible.

Other Instruments

Other articles in this issue describe how to create alternate tunings with multi-samplers ("Alternate Scales for Even-Tempered Synthesizers") and with MIDI instrument/sequencer combinations ("Just Intonation for MIDI Samplers"). Don't forget that guitars can use alternate tunings, too (see Bibliography). With the information in these articles, and the references cited, it's time to start experimenting with alternate tunings in *your* music. **EM**

Bibliography

"Exploring Just Intonation," David Doty, *Polyphony*, August 1983.

"Tuning Keyboards in Just Intonation," David Doty, *Keyboard*, October 1983.

"Build a Just Intonation Generator," Vanessa Else, *Polyphony*, February 1984.

"Justly Tuned Guitar," David Doty, *Polyphony*, April 1985.

"Tuning and Transposition on the Prophet Five," Robert Rich, *1/1*, Volume 1, Number 4, Autumn 1985.

"Do-It-Yourself-Software: Just Intonation," Carter Scholz, *Keyboard*, February 1986.

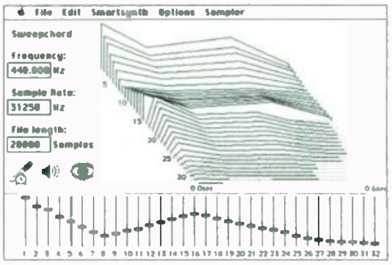
"Review: E! Board for the DX7," Alan Gary Campbell, **EM**, May 1986.

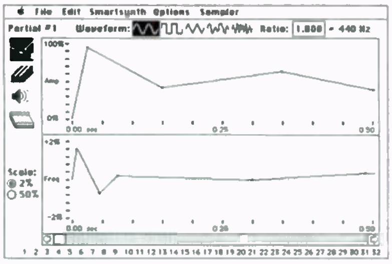
Add Digital Synthesis to your sampler!

SOFTSYNTH™

Softsynth is a revolutionary new approach to digital synthesis: an advanced 32 oscillator, digital additive synthesizer with more features and versatility than other digital synths. Best of all, it's an easy to use software program that runs on your Macintosh™ computer!

How is this possible? Softsynth uses *software-based synthesis* to create sounds you design using graphic programming screens. After you specify a group of harmonics and envelopes, Softsynth creates a high quality digital sound that can be transferred to your sampler for playback.

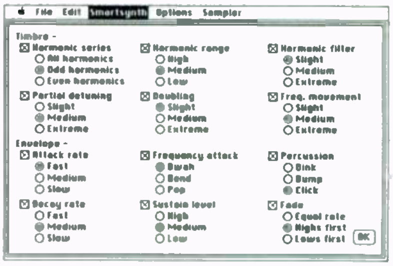




Additive synthesis is the most powerful and precise digital synthesis technique. Alas, hardware-based additive synthesizers are very expensive (usually over $10,000)! Softsynth offers an alternative—it is the first affordable, easy to use additive synth.

Softsynth provides precise control over all important synthesis parameters: *each* harmonic has a 40 (!) stage envelope, a 15 stage pitch envelope and a choice of five different wave shapes. Complete editing tools are provided that let you copy, paste and clear parameters between harmonics.

The unique *Smartsynth*™ function is even easier to use. You simply choose the characteristics of the sound you want to create, and Smartsynth will generate different variations of the sound each time you click the mouse!



Because Softsynth's sounds are software generated, they don't suffer from input sampling noise. Your Softsynth samples will sound "cleaner," and take advantage of the full playback frequency response and dynamic range of your sampler.

Add digital synthesis to your sampler—Softsynth provides the tools to create a wide range of exciting new sounds.

For more information contact:

digidesign

Digidesign Inc
Palo Alto, CA 94303

920 Commercial
(415) 494 8811

Current version works with: Ensoniq Mirage™/Multisampler,™ Sequential Prophet 2000/2002,™ Akai S900™ and S612,™ Korg DSS-1,™ E-mu Systems Emax™ and Emulator II™ (Emulator II version requires *Sound Designer*.™)

Requires Macintosh 512K, 512Ke or Macintosh Plus with a MIDI Interface.

What Price Magic?

Prepare to be suprised. Our new Emax™ will make you rethink your notion of what a digital sampling keyboard can do. And what one should cost.

Then again, we *are* talking about magic. The magic of sampled sound. Voices. Instruments. Sound effects. Machines. Anything. All digitally recorded. Ready to be woven into a musical tapestry of unlimited colors.

We're also talking about a new keyboard from E-mu Systems. The leaders in digital sampling technology.

Years ago, we invented affordable digital sampling with the Emulator™ and redefined the way music is made. Now, with Emax, we're redefining who will make it.

A sample of our power

Like all of our products, Emax features our characteristic commitment to superb sound quality. Sound quality that's evident whether you sample your own sounds or select disks from the comprehensive Emax Sound Library.

Either way, the music you'll make with Emax is like nothing you've ever heard before from an affordable sampling keyboard.

You begin with a full 19 seconds of sampling time at Emax's standard sampling rate. And you can take advantage of our variable sampling rates to allow up to 57 seconds.

Impressed? Just wait. The magic really begins when you hear what Emax can do with your sound. Emax packs a full complement of analog and digital processing functions. Like digital splicing and merging, or filters and VCAs with individual 5-stage envelopes for dynamically modifying the timbre of a sample. So one sample can be the raw material for hundreds of sounds.

Once you have that sound, give it motion. With Emax's true programmable panning, you can place each sound anywhere in the stereo image. Or sweep it with a wide variety of real-time controls.

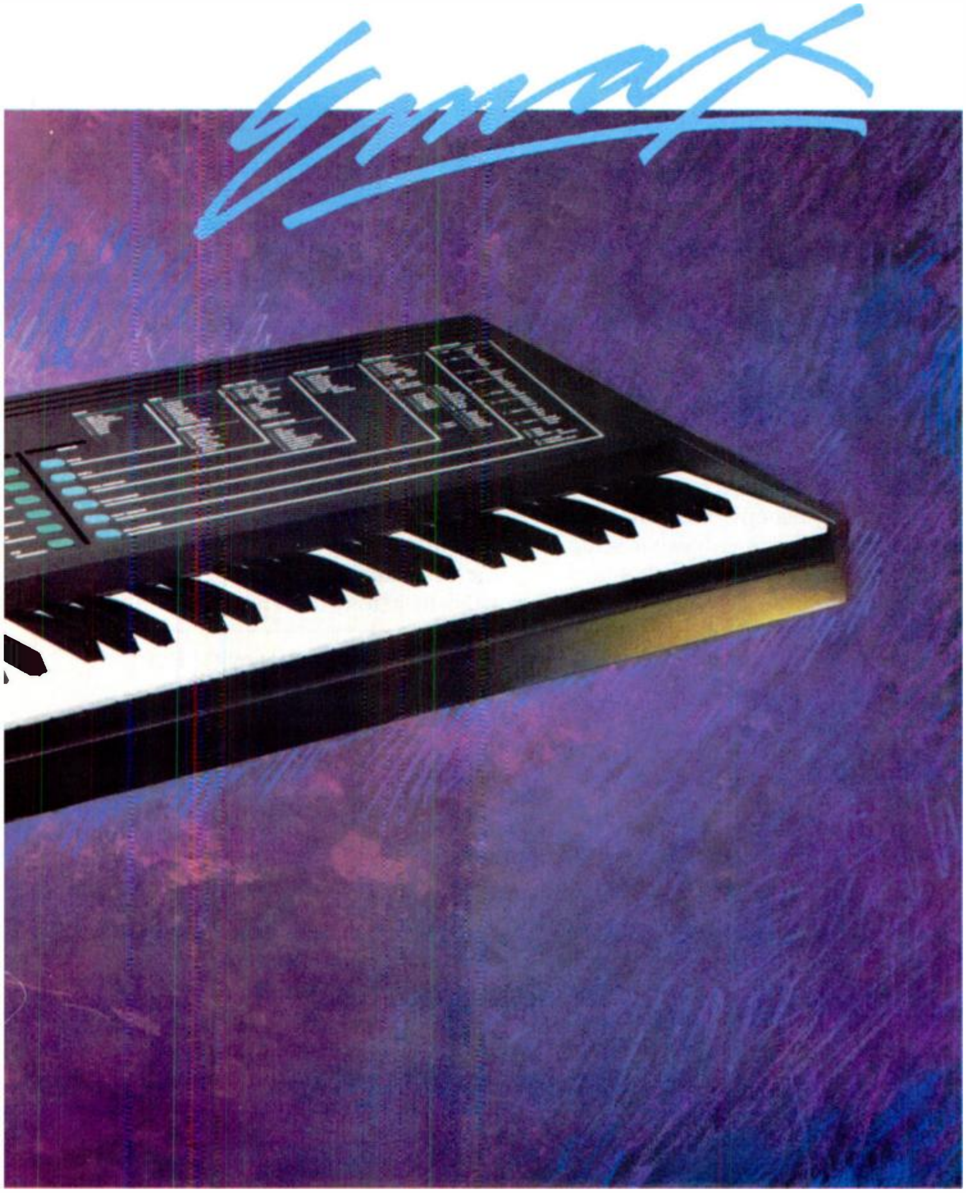
The perfect loop

If you've been frustrated in your search for a glitch-free loop, search no longer. Emax has AutoLoop™—a feature E-mu invented that ingeniously enables Emax to help you locate the best possible loop points.

But the magic doesn't stop there. With Emax you can even loop the unloopable. How? Our new Crossfade Looping.™ Which digitally modifies your sound, smoothing it around the loop points, to eliminate even the smallest glitches.

Control at your fingertips

To ensure that you maintain total control, Emax's keyboard assignment scheme lets you place sounds wherever you want them — up to 100 on the keyboard at one time. And our Dual Sample Mode™ enables each Emax voice to consist of *two* individual samples. (Think of them as the equivalent of two



VCOs on an analog synth.) What you gain is a whole new range of effects — stacked, chorused or doubled sounds — with *no* decrease in polyphony.

What about a sequencer? Consider Emax's polytimbral, multi-track, MIDI sequencer. With SuperMode™ it's powerful enough to let you download complete sequences from any dedicated sequencer or software package. So you can carry around complex sequences without having to lug around a ton of extra gear.

And if you think you know what an arpeggiator is, think again. You haven't experienced anything like the magic of Emax's sophisticated arpeggiator.

You also haven't experienced anything like our RS 422 interface for high-speed computer data transfer. Put this together with the Emax Sound Designer™ software and you wind up with a remarkably powerful digital music system with a data transfer rate that's 17 times faster than MIDI. So you can spend your time working with sound. Not waiting for it.

Stretch your capabilities with our rack

Want to add the power of the Emax to your current MIDI set-up? Consider the Emax Rack. All the capabilities of the Emax keyboard in a compact rack-mounted package.

Or add an Emax Rack to your Emax keyboard. With our MIDI Overflow Mode™ you can link two Emaxes for true 16 channel capability. And Emax accepts a full seven octaves of MIDI control.

While ideal as a keyboard expander, the Emax Rack also brings the power of sampling to anyone with *any* kind of MIDI controller. So it can deliver sampling capabilities to a MIDI guitar. Or function as the heart of a digital electronic drum kit.

Affordable magic

So what price magic? Let's just say you'll be amazed at how easy it is to afford this much power. Which is why you should rush out to your local E-mu Systems dealer for a complete demonstration. Now.

See and hear the magic.

Then practice some magic of your own.

E-mu Systems, Inc.
applied magic for the arts

1600 Green Hills Road
Scotts Valley, CA 95066
408.438.1921

The Emax Rack *— The power of Emax sampling for any MIDI controller.*

Confused about the different ways that today's synthesizers generate sounds? There is a difference between tone generation methods, as you are about to discover.

Electronic Tone Synthesis

BY ROBERT CARR

Additive. Sampling. Subtractive. FM. Phase Distortion. Vector. These methods of sound synthesis give us practically unlimited freedom to express creativity through unique tones and effects. At the same time, the technology has developed so quickly that many people feel overwhelmed by the wealth of available options.

To help clarify matters a bit, here's a brief overview of the main approaches to sound generation used in today's synthesizers. We'll assume that you have a basic understanding of terms like "sine wave," "overtones," and "harmonic series." If these concepts aren't clear to you, or you need to brush up a bit on basics, see the sidebar "Taking Tones Apart" on page 59. Now, on with the overview.

ADDITIVE SYNTHESIS

If you're familiar with the drawbar concept of tone production made famous by Hammond Organs, you've already got a good grasp of how this approach works. Drawbars are the mechanical equivalents of slide pots that control the individual levels of several sine wave tone generators; pulling out different combinations of drawbars produces different types of timbres.

The notes for a typical nine-drawbar setup were chosen to represent (from left to right on the top of the organ) the harmonic tones produced by an acoustic pipe organ. For example, with an A 110 Hz fundamental, a nine-drawbar setup would provide the following additional pitches:

Drawbar	Pipe size	Harmonic	Note/Frequency (in Hz)
#1	16′	sub fund.	A-55
#2	$5\frac{1}{3}'$	sub 3rd	E-165
#3	8′	fundament.	A-110
#4	4′	2nd harm.	A-220
#5	$2\frac{2}{3}'$	3rd harm.	E-330
#6	2′	4th harm.	A-440
#7	$1\frac{3}{5}'$	5th harm.	C#-550
#8	$1\frac{1}{3}'$	6th harm.	E-660
#9	1′	8th harm.	A-880

The pitches form a simple harmonic series, with the addition of a subfundamental one octave below the fundamental (#1) and a sub 3rd (#2). Each of the nine drawbars sounds a single sine wave at its given frequency. Pulling out a drawbar increases the amplitude of that sine wave, so by pressing a note on the keyboard and pulling out, say, the third drawbar, you hear the fundamental pitch. Adding more drawbars (harmonics) alters the overall tone; the composite sound becomes fuller and richer, because the extra harmonics interact to produce a more complicated waveform. While this system provides a great deal of flexibility for fine-tuning the tone, there are still limitations.

When playing an acoustic instrument, the harmonic content of each note varies as you play up and down the range of the instrument. In other words, *the amplitude of each harmonic changes as the pitch of the fundamental changes.* The Hammond organ approach, however, produces notes with the *same* type of harmonic content no matter where you play on the keyboard. For example, if you develop an accurate clarinet sound at A-220, the tonal quality will become more and more unnatural as you move further away from A-220 (either upwards or downwards in pitch).

To accurately synthesize an acoustic instrument across the entire keyboard using additive synthesis, you need a large number of sine wave generators that are continuously variable in pitch and amplitude. This approach is not only expensive, but you'd probably spend most of your time programming all the amplitude and pitch changes instead of playing the instrument! Instruments capable of additive synthesis include the Digital Keyboards Synergy, Fairlight CMI, and Synclavier.

SUBTRACTIVE SYNTHESIS

Subtractive synthesis works in the opposite manner of additive synthesis. Instead of adding sine waves together to create the desired tone, you start with a complex waveform that's rich in harmonics, and filter out those parts of the waveform you don't want. Since the harmonic structure of acoustic sounds tends to vary over time, the filter used for subtractive synthesis will usually be controlled via an *envelope generator* so that the filter characteristics can be dynamically varied over time. Thus, for example, a sound can have a bright attack with lots of harmonics, then during the decay the harmonic structure can become less complex. This

Robert "Beau" Carr has been playing music professionally since age 13. He spent five years with an east coast music production company doing jingles, soundtracks, and the like for TV and radio; since 1979, he has concentrated on freelance writing for various corporate projects as well as for the pro audio press. He has a Bachelor of Science in physics and is currently studying for a Master of Science in Educational Computing.

is a property found in many acoustic instrument sounds.

Subtractive synthesis also has its restrictions, because you can only use those harmonics present in the original waveform; however, the advantage of this approach is that it is much less expensive than additive synthesis. As with additive synthesis, this technique does not allow for sophisticated control of harmonic content with respect to pitch. Fortunately, though, many synthesizers that use subtractive synthesis include a *filter tracking* control so that the filter frequency can correlate somewhat to pitch. One typical use of this feature is to have less high frequency content on higher notes to avoid "screechiness" in the upper keyboard range, while retaining a full, bright sound in the lower registers. Popular subtractive synthesis instruments include the minimoog, Roland Super Jupiter, Oberheim OB-8, Sequential Prophet 5, and Korg Polysix.

Another type of synthesis, *Phase Distortion* synthesis, has been popularized by Casio in their CZ series of instruments. This method stores waveforms in computer memory and varies the rate at which these waveforms are retrieved from memory; these variations in playback rate alter the timbre. While this form of synthesis is technically different from subtractive synthesis, many of the programming techniques and sounds are similar to machines that use standard subtractive synthesis.

—page 56

Introduction to Vector Synthesis

BY STANLEY JUNGLEIB

In traditional subtractive analog synthesis, the oscillator module usually mixes together two or more oscillator waveforms to provide a complex timbre. Apart from pulse-width modulation and swept-sync effects, the timbre at the mixer output is basically static. So the job of making the sound more interesting is usually left to the filter and amplifier modules, which are in turn modulated by envelope generators, LFOs, and so on.

However, an analog filter is not the only way to perform timbre modulation. Besides, you may want to have more, or different, harmonics present than are allowed by the guillotine effect of the conventional low-pass filter. If only we could freely define waveforms, and control the oscillator mixture dynamically, then we could specify exactly what harmonics we want and when we want them. But the problem has been how to control multiple oscillators without using so many oscillators and envelope generators that programming becomes overly cumbersome.

Addressing this, Sequential's vector synthesis (VS) is essentially a method of combining extensive waveform choices with a dynamically-controlled mixer. The attractiveness of the technique is as much how easy it is to understand and use, as the astounding timbres it produces.

To fully exploit the sonic power of using four oscillators per voice, Sequential turned to the basic concepts of analytic geometry—where the Cartesian coordinate system provided an elegant solution to the mixing problem. By assigning an oscillator to each of the four poles in a plane, a single point can simultaneously represent the mixture level for all four oscillators. For example, if the mixture point is exactly in the center, you would hear all four oscillators. As the mixture point moves away from center, the oscillators it moves towards become louder and the oscilla-

—page 54

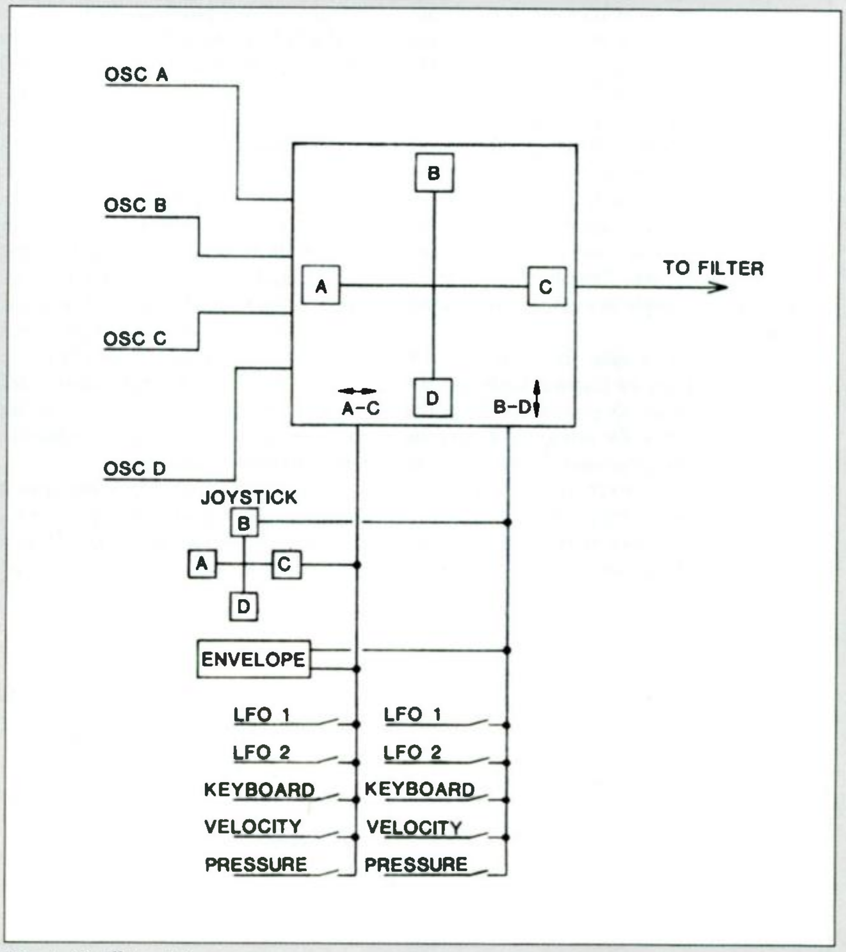


Fig. 1 *Oscillator Mixer*

—*from page 53*, **VECTOR SYNTHESIS**

tors it moves away from get softer.

Fig. 1 shows the basic design of the two-dimensional Prophet VS mixer. One dimension of the mixer (the "X axis"), is the balance of oscillators A and C, and the other dimension (the "Y axis") is the balance of oscillators B and D. Therefore, each mixture point represents a different timbre resulting from a unique combination of the four source waveforms. New waveforms can be created by simply moving the joystick to the desired mixture point. You can store these user waves in RAM and assign them to any oscillator, for remixing into yet more new timbres. One hundred and twenty-eight waveforms are available, comprising 96 factory waveforms and 32 user-defineable waveforms.

The mixer values for each oscillator are represented as percentages and always add up to 100 percent. For example, when the joystick is centered, each oscillator level is 25 percent of the overall mix. With the joystick positioned at an extreme, then a single oscillator can make up 100 percent of the mix. **Fig. 2** shows the mix ratios (A/B/C/D) for a few representative points.

In geometry, a vector describes the movement of a point. The advantage of the coordinate system is that regardless of how complex the desired movement is, it can be described by simply changing only two values, which represent the X and Y axes. Depending on exactly how these values change, the vector can move the point in simple straight lines or in elaborate geometric shapes or curves. This movement can be slow or fast, simple or complex, occasional or constant.

You can modulate the mixture point physically, using the joystick, keyboard, velocity, or pressure. Or you can modulate the mixture electronically, using the LFOs or the mixer envelope generator. In all cases, the output from the mixer section will be one waveform that changes timbre more or less quickly, as the point moves. This dynamic movement of the mixture point results in complex and lively timbre modulation unlike anything heard before.

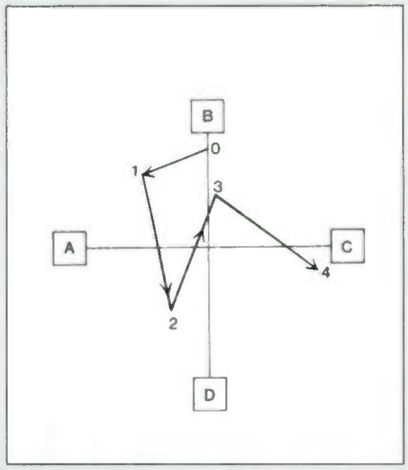


Fig. 3 *Mixer Envelope Example*

The mixer envelope generator serves the rather interesting role of in effect moving the joystick for you during the note, very quickly. In fact, to program the mixer envelope, you simply move the joystick to up to five desired mix positions, and set the rates at which the point will move between them. The main difference between the mixer envelope and the other mixer modulation sources is that the other sources are one-dimensional; they change one value at a time. The mixer envelope, however, is two-dimensional: it supplies separate X and Y coordinates so that vectors can be drawn through the mixer plane, as shown in **Fig. 3**.

When the key is pressed, the envelope moves from point 0 to point 1 at a certain rate, called rate 1. Then it moves from points 1 to 2 at rate 2, and from points 2 to 3 at rate 3. These three vectors can be used to define the attack timbre of the note. They are linear; in other words, within each segment the rate of motion is constant.

While the key is held, the envelope may remain at point 3. Or, by looping, you can continuously sweep through up to three vectors. In other words, the envelope can oscillate between point 3 and any previous point.

Normally, when the key is released, the mix point moves from 3 to 4 at rate 4, unless the alternate release footswitch is held, in which case it moves at rate 4A. In either case, to retain a desired effect the release vector is not linear, but exponential.

Of course with several modulation sources applied to each mixer axis, the movement of the mixture point becomes very complex and hard to imagine. Fortunately, to produce interesting sounds it is not necessary to think about the specific movement of the point. (That is for the computer to figure out!) It is only necessary to learn how to use the mixer modulation sources.

If this all sounds too far out, that's okay. . . sometimes I don't really believe it either. But the sounds produced speak for themselves. A model may help: think of a quadraphonic sound system, with four speakers enclosing a square space. The joystick, of course, is similar to a quad balance control. Each speaker supplies a different timbre, such as an organ on one, strings on another, brass and noise on the remainder. Now suppose that you have in your hand an omnidirectional microphone that picks up the sum of the timbres at any particular point within the field. When you stand in the center, the microphone picks up an equal mix of all four timbres. Now, to understand VS, all you need to do is imagine what the microphone picks up as you stroll or dance back and forth, or run around the room ten times in a second!

Those with some math or electronics background may be better able to intuitively picture the movements which will result from applying one LFO triangle wave to the A-C axis and the other to the B-D axis. Similar to Lissajous patterns, you can make the mixture point move in a diamond through all four quadrants, or trace figure-8s. But at this point no one knows what any specific vector motion will sound like before it is actually mixing specific waveforms, tunings, or detunings. Considering also the wide-open power of user waveform creation, including the ability to use short wave samples from a Prophet 2000 or 2002, suggests the need and opportunity for a great deal of empirical and creative work with the Prophet VS. **EM**

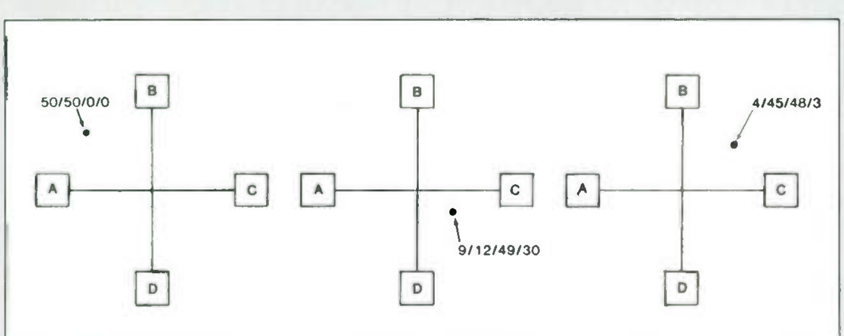


Fig. 2 *Mix Ratio Examples*

***Stanley Jungleib** minored in organ performance at San Jose State University, and was an apprentice pipe organ builder before receiving a B.A. with Honors in philosophy from the University of California, Santa Cruz. He is currently Publications Manager for Sequential; in that capacity, he has written over 60 operation and technical manuals for Sequential equipment.*

—from page 53

Digital Sampling

Faced with the complexity of sound waves, musical engineers started looking for easier and more accurate methods of tone generation. For many years, magnetic recording tape had been a popular audio storage medium, so storing samples of source instruments on tape and recalling them with the press of a key seemed like a logical way to create more realistic timbres. This concept gave birth to the Mellotron (later called Novatron), which contained a tape playback unit for every note on the keyboard. Playing a key put a tape head in contact with a circling loop of magnetic tape, and played back approximately seven seconds of the sampled sound. The machine did enjoy some degree of popularity, but its size, weight, noise (tape hiss), and inability to easily change sounds (you had to change all the tapes by hand) precluded it from winning any lasting success.

When microcomputers became cost-effective for use in musical instruments, engineers tried replacing magnetic tape with computer memory. But to store seven seconds of one sound in a digital form, with good fidelity, requires hundreds of thousands of bytes of memory—and memory is not cheap. To get around this problem, the technique of *looping* was developed to conserve memory.

Let's use a bowed cello note to explain looping. When a note is bowed, the waveform goes through three distinct phases: the attack, the sustain, and the release. (I've omitted any reference to the "initial decay" part of the envelope, because we'll assume that the volume level of a continously bowed string remains constant, and that the string is not being affected by vibrato or other modulation.) The attack may last a third of a second. The release, which can include the room acoustics (i.e. reverberation) as well as the resonance of the instrument's body, could take another two-thirds of a second.

Storing the sustain portion of the sound usually uses up the most memory. To save memory, a sampling device digitally records a small section of the instrument's sustain waveform then replays this section over and over to create a continuous sound. (This process is similar to the effect obtained by looping a piece of magnetic audio tape.) The looping action continues as long as the key is held down, so the note can last as long as you want. Only after releasing your finger from the key does the release section kick in.

The beauty of sampling machines is that pre-sampled tones on disk can be loaded into the unit's memory in a matter of seconds, or you can assemble your own library of sounds from practically any source simply by "recording" them into memory then storing them on disk. Once a sample is in memory, most machines allow for additional manipulation and processing (with options dependent on cost). Some machines can even transfer samples to a larger, outboard computer, where the full power of that computer can be brought to bear on further tailoring the sample. High-end sampling devices even offer *resynthesis*, which is the process of using a computer to analyze a sampled sound. This data can then be used to create additional variations on, or enhancements of, the original sound.

Sampled sounds can usually be transposed over a certain range of the keyboard. However, if only one sampled sound is used as the source, the harmonic content stays the same while the pitch is transposed, thus creating the same situation encountered with additive and subtractive synthesis. However, by *multi-sampling* (taking samples at various intervals—say, one sample for every octave), the sampling instrument will reproduce an acoustic instrument with greater accuracy over a wider range of the keyboard. Each sample, however, uses up memory space so accuracy is a compromise with the sampling time available in the machine.

The Fairlight and Synclavier can both provide sampling and re-synthesis; there are also numerous dedicated sampling devices such as the Emulator II, Kurzweil 250, Ensoniq Mirage, Akai S-900, Korg DSS-1, Roland S-50, Prophet-2000, etc.

FM Synthesis

At first glance, FM synthesis resembles additive synthesis, but there is a significant difference. Like additive synthesis, FM synthesis combines pure tones (sine waves) to build more complex waveforms. But the *way* in which these sine waves are combined differs. Before going any further, though, let's examine the terms Yamaha uses to explain this process.

An *operator* consists of a digital sine wave oscillator and associated digital envelope generator that controls the oscillator's amplitude. An operator can have multiple inputs, but only one output (see Fig. 1). The input accepts Pitch Frequency data and Modulation data; these direct the oscillator to create a particular

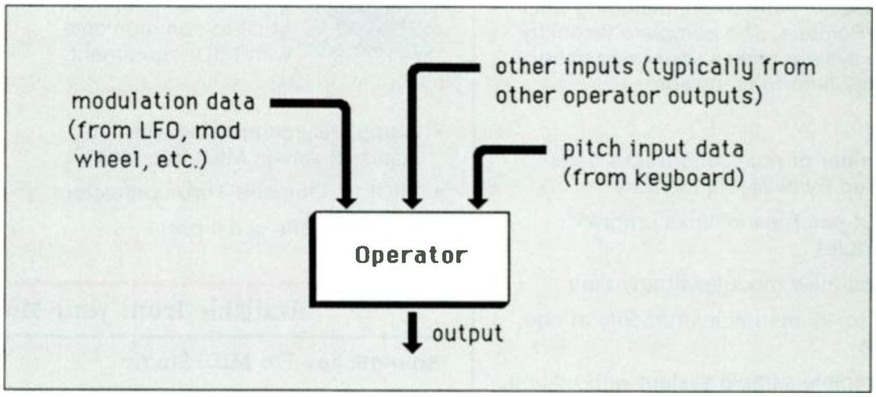


Fig. 1

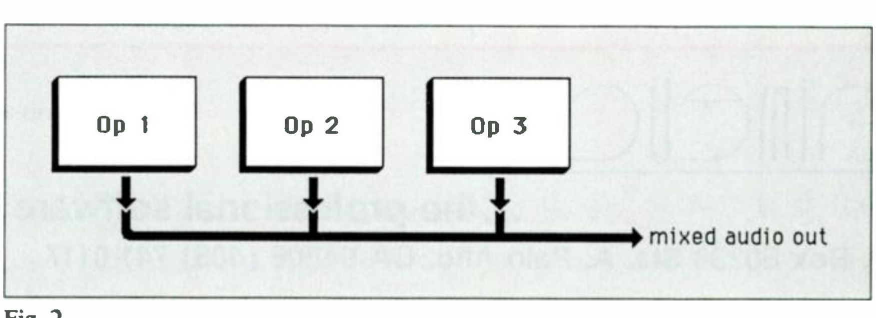


Fig. 2

pitch, whose amplitude with respect to time (dynamics) are shaped by the envelope generator according to the player's specifications.

Two or more operators can be used together in various combinations called *algorithms*. (The DX7, for instance, has six operators that can be combined into 32 algorithms.) When two or more operators are combined into an audio output without passing through another operator or being fed by another operator, the operator pattern or layout within the algorithm is called a *parallel* configuration (**Fig. 2**). This is just like additive synthesis; you hear one or more sine waves being added together, so the result is similar to combining one or more Hammond organ drawbars (although a DX7 offers much more control over the dynamics of each "drawbar").

A *series* configuration of operators can create a more complex-sounding algorithm. With a series connection (**Fig. 3**), the output of one operator (i.e. operator #2, which we'll call a *modulator*) feeds directly into the input of another operator (i.e. operator #1, which we'll call a *carrier*). The carrier produces the audio tone we hear, while the modulator influences the overall timbre according to the modulator's level and frequency. The greater the degree of modulation, the greater the change in overall timbre compared to the sound of the carrier without any modulation.

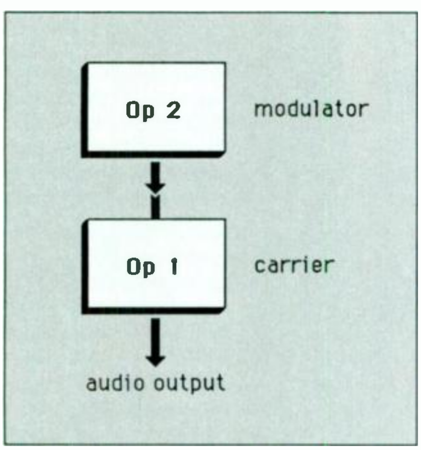


Fig. 3

Generally speaking, if an operator acts as a carrier in a given algorithm, its envelope controls the amplitude of the note. If an operator acts as a modulator, its envelope controls the timbre. So by increasing the output level of the modulator (operator #2) going into a given carrier (operator #1), you increase the number of harmonics present, and extend the bandwidth of the voice, which makes it sound more brilliant. Note that several operators can be combined in series/parallel configurations to create highly complex sounds (**Fig. 4** shows one such algorithm).

With the DX7, each oscillator has its own eight-parameter envelope generator. This provides control over four amplitude levels of a sound (the beginning of the note, the ending, and two points in between) and the rate at which the level climbs or falls to and from these four points. This flexibility means the harmonic content of the tone you create can be programmed to change over time, just as a plucked string changes its overtones as the note decays.

THE TEN BEST AMPLIFIERS YOU'VE EVER HEARD

Programax™ 10.

The Programmable Amplifier

Build a sound. Any sound. Programax 10 will deliver.

Store the sound in memory. Programax 10 will remember.

Build another sound, another program. Store the program. You don't have to be a computer wizard. Programs are easy to create. Simple to store. Effortless to modify. A snap to recall. Your sounds will be there when you need them.

Imagine the possibilities.

Call up a sparkling-clear rhythm sound. Programax 10 delivers. Ask for monster-metal distortion. Programax 10 responds at the touch of a switch. Recall a singing heart-stopper overlaid with your favorite effects, or a compressed fat midrange sound with a bit of reverb. Your sounds. They're all there. Instantly.

There's more. Programax 10 is remote-MIDI capable. Programmed sounds can be recalled from any MIDI program source, such as Peavey's new RMC™ 2000 Remote MIDI Controller. MIDI makes it possible. Programax 10 makes it happen.

Programax 10.

Another first.

From Peavey.

HandCrafted in the USA

PEAVEY®

711 A Street / Meridian, MS 39301
(601) 483-5365 / Telex: 504115

WRH

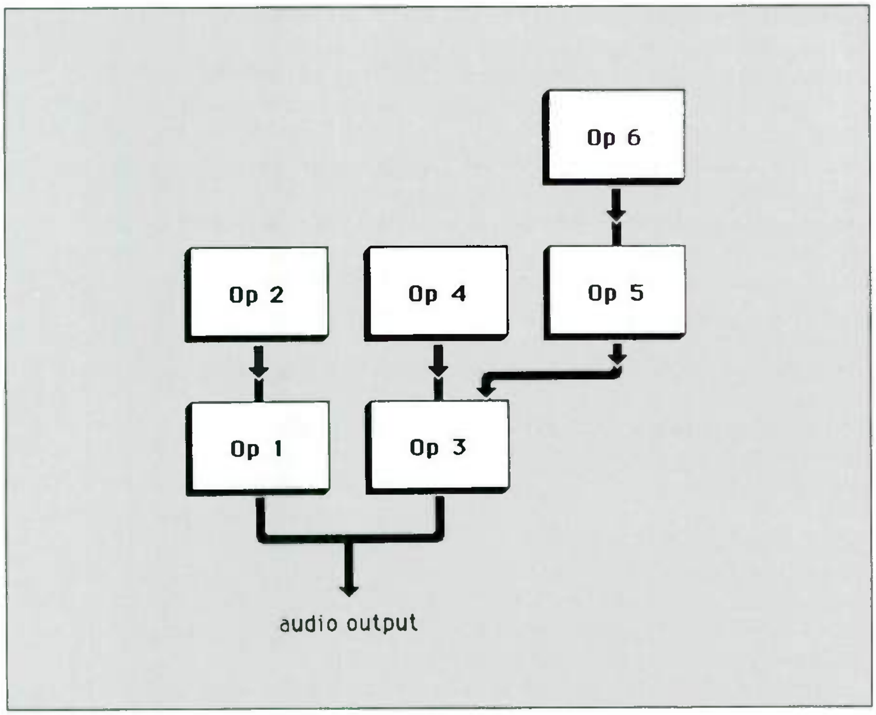


Fig. 4

Most FM synthesizers are made by Yamaha, who are primarily responsible for popularizing this technique. However, the Synclavier offers FM capabilities, and the Oberheim Xpander offers limited FM effects as well.

What Does All This Mean?

It's important to remember that no technique is inherently better or worse than any other. In fact, since each technique produces its own unique effects, musicians will often use several synthesizers-subtractive, sampling, FM, whatever—to obtain the widest possible palette of sound. The more you use various technologies and the better you understand how they work, the easier it will be to choose the right sound for the right applications. Hopefully this rather brief introduction will pique your curiosity and inspire you to fully exploit the sound capabilities inherent in different methods of tone generation. EM

Taking Tones Apart

Consider two people singing the exact same note in the same way. How can you tell the singers apart? Or tell the difference between a flute and a clarinet? Or a car engine and a truck motor? The answer lies in the components that make up the tone or timbre of the note that sounds like a single pitch.

Suppose these two people each sing an A vibrating at 220 cycles per second (one octave below A-440). Although you primarily hear the A-220 pitch (which we'll call the fundamental), there can be many other pitches that sound at the same time. For convenience, let's call these other pitches "overtones."

The overtones are not obvious, because they're very soft when compared to the level of the A-220 primary pitch. Yet these overtones have a strong effect on the sound you hear. Certainly, they add some volume to the overall sound, but primarily they affect the tone color or *timbre* (pronounced TAM-ber). A sound's timbre is what lets you differentiate one instrument from another, or one singer from another.

Overtones and Harmonics

As previously noted, overtones are all other pitches that occur at the same time as the fundamental pitch. Instruments such as drums and gongs tend to produce a cluster of overtones; this complexity sometimes makes it difficult to identify an exact pitch. To further complicate pitch identification, these instruments often produce harmonics that are not an exact multiple of the fundamental frequency. By comparison, instruments that produce more definite pitches have overtones that tend to sound according to a predetermined arrangement called the "harmonic series." (For an example of a harmonic series, refer to the section on additive synthesis in the main article.)

The overtones in the main harmonic series are multiples of the fundamental. The fundamental is also called the first harmonic. The second harmonic is always twice the frequency (an exact multiple) of the fundamental, and is an octave higher. The third harmonic is always three times the frequency (another exact multiple) of the fundamental and always sounds like a fifth of the scale, but an octave and a fifth higher than the fundamental. The fourth, fifth, and sixth harmonics are four times, five times, and six times the fundamental frequency, respectively. This multiple relationship continues for all the higher harmonics.

Building Blocks of Sound

If you analyzed the components of any particular sound, you'd find the basic building block is a type of vibrational motion called a *sine wave*. A true sine wave produces no harmonics; all its energy is concentrated at the fundamental frequency. (For more information on the mathematics behind a sine

—page 60

—*from page 59, TONES*

wave, refer to any good acoustics or physics textbook.) Adding together enough sine waves of various pitches and amplitudes can create just about any type of sound you could want—but keep in mind that the tone of an instrument changes in complex ways as the pitch of the note changes.

Acoustic instruments have a harmonic *signature* (a characteristic tone) that results from several factors, such as the body shape of the instrument and the qualities of the mechanism that creates the sound vibrations (e.g. strings for a guitar, mouthpiece for a saxophone, etc.). These factors naturally support certain frequencies and absorb or dampen other frequencies, whether the frequencies are fundamentals or overtones. For example, a steel guitar string may produce more overtones than a nylon string; a violin body will produce a different set of, and more, overtones than a clarinet.

Suppose an instrument tends to dampen the sound, for whatever reason, at A-440. If this instrument produces a fundamental pitch of A-110, then the fourth harmonic at A-440 will not be particularly strong. Further suppose that the instrument has resonances at A-220, E-330, and E-660; these will make the second, third, and sixth harmonics respectively of the fundamental appear strong. If the instrument's fundamental pitch is raised an octave to A-220, the fourth and sixth harmonics of the previous note become the second and third harmonics of the new note. Therefore, the new fundamental now has a weak second harmonic since this falls at A-440. This is just one example of how the amplitude of each harmonic can change as the pitch of the fundamental changes.

Some Common Wave Shapes

Combining harmonics in the proper proportions, and viewing these combined harmonics on a device such as an oscilloscope, produces patterns of movement that look like basic shapes—square, rectangle, triangle, and so on. With a little practice, you can learn to correlate the sound to the shape of the waveform, and anticipate how the filters and modulators on a synthesizer alter the shape of the waveform.

If you combine all the odd harmonics (1st, 3rd, 5th, 7th, etc.) with the proper amplitudes, the resulting waveform looks like a square (**Fig. 5**). The sound you'd hear would resemble a woodwind, almost a clarinet. This waveform, by the way, is the simplest one to produce electronically since the instantaneous rise and fall times of the square wave can be produced by a circuit being switched on and off.

A rectangle or pulse wave is a variation of the square wave. Where a square wave has its highest and lowest amplitudes equal in duration, the pulse wave has high and low points that are unequal to each other. The sound of a pulse wave is reedy or nasal, created by the addition of all the harmonics—odd and even.

A sawtooth wave or ramp wave (**Fig. 6**) is also produced by combining all the odd and even harmonics. But in a ramp wave, the amplitude of the higher harmonics falls away much more quickly than for the pulse wave. In fact, the sharper the edges of the waveform, the greater the higher harmonic content. An audible sawtooth wave has a brassy quality and is very full-sounding.

The triangle wave (**Fig. 7**) is similar to a sine wave, but the edges are flattened out and the peaks and troughs have points. The fundamental is very strong, and harmonics in the wave are primarily odd (like the square wave).

Many synthesizers can generate some or all of these standard waveforms. Used by themselves or in combination with each other, these waveforms provide a strong starting point for creating unique tones and effects. Additionally, some synthesizers (such as the Korg DW-8000) use waveforms drawn from acoustic instrument sounds that are more harmonically complex than the basic waveforms described previously. While these do not exactly imitate the sound of the acoustic instrument—there are many factors that make up a sound signature other than waveform—they can produce a useful variation on the common square, triangle, sine, and sawtooth sounds found in traditional synthesizers. —*Robert Carr*

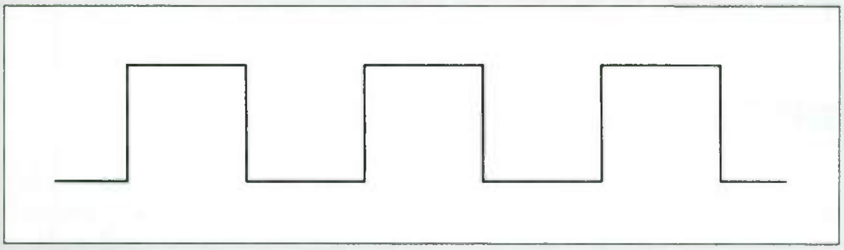


Fig. 5

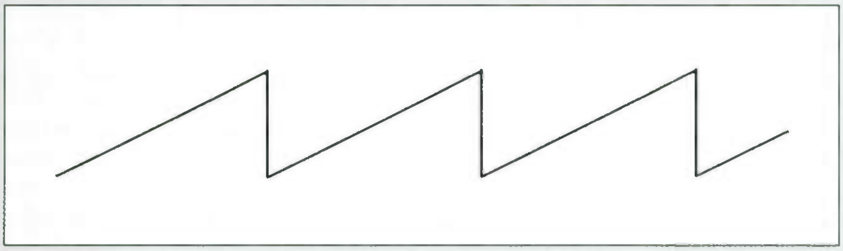


Fig. 6

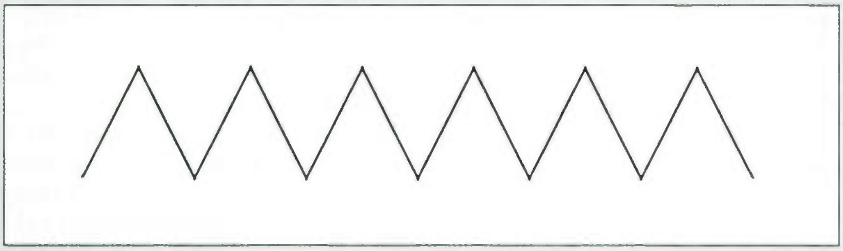
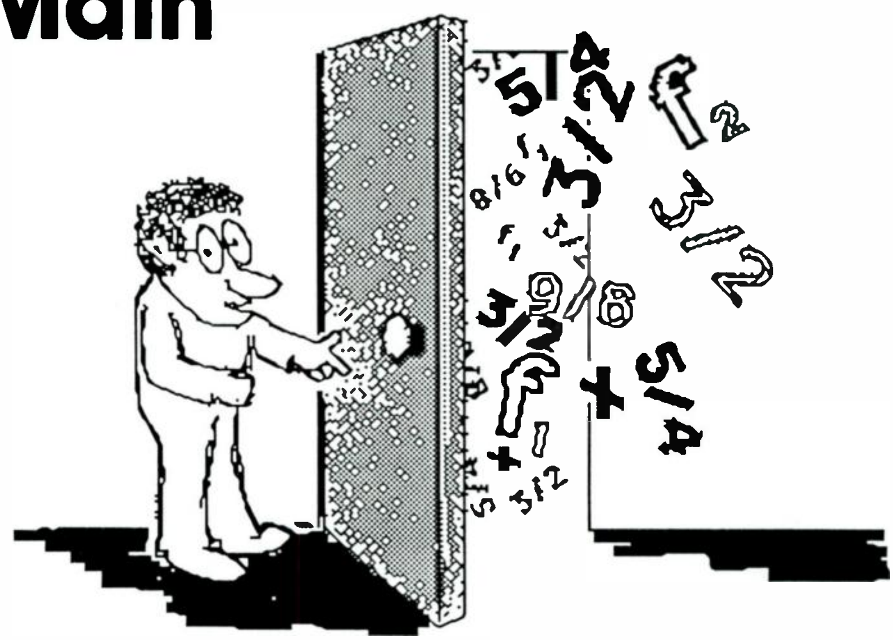


Fig. 7

Scared of all the math involved with scales and tuning? Don't worry—it all adds up to music, and this article explains how it works.

Opening the Door to Music Math



BY VANESSA ELSE

For those of you who know nothing about the mathematics involved in tuning a scale, here's some information I hope will whet your appetite for more. First, a few words in defense of math.

I have noticed that too many artists, writers, and musicians (the so-called "artsy" folks) love to regard technophiles as un-hip. This never made much sense to me since, if it weren't for hi-technology designers, most artists would be painting on cave walls and beating rhythms on a log. The tools we use today (word processors, programmable synthesizers, video cameras, computer graphics generators, amplifiers, etc.) wouldn't exist without electronics engineers, computer programmers, or mathematicians. Besides, those who are *really* hip learn the intricacies of how their tools actually work and therefore, are capable of getting the most out of them.

Vanessa Else, bored with a life of "sex, drugs, and rock & roll," decided to do something socially positive and joined EM *as assistant editor. Presently she plays a variety of musical instruments in* Transmitter, *and in her spare time practices Aikido.*

Perhaps ridiculing techophiles is based in jealousy. Math phobia and confusion runs rampant in U.S. society today. Almost all women are conditioned to believe that understanding math is beyond their intellectual capabilities, which eliminates about 40 percent of the population as potential technoids. In addition, both men and women must face the problem of a decline in the quality of public education. By the time someone is mature enough to actually do something with their life, they've probably been through a few too many incompetent teachers and boring classrooms and never want to look at a math, physics or chemistry text again.

But math is fun and exciting, especially for the electronic musician. Think of it this way. The word "apple" looks nothing like a red, juicy fruit but since we communicate in this abstract form known as English, the letters A-P-P-L-E strung together in that particular order will conjure images of the tasty food item. Thus, "apple" is merely an abstract way of expressing something that has occurred in nature—something that exists.

Mathematics is also a language—a way of communicating something in an abstract form that, on paper, doesn't look at all like what it really represents. It is a language that can be manipulated within its universe of unambiguous definitions in order to make new discoveries and simplify complicated subjects. Math is a computational language that a digital computer, working with the numbers one and zero, can understand.

FREQUENCY

Something that occurs periodically at a specific interval is said to have a *frequency*. For instance, the frequency of the moon cycle is approximately 28 days. Such a low frequency is far too low to be heard by human ears. Similarly, the radio frequencies that are zooming through the atmosphere are much to high for us to hear.

The frequency range of human hearing is usually between 20 Hz to 20 kHz (Hz is shorthand for Hertz which means "cycles per second," and k is shorthand for kilo, or one thousand). This means that a musical instrument producing an identifiable pitch is somehow making the air vibrate in a regular pattern with a frequency roughly between 20 vibrations per second to 20,000 vibrations per second. A particular frequency specifically identifies a particular note. Thus, when someone refers to "concert A" as "A four-forty" (A_{440}) they mean that 440 Hz is the tuning reference called "A"; if you want to be in tune with the rest of the orchestra, you will make your instrument vibrate at 440 Hz when you press the key you associate with A.

Octaves are merely the doubling (or halving) of a particular frequency. Thus, the octave above A_{440} will be a pitch with a frequency of 880 Hz and the octave below will be at 220 Hz. That can be expressed mathematically as:

$$f_1 = 440 \text{ Hz}$$
$$f_2 = 2 \times f_1 = 2 \times 440 \text{ Hz} = 880 \text{ Hz}$$

where f_2 is an octave above f_1.

In a simple example, suppose we have a string vibrating at frequency f_1. If we fret the string at the midpoint, we will hear the octave above. Fretting the string two-thirds the open string distance will generate a fifth; the frequency of the lowest perfect fifth we can play on a string is 3/2 (1.5) times the reference frequency (open string pitch). As we will see, however, an even-tempered fifth is not precisely 1.5 times its reference frequency (see **Fig. 4**) due to certain compromises.

Even-Tempered Basics

Just-intoned scales existed long before the even-tempered chromatic scale was devised. The even-tempered scale is a "one-size-fits-all" kind of scale that doesn't allow for any pure, in-the-pocket harmonies—but it's not a bad fit for most interval relationships and it makes transposing from one key center to another a breeze. It's really a rather clever solution to many of the problems inherent in just-intonation (which are beyond the scope of this article) and it has made mass production of standardized acoustic instruments possible. For example, if a pianist from town A is going to play with a horn player from town B, they better have the same notes (pitches/frequencies) available on their respective instruments when they get together or the audience will go home with a headache.

Since many acoustic instruments must be tuned to discrete frequencies (with unfretted string instruments a notable exception), a standard scale was adopted so musicians could play the same note frequencies on all different instruments. Unfortunately, this limitation locked the Western music world into one standard scale, that of 12-tone even-temperament. However, computerized instruments, which are capable of retuning keys at the touch of a button, will help to expand the tonal resources of the Western music world.

Even-tempered tuning, which is the scale used by every symphony and top-ten band in the country, is based on an irrational number relationship. An irrational number is a number that cannot be expressed as an integer or a quotient of integers. Integers are whole numbers such as 1, 2, 3, etc. and quotients of integers are also known as ratios, or fractions (3/2, 15/16, 5/12, etc.). For example, pi (π) is an irrational number representing a quantity approximately equal to 3.14159265.

In even temperament, all frequencies are related by the irrational number $2^{1/12}$ which is approximately 1.0595 (see **Fig. 1**). The reason for this seemingly odd number is so that, from one octave to another, there will be 12 evenly-spaced frequencies.

Let me explain. Starting with a fundamental frequency, f_1 we figure algebraically that going up a semitone will provide us with a frequency of $f_2 = x \times f_1$ where x is some number relationship. The next semitone is:

$$f_3 = x \times f_2 = x \times x \times f_1 = x^2 \times f_1$$

and the following semitone would be:

$$f_4 = x \times f_3 = x \times x^2 \times f_1 = x^3 \times f_1$$

We keep on multiplying until after 12 semitones we get to a frequency equal to $x^{12} \times f_1$. However, from above we know that the octave above your fundamental

Note Name	Pythagorean	Even-tempered	Just
A	440.00	440.00	440.00
A#	469.86	466.17	458.33
B	495.00	493.89	495.00
C	528.60	523.25	515.63
C#	556.88	554.37	550.00
D	594.67	587.33	586.67
D#	626.48	622.26	618.75
E	660.00	659.26	660.00
F	704.80	698.46	687.50
F#	742.50	739.00	733.33
G	792.90	784.00	773.44
G#	835.31	830.61	825.00
A	880.00	880.00	880.00
(G##)	892.01	All frequencies in Hertz	

Fig. 4 *Comparison of frequencies of three scales built from A 440*

frequency (f_1) will be expressed algebraically as $2 \times f_1$. Equating these two formulas we see that:

$2 \times f_1 = x^{12} \times f_1$
Solving for x:

$x = 2^{1/12}$

In **Fig. 1**, the frequencies for an even-tempered scale have been calculated according to this relationship using A_{440} as the beginning frequency.

Note Name	Formula	Calculated Frequency
A	$f_1 = f_1$	440.00
A#	$f_2 = 2^{1/12} \times f_1$	466.17
B	$f_3 = 2^{2/12} \times f_1$	493.89
C	$f_4 = 2^{3/12} \times f_1$	523.25
C#	$f_5 = 2^{4/12} \times f_1$	554.37
D	$f_6 = 2^{5/12} \times f_1$	587.33
D#	$f_7 = 2^{6/12} \times f_1$	622.26
E	$f_8 = 2^{7/12} \times f_1$	659.26
F	$f_9 = 2^{8/12} \times f_1$	698.46
F#	$f_{10} = 2^{9/12} \times f_1$	739.00
G	$f_{11} = 2^{10/12} \times f_1$	784.00
G#	$f_{12} = 2^{11/12} \times f_1$	830.61
A	$f_{13} = 2^{12/12} \times f_1$	880.00

Fig. 1 *Even-tempered tuning*

PYTHAGOREAN TUNING

Pythagorean tuning is based on the assumption that fifths (F to C, C to G, G to D, etc.) will all have the consonant relationship of 3/2 times the relative fundamental frequency (see **Fig. 2**). Since successive multiplication by 3/2 results in some very high frequencies we need to divide each calculated frequency by two (or four, or some multiple of two) to bring them back down within one octave. Remember, multiplying or dividing a frequency by two provides us with the same note an octave away. However, in **Fig. 2** we see that G## and A, which should be the same note, are *not* the same frequency. G## is 892.01 Hz and A is 880 Hz. Also, major thirds are not "pure"; that is, the relationship between, say, A and C is not a ratio of 5/4 which is the intervallic ratio for a pure major third. A pure major third above 440 Hz would be 550 Hz ($440 \times 5/4 = 550$) and not the 528.6 Hz we see in **Fig. 2**. Hence, we witness some of the problems of alternate tunings.

JUST TUNING

Another way of tuning a scale is to try and make some fifths and some thirds pure. Looking at **Fig. 3**, we calculate the ratios for C# and E (based on A) to form a perfect triad. Remember that a ratio of 5/4 produces a third and a ratio of 3/2

Interval Relationship Formulas	Adjusted Calculated Ratio	Frequency (in Hz)
$A = f_1$	f_1	440.00
$C\# = 5/4 \times A = 5/4 \times f_1$	$5/4 \times f_1$	550.00
$E = 3/2 \times A = 3/2 \times f_1$	$3/2 \times f_1$	660.00
$D = 2/3 \times A = 2/3 \times f_1$	$\times 2 = 4/3 \times f_1$	586.67
$B = 3/2 \times E = 3/2 \times 3/2 \times f_1 = 9/4 \times f_1$	$\div 2 = 9/8 \times f_1$	495.00
$F\# = 5/4 \times D = 5/4 \times 2/3 \times f_1 = 10/12 \times f_1$	$\times 2 = 5/3 \times f_1$	733.33
$G\# = 5/4 \times E = 5/4 \times 3/2 \times f_1 = 15/8 \times f_1$	$15/8 \times f_1$	825.00
$D\# = 3/2 \times G\# = 3/2 \times 15/8 \times f_1 = 45/16 \times f_1$	$\div 2 = 45/32 \times f_1$	618.75
$F = 5/4 \times C\# = 5/4 \times 5/4 \times f_1 = 25/16 \times f_1$	$25/16 \times f_1$	687.50
$C = 3/2 \times F = 3/2 \times 25/16 \times f_1 = 75/64 \times f_1$	$75/64 \times f_1$	515.63
$A\# = 5/4 \times F\# = 5/4 \times 5/6 \times f_1 = 25/24 \times f_1$	$25/24 \times f_1$	458.33
$G = 3/2 \times C = 3/2 \times 75/64 \times f_1 = 225/128 \times f_1$	$225/128 \times f_1$	773.44

Fig. 3 *One form of just tuning*

Note Name	Ratio Formula	Calculated Frequency	Adjusted Frequency
A	$f_1 = f_1$	440.00	÷ 1 = 440.00
E	$f_2 = 3/2 \times f_1$	660.00	÷ 1 = 660.00
B	$f_3 = (3/2)^2 \times f_1$	990.00	÷ 2 = 495.00
F #	$f_4 = (3/2)^3 \times f_1$	1485.00	÷ 2 = 742.50
C #	$f_5 = (3/2)^4 \times f_1$	2227.50	÷ 4 = 556.88
G #	$f_6 = (3/2)^5 \times f_1$	3341.25	÷ 4 = 835.31
D #	$f_7 = (3/2)^6 \times f_1$	5011.86	÷ 8 = 626.48
A #	$f_8 = (3/2)^7 \times f_1$	7517.81	÷16 = 469.86
(E#) F	$f_9 = (3/2)^8 \times f_1$	11276.72	÷16 = 704.80
(B#) C	$f_{10} = (3/2)^9 \times f_1$	16915.08	÷32 = 528.60
(F ##) G	$f_{11} = (3/2)^{10} \times f_1$	25372.62	÷32 = 792.90
(C ##) D	$f_{12} = (3/2)^{11} \times f_1$	38058.93	÷64 = 594.67
(G ##)	$f_{13} = (3/2)^{12} \times f_1$	57088.39	÷64 = 892.01
A	$f_{14} = 2 \times f_1$	880.00	÷ 1 = 880.00

Fig. 2 *Pythagorean tuning*

produces a fifth. To find the ratio for D, we multiply the fundamental frequency, A, by 2/3 (the inverse of 3/2) because D is a fifth below A. We have to do some octave adjustment as we did in Pythagorean tuning in order to produce the frequencies within one octave.

Summary

There are many ways to tune a scale in addition to the three I have presented, and you don't have to be limited to 12 tones per octave. However, some methods are very complicated. As we can see, even-tempered scales are the easiest to put into a formula. For instance, to calculate any scale degree (n) our formula for even-temperament would be:

$$f_n = f_1 \times 2^{(n-1)/12}.$$

This is very easy to program into the software of a digital synthesizer. Things are not so easy in just intonation. This difficulty is perhaps the reason that so many computer instrument developers have avoided the issue and only provide even-tempered tuning for their products. Another reason is that most musicians (as well as most people) are just plain lazy, and the way to the pop charts is by imitation of what exists rather than experimentation of something new. Therefore, it's often not worth the time for a manufacturer to develop the software to support alternate tunings when not many people are willing to pay the extra cost. Thankfully there are innovators already breaking from the mold, and soon, the new and interesting tones of alternate tunings will be in the air.

References

For those of you who want to learn more about this subject, refer to any of the books listed in David Doty's article "What Is Just Intonation?" in this issue. Additional info can be obtained in:

Backus, John G. *The Acoustical Foundations of Music*. NY: W. W. Norton, 1977.

Benade, Arthur H. *Fundamentals of Musical Acoustics*. NY: Oxford University Press, 1976.

Hall, Donald E. *Musical Acoustics*. Belmont, CA: Wadsworth Publishing Co., 1980.

Lloyd, L. S. and H. Boyle. *Intervals, Scales and Temperaments (Revised Edition)*. (London: Macdonald & Jane, 1979)

EM

So you think you've invented the better mousetrap . . . now find out what it really takes to get the world to beat a path to your door.

So You Want to be a Music Software Company?

BY PAUL D. LEHRMAN

Making and selling music software is like nothing else. Unlike the record business, you can't just produce something and forget about it—the field is so volatile, you need constant direct feedback from your end users in order to upgrade your product and get ideas for new ones. Unlike business software, music software tends to be purchased by individuals, not according to the recommendation of some committee; this requires dealing with customers on a personal basis. Unlike computers, music software is going to be used for a specific purpose, not a lot of different ones, so how your product meets a customer's specific need is more important than how many bells and whistles it includes.

The music software field is still young, but already companies with bad products, and those with good products but bad image or distributing, are falling by the wayside. Music programs are not big-ticket items—most companies can't just sell a few, take the money, and go home—so its customer base has to keep growing or a company will fail. And changing technology and tastes have to be considered; companies that lock themselves into a closet are likely to end up staying there. As in any other field, the majority of music software startups are not going to succeed. But if you keep your eyes and ears open, your company might be one of the ones that makes it. Here are a few rules, culled from joyous and bitter experience, that might improve your chances of surviving in the real world.

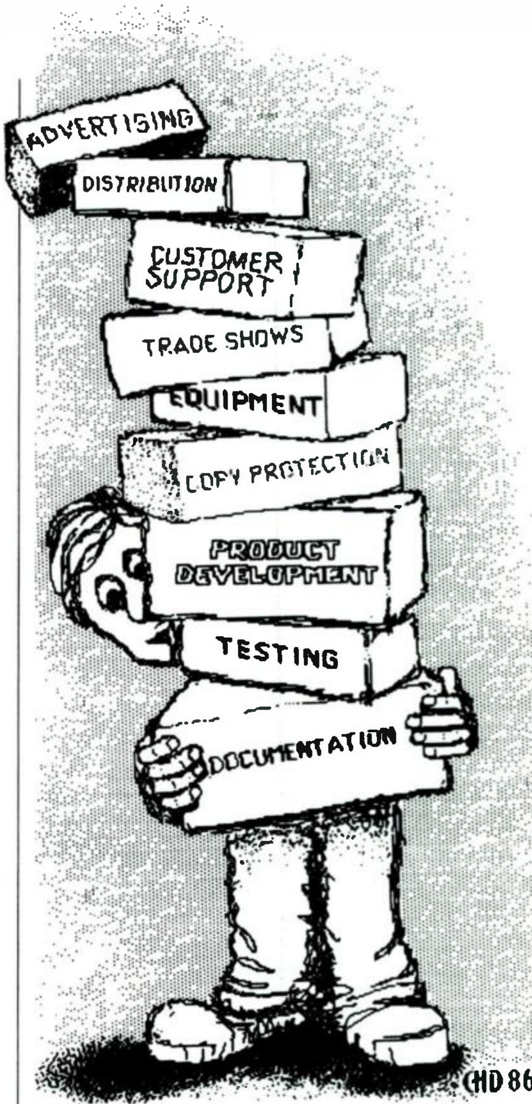
DESIGNING YOUR PRODUCT

First, know your market. *Talk* to people at various levels of the industry, and find out what's missing in their existing tools—how the hardware and software they already have falls short of doing the job they need to do.

You may find that what you want to do has already been done, in which case you'll have to determine whether your product would be redundant. If there are a couple of MIDI sequencing programs for the HAL9000 out there that nobody can stand, and you can do better, then go for it. However, if there are already 42 graphics-based voicing librarians for the ZZ-1200 synthesizer running on the Commander 300 computer, there's no particular reason to develop a 43rd, even if you can prove that it's better than the others.

DON'T FORCE OTHERS TO BUY OTHER EQUIPMENT

. . . or extra memory, or upgrades, or whatever. Sure, any program will work better with 800,000K of internal RAM, but work for the lowest common denominator so that users can get started with the equipment they have. Programs should look good in monochrome as well as color, since not everyone has a color card. If your program can't possibly work with-



out some additional hardware, get a wholesale line on it, and be willing to offer complete packages to customers—even if you don't make a dime on resale.

Similarly, don't write software to work with equipment that nobody has, no matter how much *you* like it. The new Avanti

Paul D. Lehrman *is a musician, producer, programmer, and writer. In 1983 he founded LehrWare to market his own music software, and has since expanded the company to include products from other developers. He served as vice president for product support and distribution for Southworth Music Systems, and has been a development and marketing consultant for several software and hardware companies.*

ZX-68Q computer may indeed be designed perfectly for the program you have in mind, but if only 400 of them have been sold in the Western hemisphere, your little company's software is not going to do much to change that.

A corollary to this is *don't be too dependent on other manufacturers.* That's not easy to do, because someone else builds the computers on which your software is going to run. Any time a computer maker comes out with a new hardware upgrade or a new operating system, chances are something they consider an "improvement" will end up crashing your program. To minimize this problem, try to make your program disks as complete as possible. Don't tell users to "Insert the QRZ8.2 operating system disk in the drive first"—they may not have the QRZ8.2 operating system. Instead, put the operating system on *your* disk, and if you have to pay a licensing fee, so be it. Also, if there are a lot of popular utility programs or peripheral devices that customers might want to use with your software, test them out. If they don't work with your program, try to fix it so they will, and if you can't, then warn customers about the problems so they don't waste their money. No one wants to spend $2,000 on a hard disk drive, only to find that its installation routine erases all their music files.

If you're building hardware, avoid using parts that are only available from one manufacturer. And stay on top of your parts flow, so you don't find yourself with 1,000 unfillable orders while those capacitors are stuck on a slow boat from Singapore.

Beta Testers Are Your Best Friends

Good feedback prior to the general release of a product from knowledgeable users (called beta testers) is probably the most important factor in successful software development. As the developer, you are much too close to your product to know what might be wrong with it; it needs to be placed in a completely alien environment to find out if it really works. Beta-testers not only find bugs, but can provide valuable ideas about what's hot and what's not in your software—pay attention to what they have to say.

Pick beta sites carefully. Testers must understand they're getting an unreleased product, and that if they find something dreadfully wrong, they shouldn't tell the world about it. Go for a good mix of low-budget home studios, superstars' private facilities, and big-budget commercial music houses. And don't expect these folks to work for nothing. Sure, they'll be tickled that you've chosen them, and grateful that they will be the first on their block to get your new system, but they have to earn a living too. Don't demand your product back when the test period is over, unless you're going to replace it immediately with a new version. When the testing is over, treat testers as valuable customers: honor their warranties, and keep sending them updates.

Don't Fall Prey To Programmer's Disease

Programmers, even ones from California, are usually highly motivated people, with lots of drive and creative spirit. As such, they are prone to want to seek out new worlds and new civilizations before they finish building the old ones. This is a manifestation of *programmer's disease,* where cleverness and elegance are the goal instead of robustness and usability. As Tom Waits once said, "A great bar is the lousiest bar in the world if it's closed," and similarly the most gorgeous program ever devised is completely useless if it crashes every hour on the hour or fails to cover basic needs.

If you're the programmer, accept the fact that you're going to make mistakes, and take a healthy attitude towards fixing them. Better still (and much harder, ego-wise), hire someone you trust to look over your shoulder, and *listen* when you're told that something needs changing or fixing.

Getting It Out The Door

Most new software companies will want to do their own distribution, either through music and/or computer dealers, or directly to end users, or both. Normal software distribution channels are not set up well to address music software; they aren't used to dealing with music stores, and their level of customer support will inevitably fall far short of what your program requires. There are a couple of good music-software distributors, but inasmuch as they need to do volume business, they tend to be fairly conservative in the products they pick up. And of course, when going through a distributor your share of the profits will be significantly smaller.

Use Copy Protection Only When Absolutely Necessary

Sure, you don't want your valuable software pirated, but nothing tees off users more than not being able to make backups. Programs, even yours, really do crash, and according to Murphy's Law will do so during the most expensive part of a client's project, and said crash will wipe the program disk and all of the files. Also, professional clients will have hard disk drives, and will want to copy your program onto their hard disk to speed up operations.

There are many solutions to the problem. One company sold a disk that was not copy-protected at all, but it would only work with a specific piece of hardware, and the two were only sold as a package. The incidence of piracy .was zero. Other companies code each disk, so a specific number of copies can be made from it, and no more. Others don't protect the program, but tie it to a protected "key" disk that has to be inserted once a month, or every 50 uses, or whatever. Be clever, and be flexible.

Documentation Is Crucial

Unless you're both a musician *and* a very good writer, don't do your own documentation—you're too close to the product. If possible, bring in someone to write the manual who has never seen the program and will learn the program from scratch.

Include plenty of hints on how to *use* the program, and a comprehensive index or table of contents. Don't be afraid to be redundant, if it means that users will be able to quickly find a crucial bit of information. Good documentation will save you many, many hours on the phone with desperate users. (Note: if you plan to market your software in non-English speaking countries, choose translators who are *native* speakers of the languages in question.)

Show Your Best Face At Shows and Clinics

Trade shows (NAMM expos, regional music and computer fairs, AES conventions, etc.) are a very powerful selling tool. Sometimes, however, they create a Catch-22 situation; if you've done a few shows and then skip one because you don't have anything new, people will wonder where you are, and what's wrong...but you also don't want to go in with a half-finished product that won't be delivered for nine months.

Relax. These days everyone knows that some products take a long time to develop, so if your new program isn't really done, don't be afraid to fake it. But be *realistic* about shipping dates. Dealers get very unhappy when they've committed themselves (and their customers) to buying a product three months down the road, only to be told later that it will take another year.

In any case, try not to announce anything you can't at least demonstrate. Putting a few specs and a price on a piece of paper will only show people that you're a dreamer, unless you have at least a partially-functional prototype to back it up.

Having the right celebrity in your booth will attract customers and can add credibility to your product line, but avoid non-music industry people. TV personalities or Playmates of the Month are lots of fun, but you'll end up with hordes of irrelevant people lining up to get autographs and pictures (or dates), while your serious prospects will get turned off by the crowds and go elsewhere.

Clinics for prospective customers are also great sales boosters, and can provide feedback on how the world views your product. Take advantage of the many user groups across the country, who love demonstrations of hot new stuff. A dealer who is really excited about your product can announce clinics and draw in customers. Another good idea (which requires more effort) is to get a bunch of dealers together in one location (a neutral one, like a friendly recording studio), to show them the best way to sell your product.

> **"Announcing that 'This year's model will make last year's look sick' is something only the automobile industry can get away with"**

Clinics can be expensive, though, so plan them carefully. If you're a good presenter, by all means do the clinic yourself; otherwise, find someone else to do it. And make sure any clinician knows the product inside out—someone who can't adequately answer technical questions will make your company look pretty foolish.

Don't Announce New Products Until You Know When They'll Be Ready

Osborne Computers learned this the hard way—they announced a new computer to replace their older model, and then couldn't get the new ones manufactured on time. Orders for the original model dropped down to zero, dealers were left holding stock they couldn't sell, cash flow came to a screeching halt, and you can imagine the rest. Announcing that "This year's model will make last year's look sick" is something only the automobile industry can get away with.

Be Extremely Careful About Shipping Unfinished Product

Many computer musicians won't mind getting an incomplete product if they're

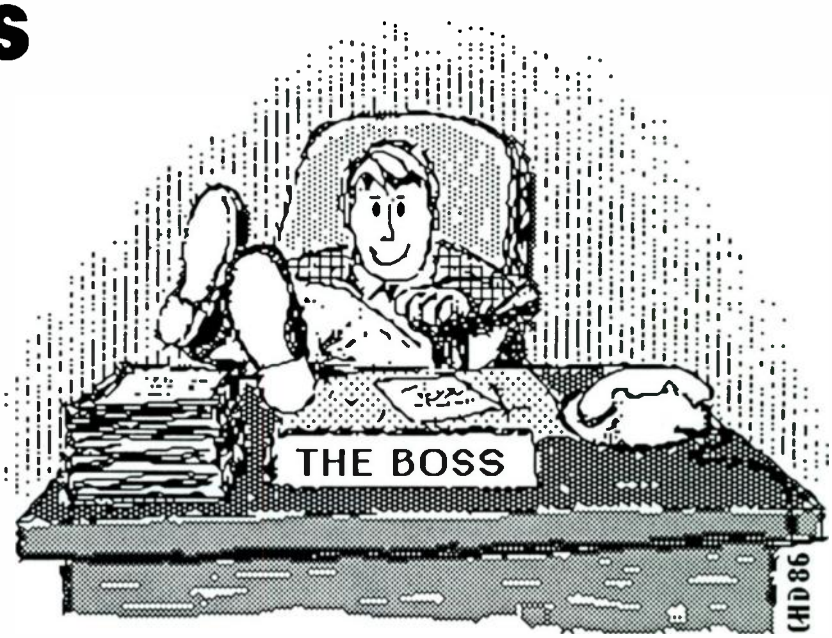
—page 96

If you've always wanted to work for yourself, musical electronics offers many opportunities for self-employment. . .but be realistic about the costs and benefits.

Freelancing in Musical Electronics

BY CRAIG ANDERTON

"If your work isn't what you love, then something isn't right." —Talking Heads



We're alive for only a short time, and those of us who weren't born into wealth have to spend a significant amount of that time working to support ourselves. Life and work are intertwined; if you don't like your work, life will be less enjoyable too.

There are many ways to make a living in musical electronics, but first, some general warnings and tips.

The music business, by and large, does not pay a lot. My theory is that this is because people want to pay you less if they think you enjoy your work. After all, musicians don't "work" music, they "play" it! But if you're like me, you'd rather make $10,000 a year doing something you love than $200,000 a year doing something you despise.

Jobs are not abundant. The music business is fairly small; compared to cars, toasters, telephones, computers, cosmetics, and so on, our favorite industry is almost insignificant.

Job security is virtually non-existent. The music biz is like the fashion biz, and companies that are rolling in the dough one day can be bankrupt by the next NAMM show.

The music business is incestuous. Sometimes I feel the people in the industry are a constant—what changes is their corporate affiliation. It's not unusual for Company A's head of marketing to move over to Company B, and six months later, shift over to Company C. Moral of the story: don't mess up, don't tick people off, and admit when you're wrong. If someone is unethical, mean-spirited, drugged-out, or whatever, the word gets around fast—and it takes a lot more effort to reverse an opinion than it does to form one in the first place.

The above are not reasons to avoid involvement in the music business, just warnings that if you want to get rich quick, you're probably better off elsewhere.

Is Self-Employment For You?

There's a joke that says that if you're self-employed, you only work half-days—because you can do anything you want with the other 12 hours. This is true, especially if you work out of your home. Although some of this time will be spent doing things you like to do, it will also be spent on things you don't like to do (pay bills, keep records, deal with problems, etc.).

Self-employment has other disadvantages. There is no paid vacation, sick leave, company car, health plan, or employer contribution to social security—but there is a *horrendously* complex tax scene where you have to keep detailed records of every financial move you make. True, there are also some totally legal, if not downright encouraged, tax benefits; but you have to really plan to take advantage of these (and hope that the tax law or the interpretation thereof doesn't change—by no means a sure thing). And while you can keep your own hours, by necessity those hours often extend from when you get up to when you go to sleep. Family life can also suffer; a self-employed lifestyle, which may involve frequent traveling, unusual hours, and lots of work, is often not compatible with those who want to lead a "normal" life.

Another problem is that you have to

Craig Anderton has just completed programming and mixdown work for the Tingstad/Brewer/Rumbel album Emerald, *scheduled for October release on Narada/MCA Records.*

learn to live without regular paychecks. This means socking away bucks in savings for those times when jobs are few and far between. Even if you're not making very much, you have to put some of your earnings away as insurance. It's possible to make one or two hundred dollars one month, then have all your receivables come in at once and suddenly, you're thousands of dollars richer. If you crave consistency or security, don't even think about self-employment.

To me, though, the benefits outweigh the disadvantages. Through traveling, I've met some wonderful people and seen some beautiful places. When doing seminars, I'll often have all my expenses paid to go to some interesting locale and talk about fun stuff like MIDI for a few hours. Sometimes after a seminar, all the diehards who have additional questions will head for a bar, restaurant, or whatever and we'll all get into the meaning of life (or at least, of musical electronics). Most importantly to me, though, being self-employed means not being trapped in a predictable situation. Life is constantly changing, sometimes for the better and

> **"If you crave consistency or security, don't even think about self-employment"**

sometimes for the worse, but I can't complain that it's dull. Over the past 20 years I've done such things as consult to major musical manufacturers, write ad copy, score a play, mix and produce albums, play with a band for three years and tour the U.S., write documentation, tape instructional videos. . . and somehow, it all led to me editing this magazine. If you enjoy different experiences, self-employment is great. (A good time to remember this is if you catch the flu, get audited by the IRS, earn $2,700 in one year—which happened to me once and was *not* fun, or deal with companies that take six months to pay your invoice, if at all!)

One more caution: it takes years—I'd say at least five, and more like ten—to become fully established in a field. Patience is not just a virtue, but a necessity.

That takes care of generalities. Now, let's take a quick look at some opportunities for self-employment, and follow that with specific tips on how to land jobs.

Writing

If you're into musical electronics and know how to write, there are plenty of magazines hungry for good material. But don't expect to support yourself by writing! Typical rates for this industry are 5 to 10 cents a word—and magazines don't publish many 8,000 word epics. However, writing is the best form of advertising. It gets your name out into the world and opens up many possibilities, including consulting, documentation, and seminar or clinic gigs. (Even writing a book doesn't provide enough income to support yourself; you have to build up a stable of books so that the winners can make up for the duds.)

The secret to getting published is simple: make your article as easy as possible to publish. Follow the magazine's style and guidelines religiously, choose a can't-miss topic, send files on disk or by modem if requested, think up some interesting graphic concepts, furnish clear diagrams, meet any deadlines, and by all means, edit your work a few times *before* you send it in. Also, try to understand the impossible conditions under which magazines are put together so that you can work *with* the magazine's staff. Many times articles have to be cut by thousands of words due to space problems, postponed until several months in the future, or rushed into print without the opportunity to get back to the author concerning any changes; unfortunately, this type of semi-controlled chaos is the norm, not the exception, in the publishing industry.

Consulting

Consulting is a difficult job and requires both extensive and unique experience in a particular field. Usually you are brought in to consult because a company cannot,

> **"The best way to attract consulting jobs is to acquire a reputation as an expert in some field"**

for whatever reason, pull off a certain project, or feels they lack expertise you might have. The best way to attract consulting jobs is to acquire a reputation as an expert in some field. For example, if you write a dozen definitive articles on the science of pickups, do some seminars on pickups, and write a book about pickups, some pickup manufacturer is going to give you a call someday and want your advice.

Consulting gigs tend to be high-paying, short duration projects, unless the company places you *on retainer* (i.e. sends you a fixed fee each month in return for making your expertise available). Much consulting work involves being a troubleshooter who can solve some particular problem, or help the company make some particular decision, usually under deadline pressure. Consulting tends to be somewhat chancy in that it often involves company politics—you may have to work with someone who was opposed to your being hired—and also, your ideas

Write some absolutely superb, highly educational magazine articles (for EM, naturally). Write a thoughtful, insightful letter to the editor and get it published. If you've come up with some fantastic patches for the MegaGorp synthesizer, attend a local music convention where MegaGorp is exhibiting, and strike up a rapport with the people at the booth. If you're looking for an engineering gig with a company, then tell that company about the fabulous mod you implemented for one of their machines. In other words, if you've got it, flaunt it.

Approach the people with whom you want to do business in a professional manner. If you seek documentation jobs, send a professional-looking proposal to several companies, stating your availability to do documentation. Include a sample of your work, and details on any experiences that might show the company you're the right person for the job. Also, unambiguously describe your rates. This can be by the word, by the hour, or a flat fee. If you're starting out, 5 to 10 cents a word or a flat fee is reasonable. As you garner expertise, and if you can indeed deliver a superior product (with graphics, text on a disk ready for typesetting, and so on), this can go up to as much 25 cents a word. Companies tend to shy away from hourly rates unless they know your work well and know that you can be trusted; documentation rates range from $20 to $60 and up per hour, depending on experience and type of project.

Be sure to mention any other services you can perform in your proposal. I've often been hired because I could provide camera-ready graphics, demonstration cassettes, ad concepts, or whatever in addition to the main job. But don't try to indicate that you're a jack of all trades, or you'll lose credibility. I tend to contract out additional services to other people when possible. It's better to be able to say you work with a great photographer (bring along examples of his or her work) then to try to also be a great photographer yourself. There are exceptions, but focus your abilities on what you do best, and communicate those abilities to your prospective employer.

Aim for long-term relationships with a few key companies or individuals. Undercharge for your first job, and make it clear that you are doing this as a sort of introductory offer. Your first "important" mix session, for example, might be a freebie for a local band just so you can get something on tape for your portfolio. Undercharging takes the pressure off your potential employer, in that if they don't like your work, they will at least not resent you for charging a lot. Then, *do the best job in the world.* This sometimes takes sacrifice. If you're doing a mix and the company runs out of money before you're happy with the mix, then offer to forego some of your pay, or even pay for a couple extra hours of studio time yourself, in order to

> **"Estimate deadlines based on the premise that everything takes longer than you think**

get it right. If you're writing a manual, go over that manual as many times as is necessary to insure completeness. One trick I use is to hire a local musician who knows nothing about the piece of gear to go through the manual and see if it is complete and accurate. If it isn't, you're better off discovering the bugs before sending your work to the company.

Be gracious and forthright at all times. Once you are hired, someone is counting on you. If you're running behind on a project, don't avoid the issue—tell your employer what's going on, apologize for the inconvenience, don't make excuses (that just wastes their time; they don't care whether your car broke down on the way to the airport, that's your problem) but explain why additional time is necessary, and set a new deadline that you can make without fail. Estimate deadlines based on the premise that everything takes longer than you think. Really!! If you give yourself a little slack and get the project in early, they'll love you. If you don't give yourself that slack and get the project in late, trouble.

Everything you put out is a statement. During my ad agency days, I often did radio spots and demo tapes. I exploited my studio production/engineering experiences to send out tape packages that were more of a "production" than those coming out of some other agencies. Tapes were always sent tails out and identified as such; labels were neatly typed, my phone number was prominently displayed in case there were any questions, all technical specs were included (speed, tape type, noise reduction used, etc.), and each tape had test tones at the head as well as proper leadering. I would often include three or four versions of the same commercial recorded at different speeds or with different tape formats for the convenience of the people receiving the tape. Do everything you can to make people *want* to do business with you. The easier you make it for them, the more they'll want you.

If you're writing a manual, include a glossary of terms, or design some really clever patch sheets, or whatever else will make life easier for the customer and impress the company. If you're designing a circuit, specify which parts can be substituted in case of difficulty obtaining parts. Remember—if people don't know you, they will make assumptions based on what they do know. Whenever you put something out into the world, always do the best and most thorough job you can.

Work synergistically. As one example of what I mean, suppose you go out and buy a piece of gear. You might then submit a review for publication on that piece of gear, thus helping defray some of the expenses. If you devise a helpful modification, you could publish that too, or maybe install the modification on units owned by other people. If you come up with a ton of clever applications, you might be able to persuade the manufacturer to pay you to write an applications booklet, or produce a demo tape. And finally, having reviewed the thing, written about applications, and produced a demo tape, some music store will probably ask you to give a clinic on the product. That's a lot of mileage out of one piece of gear!

BACK TO WORK...

I hope the above has been helpful to those who are serious about self-employment in the music field. There are many job opportunities available, and if you're creative, you can even make your own. The whole point is to pick what you like to do, and then do it really well. If you can provide a service that people need, they'll hire you...it's that simple—and that difficult. EM

If you've got better things to do than patch and re-patch MIDI cables every time you want to change configurations, then this is the article for you.

MIDI Switch Boxes

The Magic, The Mystery, but Not Just for Monster Setups!

BY RICK SCHWARTZ

Along with the Magic of "MIDIfication" comes the challenge of making it all work together harmoniously—and a whole new mess of cables to complement your existing AC and audio "spaghetti." Unfortunately, MIDI cannot read your mind, and signal flow must be controlled by the tiresome re-patching of MIDI cables. Although you could daisy-chain MIDI devices together via their MIDI Thru jacks, that seriously limits your flexibility and may create MIDI data distortion (see sidebar); therefore, all but the simplest setups require some type of MIDI switch box for signal routing.

A MIDI Switch Box serves as the heart of your system, and controls the flow of MIDI data from the "mother keyboard" controller to multiple "offspring" or "slave" synths. MIDI Switch Boxes fall into two general categories: *passive input selectors,* such as the Roland MPU-104, and *switchable MIDI Thru boxes,* such as the Roland MPU-105 (see **Fig. 1**). Input selectors are the simplest type of MIDI Switch Box and are necessary when using multiple master controllers. They simply let you choose one of several controllers as the master. Thru boxes let you drive a selectable number of synthesizers at once and are often *programmable,* which means that they include electronic switching and memory to store system configuration setups. These setups can then be recalled at the touch of a button.

HOW TO BUY A SWITCH BOX

All MIDI Switch Boxes have several things in common: input jacks, output jacks, and some type of selector or switch. Prices range from $80 to well over a thousand dollars. High-end units feature programmability, LED displays to monitor system status, and large numbers of MIDI connectors for connecting up multiple instruments. Switch box size is specified by the number of input ports (connectors) and output ports; for example, the Yamaha YME-8 is specified as a 2 × 8 box, which means that it has two inputs and eight outputs. This would allow for two masters and eight slaves.

Before purchasing a MIDI Switch Box, consider your future needs. Even though a switch box may have enough ports to cover every keyboard you currently own, don't forget all the other MIDI products you may eventually acquire such as sequencers, drum machines, computers, effects units, pitch-to-MIDI converters, sync boxes, MIDI mergers, etc. Eventually some, if not most, of these will work their way into your setup and you will want to be prepared. Although you could use some units' MIDI Thru connectors to daisy-chain sub-units as your system grows, this does not provide the same flexibility obtained with a central switch box controlling every MIDI device. Besides, all of those little boxes and AC adapters can get to be a mess.

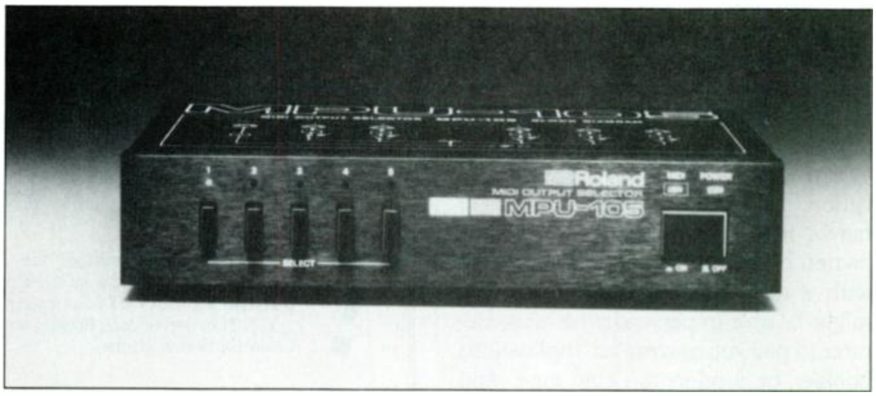


Fig. 1 *Roland MPU-105 switchable MIDI thru box*

AFFORDABLE SOLUTIONS

Although commercially available units start at around $80, you can build your own simple MIDI Switch Box for under $10 (see **Fig. 2**). This circuit is an A/B selector which either switches one output to two inputs, or two outputs to one input, depending on how you patch it. Note

Rick Schwartz works for Serafine FX, whose credits include Poltergeist II, Short Circuit, Star Trek, Tron, *and* Brainstorm. *Rick attended the University of Nebraska and studied Electrical Engineering; he has managed a 24-track recording studio, toured with many national acts, and is currently writing software for the Amiga computer.*

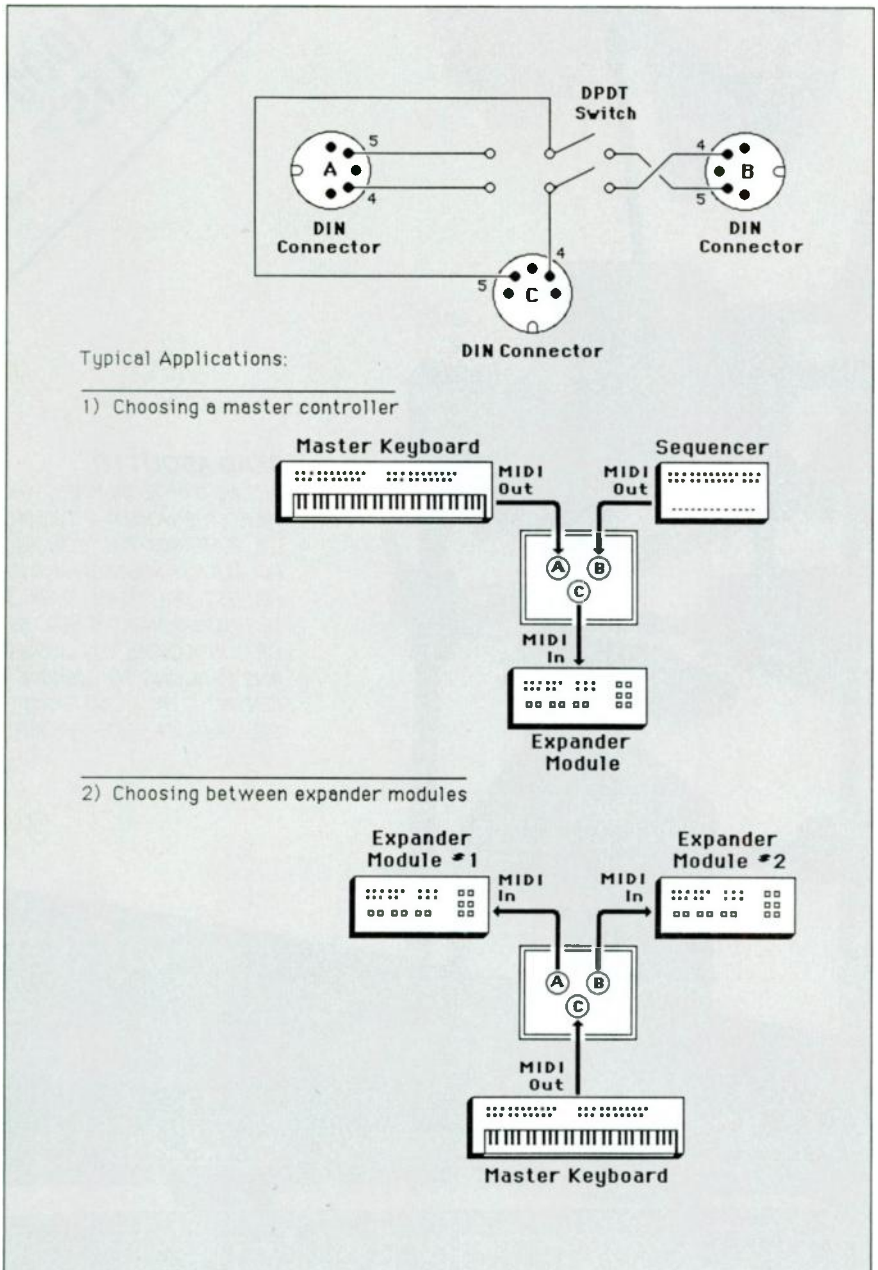


Fig. 2 *A simple MIDI switch box you can build for under $10*

that this device is *passive*, and does not provide any signal conditioning (i.e. buffered outputs and opto-isolated inputs). It *will*, however, free you from some of the burden of repatching MIDI cables.

Fig. 3 shows one possible (and relatively inexpensive) signal routing scheme for medium size setups. In this system, all MIDI Outputs connect to the Roland MPU-104, which selects the desired controller to drive the sequencer input. The companion MPU-105 Output selector determines which slaves will be played by the sequencer.

The Mystery of Programmable Switch Boxes

Programmable MIDI Switch Boxes (MSBs) are electronic patchbays for MIDI data that allow one or more master devices to control any combination of slaves. They include deluxe features such as memory presets, LED patch displays, and other advanced options. Programmable MSBs have the power and flexibility needed for large "MIDI Studio" and live-performance systems that might include several keyboards, drum machines, MIDI-controlled signal processors, computers, etc.

Unfortunately, increased flexibility sometimes means increased possibility for confusion. For example, the 20 character hexadecimal LED display on J.L. Cooper's MSB 16/20 (see **Fig. 4**) has nothing to do with MIDI channel designation or keyboard voice presets. Instead, each of the 20 readouts represents a keyboard (or MIDI device); the number displays what port number is controlling that device. For example, with a DX7 connected to port 1, and all of the LED readouts displaying ones, the DX7 would be the "mother keyboard" and control every keyboard connected to the switch box. Not all switch boxes use the same display scheme as Cooper; 360 Systems' MIDI Patcher displays patch configurations using an array of small LEDs (**Fig. 5**). Interpreting the displays might be confusing at first, but in a little while it becomes second nature—just like working with audio patchbays.

> **". . . all but the simplest setups require some type of MIDI switch box for signal routing"**

Because MIDI Switch Boxes are simply routing devices, you need not always have each keyboard set to a different MIDI channel. For example, you could have two different "masters" transmitting on channel #1, each controlling its own "slave(s)," with no crosstalk when one or the other was selected. Another possibility is to switch an expander module's MIDI In between a computer interface card output and a master keyboard. Thus, you could switch between using the computer to load and save patches, or playing the keyboard to hear what the patches sound like.

Advanced Features

Top-of-the-line programmable units include such features as remote control program change and memory dump capability. Remote control allows you to change switch box programs from any keyboard

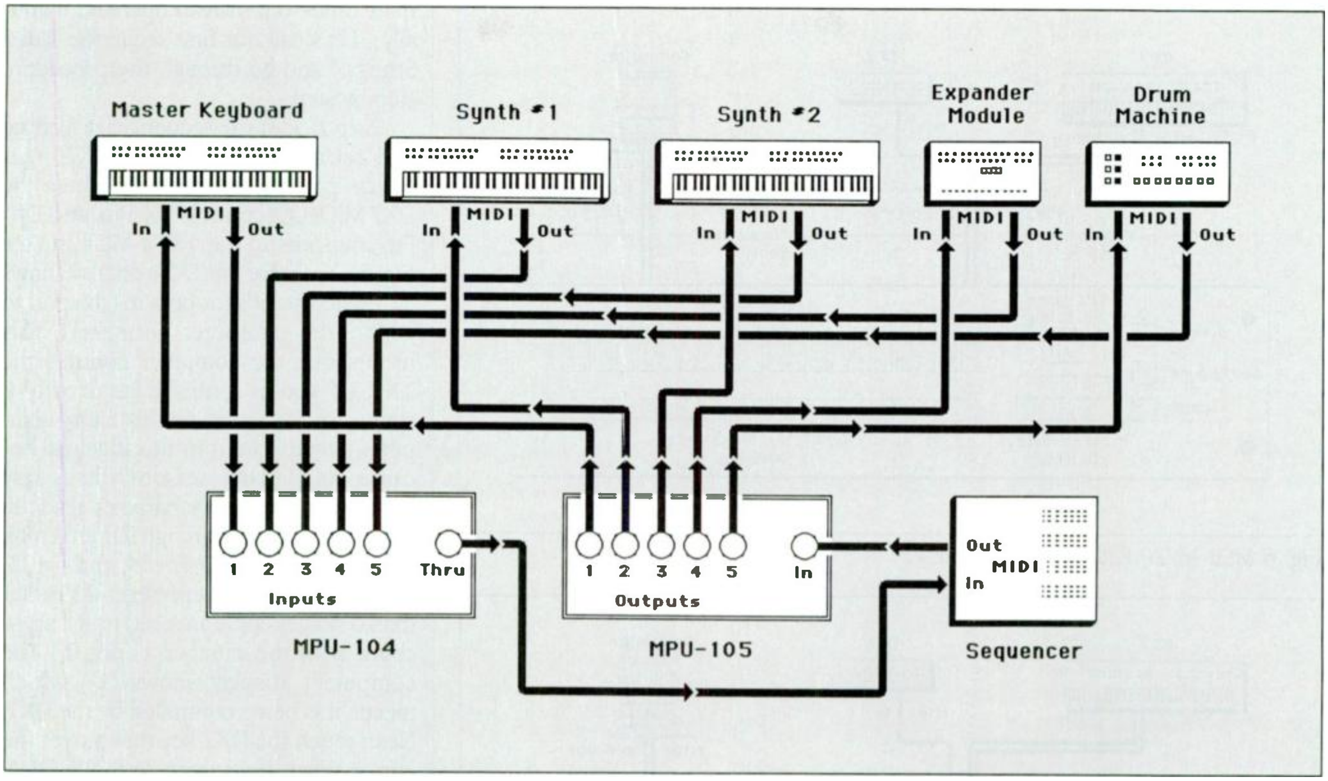


Fig. 3 *A medium-size MIDI routing setup*

that sends out program change data (almost all do). This feature is especially useful for live-performance situations, where you know in advance what combinations of setups you will need. Changing presets on your master keyboard changes the switch box and all slaves to the same preset number (provided they are set to receive the desired MIDI Channel). Thus, you can reconfigure the entire system by pressing one button. Another advanced feature available on some programmable switch boxes is program data dump. This allows switch box patch data to be transferred to a storage device such as the Cooper MidiDisk.

Some switch boxes have intelligent patch changing circuits that prevent notes from being "stuck on." With MIDI systems, notes continue playing until they receive a "note off" command. A "smart" switch box will send an "all notes off" command when a keyboard is switched out of the MIDI data stream.

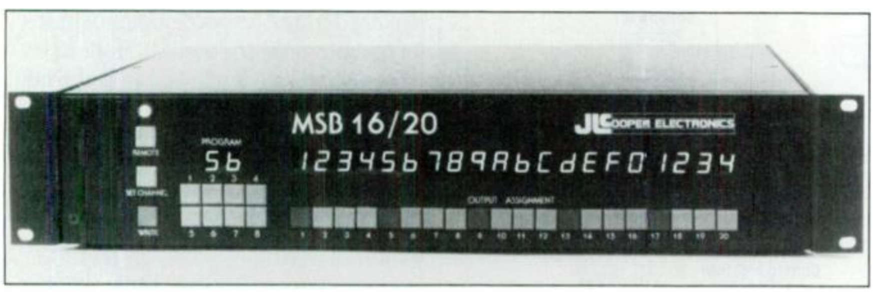


Fig. 4 *JL Cooper MSB 16 in/20 out MIDI switcher*

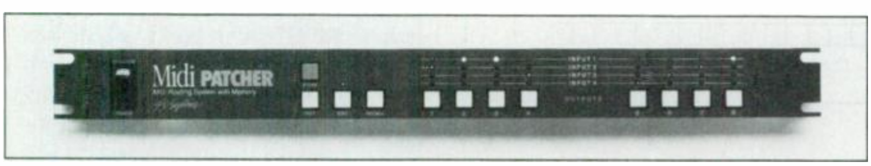


Fig. 5 *The MIDI Patcher from 360 Systems*

Programmable MSBs allow MIDI devices to be linked in series, parallel, or any combination, which allows the use of a single MIDI product on more than one keyboard at a time! For example, an accessory such as a MIDI Channelizer could feed data to two keyboards at once.

Unusual Applications

Imagine having your sequencer automatically load separate groups of voice patches into different keyboards at the touch of a single button. Well, all you need is a programmable switch box with remote capability, keyboard controllable voice librarian software, and a sequencer that can record system exclusive and program change commands. Remember, any type of software that can be controlled by pressing keys on a keyboard can be used with a MIDI Sequencer; as far as the sequencer is concerned, a key driven command "looks" exactly the same as regular note data.

Let's say you are using a Yamaha DX7 and TX7 with DX-Pro software. Turn everything else on before booting up DX-Pro to ensure that the DX7s are set up correctly (memory protect off, etc.). Now set the system to record from the DX7 (note: the MSB should not be set to Re-

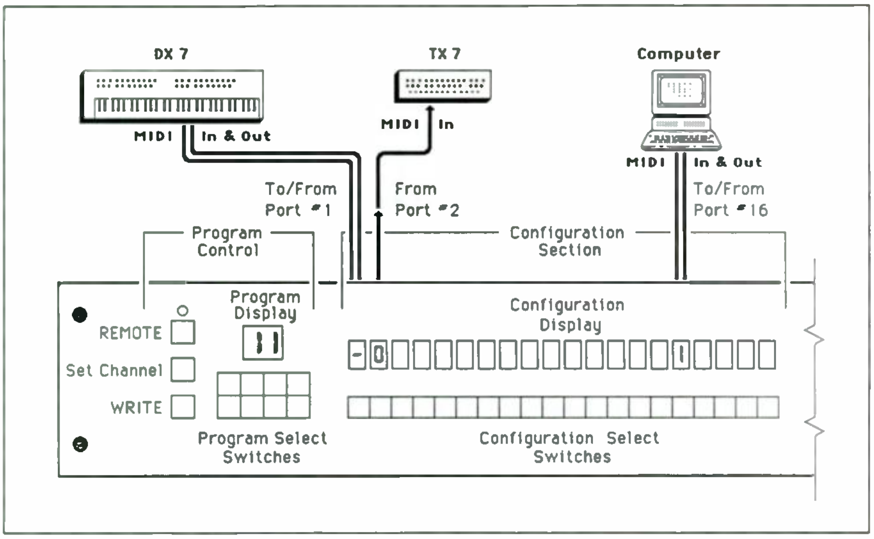


Fig. 6 *MSB 16/20 Patch Configuration #1*

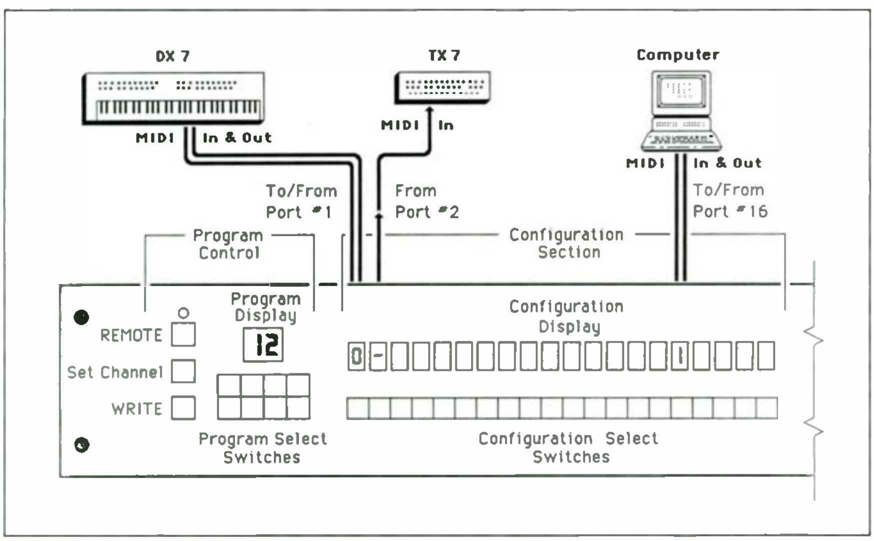


Fig. 7 *MSB 16/20 Patch Configuration #2*

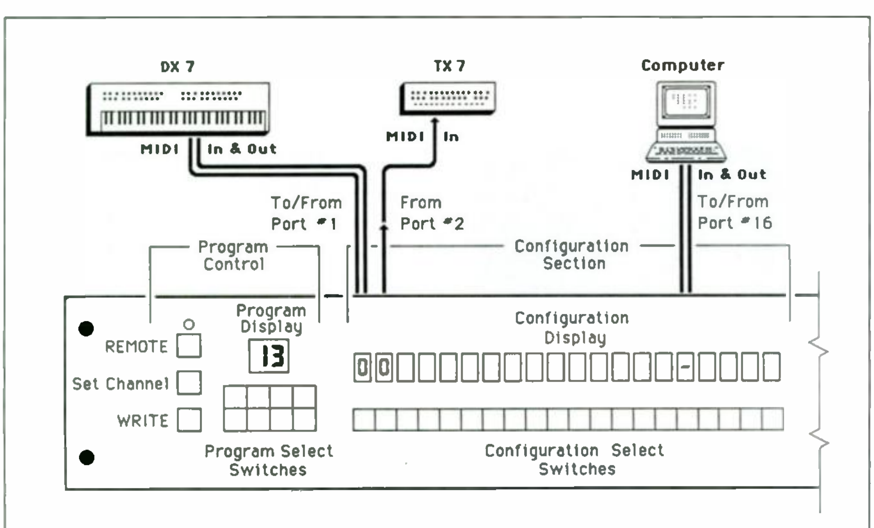


Fig. 8 *MSB 16/20 Patch Configuration #3*

mote Mode but instead operated manually). Let's call our first sequence "Load Strings," and go through the procedure step by step.

Step 1: Start the sequencer recording and select preset 1 on the DX7. This selects patch 1 on the MSB, where the DX7 MIDI Out controls DX-Pro, and DX-Pro transmits to the TX7's MIDI In (see Fig. 6). Note that the TX7's display shows "0," which stands for port 16 (the port to which the computer connects); this means that the computer controls the TX7. (If you're confused as to why 0 stands for 16, remember that many computer circuits count in hexadecimal because, among other reasons, this is easy to show on a single-character readout. Hex counts from 0 through 9 then A = 10, B = 11, C = 12, D = 13, E = 14, and F = 15. In this example, 0 represents 16 rather than 0 since people are used to starting a count with the number 1, not 0.) The computer's display shows "1," which means it is being controlled by the DX7. Next, touch the DX7 key that moves the cursor down the screen to STRINGS A, then hit the DX7 key that sends voice data to the synthesizer. *Step 2:* Press preset 2 on the DX7 to select MSB setup number two (Fig. 7). In this setup, the

MIDI Distortion

Before MIDI Thru boxes were available, keyboards had to be *daisy-chained* together (i.e. the Thru of one keyboard would connect to the In of the next device, whose Thru would connect to the next device's In, and so on), which brought on complaints of various MIDI glitches. These timing glitches were caused by the response times of opto-isolators within the MIDI devices themselves (each MIDI Input connects to an opto-isolator, which couples the MIDI data into the machine). Each successive opto-isolator introduces slew-rate limiting distortion to the MIDI data and in practice, three or four receiving devices is the limit when daisy-chaining. MIDI Switch Boxes do not experience these type of MIDI delay problems due to the fact that a MIDI Switch Box is a Thru box with multiple outputs. Therefore, a single MIDI source can drive many receiving devices with a virtually distortionless replica of the transmitted data.

DX7 controls the computer, and the computer sends data to the DX7. Load another Group (STRINGS B) into the DX7, just as you loaded STRINGS A into the TX7 in the previous step. (Remember, the sequencer is still recording, and therefore keeping track of the keystrokes that tell DX-Pro what to do.) *Step 3:* Now touch preset 3 on the DX7 to select the MSB configuration where the sequencer drives both the DX7 and TX7 (**Fig. 8**). Hit "stop" on the sequencer, and you're finished with the programming mode. *Step 4:* Record a song on the sequencer and append it to your "Load Strings" sequence (you may need to change the MIDI receive channel on the synths before you play back a sequence). Now just hit play on the sequencer; the first part of the sequence will take care of loading your DX and TX with the correct banks of sounds, then the selected composition will play. This technique is especially useful if you change internal voices often yet want to hear a song played back with its proper instrumentation. If you would like to speed up things a bit you can increase the tempo of the sequencer during playback.

To insure that the DX and TX play the desired programs upon receiving a program change command, keyboard presets must be arranged in advance using voice librarian software. However, if you do not have voice librarian software, or do not want to take the time to rearrange your patches, there are several "program change managers" (e.g. the J.L. Cooper MIDI Link or Axxess Unlimited Mapper) that translate an incoming program change command into an outgoing program change number of your choice.

FUTURE PRODUCTS

Since many musicians now own personal computers, it would be great to see MIDI Switch Box software for products such as the Macintosh computer. A piece of hardware with MIDI jacks on it would plug into the back of the computer. MIDI signal flow could be displayed on the video monitor in a very easy-to-read manner, with MIDI Outputs on the left, and MIDI Inputs shuffled on the right to line up with the selected Outputs. MIDI "software cables" could then be effortlessly "re-patched" using the computer's mouse, and stored to memory. The ultimate goal may be to combine a computer-based MIDI Switch Box with other programs, such as voice librarian and keyboard patch change software. An integrated software package of this type could display MIDI signal flow in an easy-to-read manner and provide instant "total system recall."

> **"After discovering what you can achieve with MIDI Switch Boxes, you may wonder how you ever got along without one"**

SUMMARY

If you already own a MIDI Switch Box, you may not be taking full advantage of all its power. If you don't own one, then you probably don't know what you've been missing! After discovering what you can achieve with MIDI Switch Boxes, you may wonder how you ever got along without one. MIDI Switch Boxes allow you to get the most out of MIDI, with a minimum of headaches. EM

If someone keeps feeding you the same old dirty line, clean it up with a few choice components in the right places.

Protect Your Gear from the AC Gremlins

BY JACK ORMAN

Modern electronic instruments are sensitive, complicated devices that depend on a stable and clean source of power. Unfortunately, the playing environment teems with various forms of interference that can hitch a ride on the AC line and sneak into your equipment's power supplies. Motors, relays, and many other devices often generate AC spikes, surges, and noise that can wreak havoc with your gear—or at the very least inject non-musical noise. And a lightning strike, even miles away, can induce kiloVolt spikes through the utility lines. Furthermore, radio waves can creep in by way of the power plug; who hasn't heard a CBer or radio station come in over an amplifier?

Fortunately, you can take some electronic counter-measures against these nasty problems. (Note: no matter how good this circuit is, *nothing* will protect your gear from a direct lightning strike to the power lines, except unplugging it. You should *never* operate your equipment during an electrical storm and power surges can be great enough to fry your gear even if it is off but still plugged in.)

> **"AC spikes, surges, and noise can wreak havoc with your gear—or at the very least inject non-musical noise"**

Metal oxide varistors (MOVs) can clip surges and spikes, thus limiting them to the line voltage or slightly above. Taking care of noise (hash) or radio frequency interference (RFI) is another matter. Small, low inductance ceramic capacitors are virtually open circuits at the 60 Hz power line frequency, but are almost short circuits at the high frequencies where noise and hash reside. This property lets you use caps to take care of both differential and common mode problems. Now, let's put all of this together to create a line filter/ surge protector (see Fig. 1).

For a 10 Amp circuit (suitable for pow-

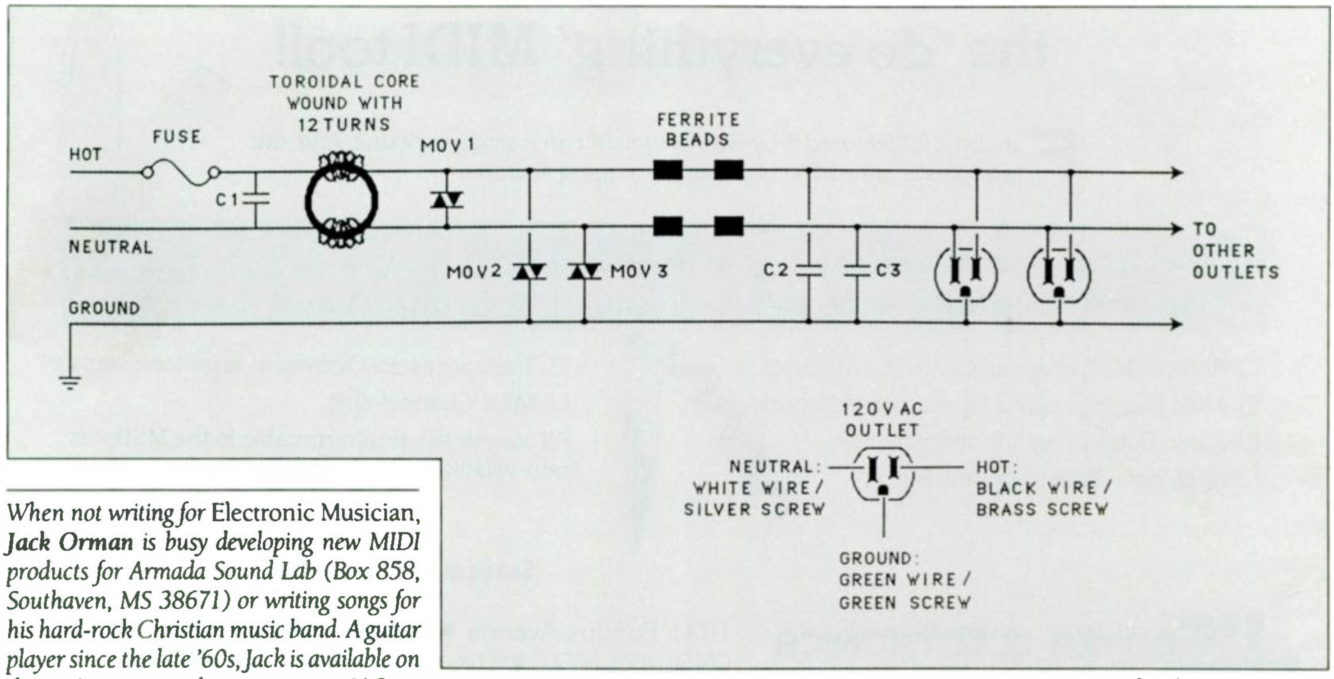


Fig. 1 *Line Filter/Surge Protector*

When not writing for Electronic Musician, ***Jack Orman*** *is busy developing new MIDI products for Armada Sound Lab (Box 858, Southaven, MS 38671) or writing songs for his hard-rock Christian music band. A guitar player since the late '60s, Jack is available on the DELPHI network via username JAO.*

ering a typical keyboard or small studio setup), use 18 gauge solid copper wire. Fuse the hot lead (black wire) with a 10 Amp fuse as protection against inadvertent short circuits. C1, a 0.01 μF (10 nF) capacitor wired across the AC line, precedes the choke pair wound on the toroidal core; this choke pair consists of a dozen turns of wire on each side of the core. A dozen turns on each side is sufficient and they should be wound in opposite directions for better efficiency (**Fig. 2**).

MOV1, which is wired across the hot (black wire) and neutral (white wire) AC lines, protects against peaks that are induced on one of the lines. If a spike is introduced on both the hot and neutral wires at the same time (common mode), though, this single MOV has no effect. For common mode protection, additional varistors (MOV2 and MOV3) need to be added from *each* of the AC lines to ground (green wire). Each line then passes through a pair of ferrite beads (small cylinders with a central hole through which the wire passes) to increase inductance. Space the beads about a half-inch apart.

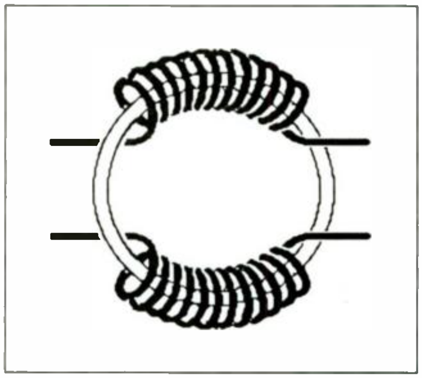


Fig. 2 *Close-up of toroidal core winding in opposite directions.*

The remaining 0.01 μF capacitors, C2 and C3, filter out common mode noise. I use Panasonic ZNR surge absorbers that are rated at 130V RMS with a peak current (Ip) of 25 Amps. These are available from Digi-Key at around a dollar each. GE and Thomson-CSF also make similar units. The ferrite parts were obtained from a $2 Radio Shack assortment pack; while discontinued, I still see some at stores around town. If Radio Shack is out of stock in your area, try surplus houses and other electronics outlets (Mouser Electronics carries ferrite beads as well as the MOVs).

Any sensitive electronic equipment—computer, synthesizer, or stereo system—can benefit from the surge protector/line filter combination. But you **must** follow the wire codes carefully and work neatly!! You're dealing with **high voltages** and any careless mistake can be costly to your well-being or that of your expensive equipment. If you have any doubts about your ability to wire a project like this, *don't!* Unlike something like a fuzz, where a wiring error produces nothing more than bad sounds or a damaged ego, a botched wiring job on an AC line filter can be *lethal*. For best results, insulate all soldered connections with a silicone sealant when finished to protect against accidental short circuits.

Try this protection circuit with your AC powered units—it can increase the reliability of data transfers and improve sound performance, while protecting your gear from AC line gremlins. EM

Give your analog sequencer a new lease on life.

A Voltage Controlled Counter

BY JOHN LOFFINK

Commercial analog sequencers have virtually disappeared in favor of more complex and expensive digital sequencers. While analog sequencers cannot match the mass storage of digital devices, digital units are limited to equal-tempered scales; any scale is possible with an (unquantized) analog sequencer. The greatest feature of analog sequencers is real time flexibility—they can be changed during performance for gradually or abruptly evolving rhythms and rhythmic inprovisation, or irregularly triggered for pseudo-random effects. Complex polyrhythms are also easier to realize with analog technology.

The weakness of analog sequencers is that they usually cannot be synchronized to other electronic rhythm devices or even other analog sequencers. Rhythms containing notes of different durations are usually obtained with a Voltage Controlled Clock/LFO. Using this clock to control your other sequencers would merely give the same metric pattern (though the sequence length could be different, thus creating interesting cyclic patterns).

For accurate synchronization, we need to enter the digital realm. A Voltage Controlled Counter can precisely synchronize an analog sequencer to other analog sequencers, click tracks (for multi-track recording), drum units, and digital sequencers. The circuit described here will greatly expand the capabilities of any sequencer that has a clock input and two rows of control voltage outputs.

John Loffink formerly published Surface Noise, *a magazine devoted to new musics, including electronic music. He designs ground support equipment for the space shuttle launch system at the Kennedy Space Center. Much of his spare time is spent developing new electronic music modules and systems.*

CIRCUIT DESCRIPTION

Fig. 1 shows the Voltage Controlled (Divide-by-1-Through-15) Counter. The circuit consists of three basic sections. The first is a simple four-bit Analog-to-Digital Converter formed around IC1. The second stage, IC2, does the actual counting. The third stage, composed of IC3, IC4, IC5, and IC6 derives the desired gate length.

The circuitry associated with IC 1 was described by John S. Simonton in "Lab Notes: Digitizers" (*Polyphony* Vol. 5, No. 2, July-August, 1979). The first op amp (pins 4, 5, 2) compares the control voltage input to 2.5 Volts (set by voltage divider R1/R2). The first op amp's output feeds a resistor to the second op amp input (pin 6) and when combined with the effects of the R1/R2 divider, makes this stage change state at 1.25, 2.5, and 3.75 Volts. The first and second stage outputs feed forward to the third stage input to determine bit D2. The LSB is similarly derived.

There are a few changes from the original circuit. R1 and R2 can be any handy value from 390 Ohms to 750 Ohms as long as both resistors are equal. Pullup resistors R6, R11, R18, and R26 are larger because the CMOS counter requires very little current. Their differing values, with lower values giving greater drive, reflect the fact that some outputs drive more comparator inputs than others. Finally, R13 and R20 are more logical values to use in the voltage division scheme.

PARTS LIST

Resistors (¼ Watt, 5%)

R1, R2	*510 Ohm*
R3, R4, R9, R10, R16, R17, R24, R25	*39k*
R5, R12, R19, R27	*2M2*
R6	*15k*
R7, R8, R26	*100k*
R11, R18	*30k*
R13, R14, R22	*470k*
R15, R23	*220k*
R28	*100k linear potentiometer*

Integrated Circuits

IC1	*LM339 or MC3302 Quad Comparator*
IC2	*4526 Presettable Divide-by-1-thru-16 Counter*
IC3	*4049 Hex Inverter*
IC4	*4071 Quad 2 Input OR Gate*
IC5	*4073 Triple Input AND Gate*
IC6	*4072 Dual 4 Input OR Gate*

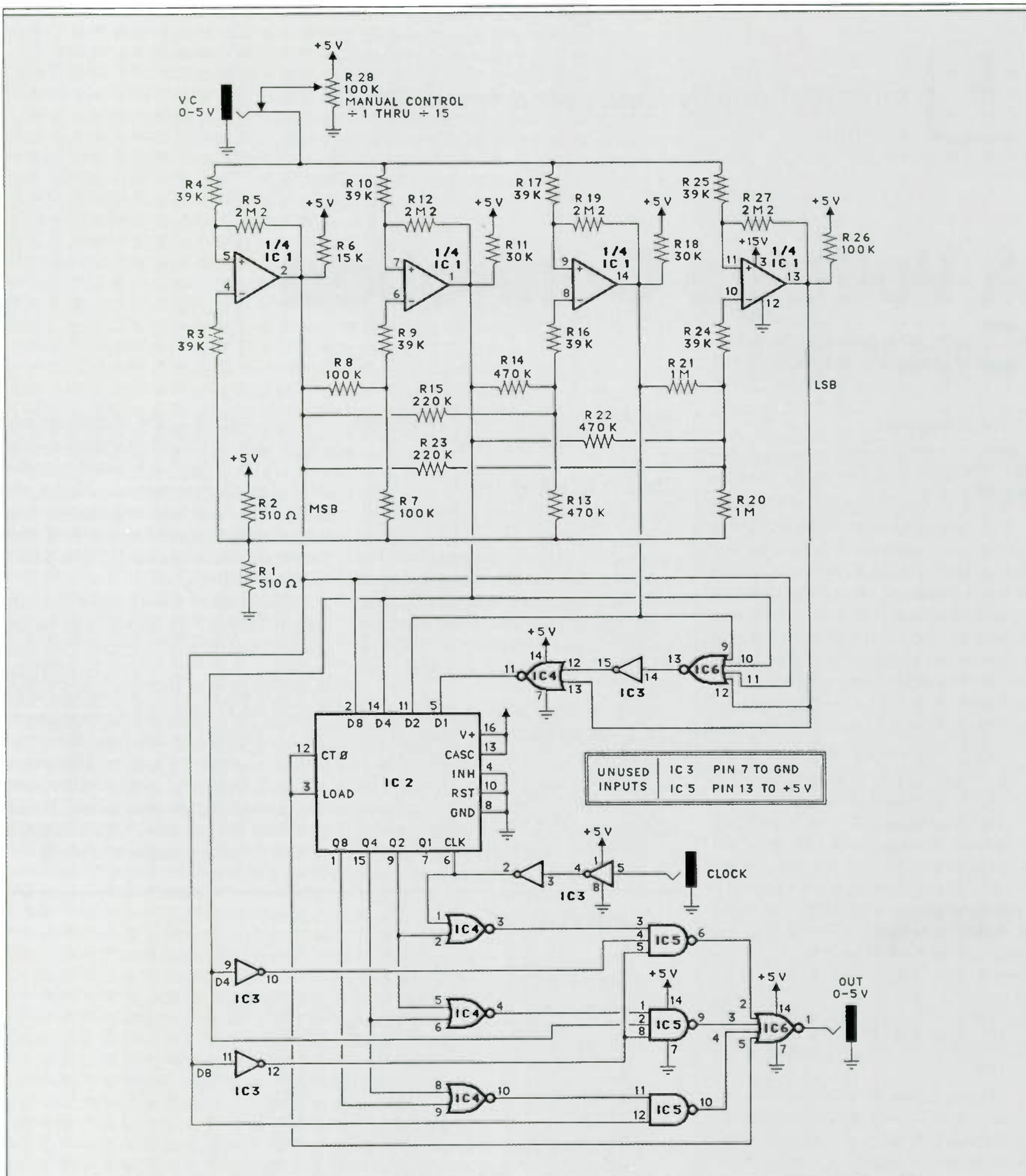


Fig. 1 *Voltage Controlled Counter*

The usual construction tips apply. Use sockets for all CMOS chips and make sure you and your tools are grounded during handling of CMOS to avoid static electricity damage. Connect a 10 μF electrolytic capacitor and one or two 100 nF (0.1 μF) disc caps from each IC supply voltage pin to ground, as close to the IC socket as possible.

Note that IC1 *must* be powered by a +12 or +15 Volt supply. Also, the comparator IC is susceptible to oscillation due to stray capacitance. With so many resistors around the IC this is a likely problem. If your circuit exhibits any DC voltage greater than 100mV and less than 4.0 Volts on pins 2, 1, 14 or 13 then check the output for AC, which should be near zero. To correct oscillation, increase the hysteresis for that stage by changing the positive feedback resistor R25 from 2.2M to a value between 680K to 1M. If you're building more than one VC Counter, then PAiA's Dual Digitizer kit is recommended to avoid such problems.

The least significant bit from pin 13 of IC1 must be modified so that a binary zero (0000) cannot be loaded into IC2's data inputs. You can't divide by zero, not even with CMOS! The 16th state is normally provided by grounding the load input at pin 3 of IC2, but is not used here. The chain of three logic gates leading to D1 create an input of 0001 for an output of 0000 from the digitizer. IC2 counts backwards, from the count loaded at D8, D4, D2, and D1 to one. The count zero output at pin 12 generates a pulse of the same width as the clock pulse width immediately upon reaching 0000.

The clock input is buffered by two NOT gate stages. Any zero to positive pulse signal from +5 to +15 Volts and with a risetime better than five microseconds is acceptable, including audio frequencies.

The logic gates at the bottom of the diagram simply decode a suitable gate length so that an eighth note and a whole note don't have the same durations. When D8 is high, then the count will be eight or greater and the gate length determined by Q8 and Q4. Remember that this is a downwards counter, so D8 is first high, then low. The NOT D8 gate disables the shorter gates used for shorter counts. Similarly, when D4 is high and D8 is low the shorter count is disabled; thus Q4 and Q2 determine the gate length. When both D8 and D4 are low, Q2 and the clock pulse width determine the gate length.

The output gate will normally be used to trigger the next stage on the sequencer. Since there is some propagation delay in all sequencers, the VC input will begin reading a new value a microsecond or two before that voltage for the next stage has actually occurred. This can result in

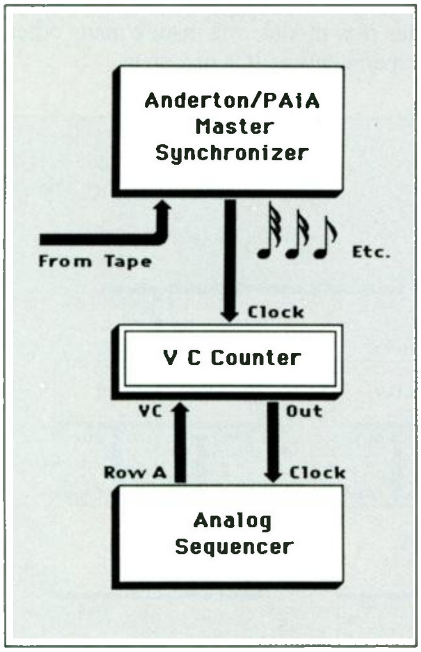


Fig. 2 *Synchronized Overdubbing*

erroneous states. Sending the Count Zero output from pin 12 to IC4B insures that the circuit reads long enough to obtain the correct voltage level.

Applications

The basic module setup is to plug Row A (CV outputs) of your sequencer into the VC input and the VC Counter's output into the sequencer's clock input. The system is then ready to accept a clock input from any number of sources. Synchronized overdubbing (see Fig 2) is easy with the Anderton/PAiA Master Synchronizer. The VC Counter accepts the desired note value (32nd, 16th, eighth, etc.) and provides notes from one to 15 times this length. For example, 16th, eighth, quarter, and half notes can all be derived from a 16th note clocking rate. Other values, some quite unusual, are also available.

For synchronization with commercial drum units and digital sequencers, you'll need a digital divider (with the proper logic interface for your particular unit), as shown in Fig. 3. Most commercial units output 24 or 48 pulses per quarter note, so a similar division is required.

Using multiple analog sequencers requires patching a VC Counter between the master clock and each sequencer (Fig. 4). With this setup virtually any polyrhythmic pattern is possible. While this effect is possible on digital sequencers, each rhythm must be repeated until reaching the end of the polyrhythmic period, which can be quite long. This consumes a lot of memory as well as programming time.

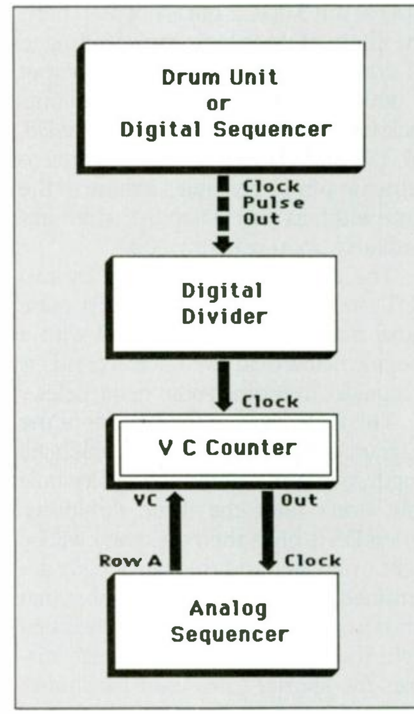


Fig. 3 *Drum Unit/Digital Sequencer Synchronization*

Even when synchronization is not needed, this module is much easier to use than a VC clock because the note values are in effect quantized. With no voltage control input, the VC Counter can also function as a 2-thru-15 frequency divider (dividing by one would be pretty useless in this case). Additional applications include inputting an LFO or Random Low Frequency to the VC input for semi-random sequences or voltage division. Hopefully, this new module will inspire many other experiments with your system.

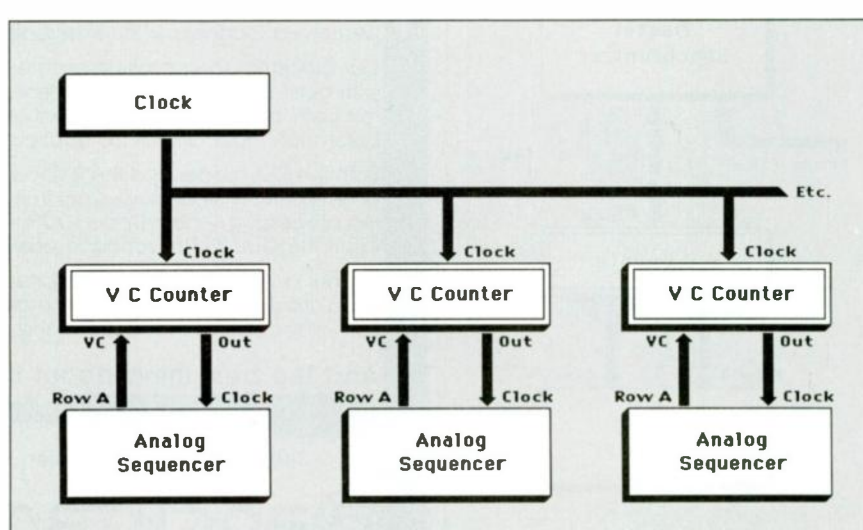


Fig. 4 *Analog Sequencer Synchronization*

339
Quad Comparator

OUTPUT B	1	14	OUTPUT C
OUTPUT A	2	13	OUTPUT D
+12 to +18 V	3	12	GND
INPUT A−	4	11	INPUT D+
INPUT A+	5	10	INPUT D−
INPUT B−	6	9	INPUT C+
INPUT B+	7	8	INPUT C−

4071
Quad 2-Input OR Gate

IN A	1	14	+3 to +15 V
IN A	2	13	OUT D
OUT A	3	12	IN D
OUT B	4	11	IN D
IN B	5	10	OUT C
IN B	6	9	IN C
GND	7	8	IN C

4072
Dual 4-Input OR Gate

OUT A	1	14	+3 to +15 V
IN A	2	13	OUT B
IN A	3	12	IN B
IN A	4	11	IN B
IN A	5	10	IN B
N.C.	6	9	IN B
GND	7	8	IN C

4073
Triple 3-Input AND Gate

IN B	1	14	+3 to +15 V
IN B	2	13	IN C
IN A	3	12	IN C
IN A	4	11	IN C
IN A	5	10	OUT C
OUT A	6	9	OUT B
GND	7	8	IN B

4049
Hex Inverter

+3 to +15 V	1	16	NC
OUT 1	2	15	OUT 6
IN 1	3	14	IN 6
OUT 2	4	13	NC
IN 2	5	12	OUT 5
OUT 3	6	11	IN 5
IN 3	7	10	OUT 4
GND	8	9	IN 4

4526
Presettable Divide-by-1 thru 16 Counter

Q8	1	16	+3 to +15 V
D8	2	15	Q4
LOAD	3	14	D4
INHIBIT	4	13	CASCADE
D1	5	12	COUNT Ø OUT
CLOCK	6	11	D2
Q1	7	10	RST
GND	8	9	Q2

EM

Yamaha has been mining the FM mother lode for over two years now—but it still comes as a bit of a shock to see an eight-voice multi-timbral, 336 program MIDI expander for under $400.

Yamaha FB-01 Sound Module

BY TONY THOMAS

I can't tell you how many times I've wanted a compact, low cost, and versatile multi-timbral MIDI expander unit. The Casio CZ-101 comes close, but four monophonic voices with no individual volume controls limits its usefulness as a multi-timbral device. But with the FB-01, Yamaha has given me what I have been hoping for and much more.

WHAT IS IT?

The FB-01 is a compact (half rack space), eight-voice, velocity *and* aftertouch sensitive, multi-timbral MIDI expander module (i.e. no keyboard) that utilizes Yamaha's four operator/eight algorithm FM sound generation system (essentially a scaled-down version of the one used in the ever-popular DX7). Good things really do come in small packages!

While the FB-01's voice architecture is nearly identical to that used in the DX21, 27 and 100 synthesizers, the FB-01 is not voice compatible with any of them. This is somewhat of a problem, since if you have another DX synth, you won't be able to transfer any of your patches to the FB-01. Also, there is no way to program the module except via the FB-01 Voicing Program (YRM-506; retail $60) for Yamaha's CX5M computer. These are not debilitating drawbacks, however, since the FB-01 has internal sounds aplenty—240 preset (not alterable) patches in ROM, with an additional 96 in user RAM for a total of 336 (a new record?). The full gamut of DX sounds are in residence, including the obligatory tine piano, horn, bass, strings, woodwinds, plucked sounds, percussion, organs, pianos, clavs, bells and sound effects. Remember, though, that since the FB-01 has no cassette interface, a computer or disk-based MIDI voice librarian program are the only means of storing and retrieving patches created by the user.

Tony Thomas has been involved in advertising, broadcasting, recording, and publishing for the past ten years. He is presently the managing director of Target Communications International, a full-service advertising agency, broadcast production company, and MIDI-based recording studio.

"... combining two patches... for a rather crude form of additive synthesis provides a superb eight-algorithm sound, in stereo no less"

WHAT'S IT ALL ABOUT?

The FB-01 sports an amber backlit LCD display that glows brightly in the dark—great for those of us who must work regularly in poorly lit studios or live situations. The rear panel includes MIDI In, Out and Thru jacks, the power switch, battery backup switch, and a pair of outputs for true (not merely chorused) stereo. The front panel consists of the aforementioned LCD, as well as a group of eight pushbuttons which access the various functions contained in the FB-01's software. These switches are named System Setup, Instrument Assign, Instrument Select, Instrument Function, Voice Select, Voice Function and Data Select Increment/Decrement (Yes/No).

Only when you examine the FB-01's internal software functions does its considerable power become apparent. You can allocate its eight voices any way you want—from eight note polyphony, to four-voice splits and layers for live gigs, to eight *different* mono voices on separate MIDI channels for some really serious fugues! These *configurations* (16 user programmable/four factory) contain associated voice data (i.e. patches), function data (see next paragraph for definition), stereo pan assignments, MIDI channel, upper/lower key limits for assigning each voice to a different keyboard zone (you can even do eight-way splits), octave, and so on. These configurations can be stored in RAM memory and recalled for later use.

The 336 resident voices are stored in seven 48-voice banks. The function data that can be stored for each voice includes pitch bend range, portamento time, poly/mono and pitch modulation depth (which can be assigned to the modulation wheel or other controller), aftertouch, and foot or breath controller if your keyboard controller supports these devices. An interesting MIDI key number receive mode permits you to configure the FB-01 to receive either odd or even MIDI note numbers; thus, you can strap two units together to operate as a single 16 note multi-timbral MIDI expander.

ONCE AROUND THE BLOCK

After reviewing the manual and impressive features of the FB-01, I decided to take the unit for a test spin. I first set up User Configuration #1 as follows:

MIDI Chan. 1: E. Bass (one voice)
MIDI Chan. 1: Rubato Bass (one voice)
MIDI Chan. 2: New EP (electric piano) 5 (four voices)
MIDI Chan. 3: Metal (one voice)
MIDI Chan. 3: Clavinet (one voice)

As I began recording my sequence into the FB-01, I noticed that even though it is a four operator/eight algorithm device, the sounds are nearly as good as those on the DX7. In fact, combining two patches (as I did with the bass and lead sounds) for a rather crude form of additive synthesis provides a superb eight-algorithm sound, in stereo no less.

One problem with the factory patches is that, even though they are velocity-sensitive, all the operators were set to the same value of velocity sensitivity. Because of this, you only get a dramatic (and often uncontrollable) volume change and no timbre change; this feature was probably included to accommodate non-velocity instruments such as the DX21. This prevents the FB's sound from really shining, unfortunately, since much of the allure of the DX system is its ability to dramatically change timbre according to how hard you hit the keys, as occurs with an acoustic instrument. As computer-based patch editors become available for this unit, musicians with velocity keyboards could tailor the internal sounds, as well as create new ones, to take advantage of all of the FB's expressive potential. Another point about the overall sound of the unit is that a single DX does not a system make; although the multi-timbral sound is quite acceptable for demos, it could stand some help from a MIDIed analog synth or sampler if you are involved in a serious project.

One of the FB-01's best features is its ability to store user configurations. I found this ability really helpful when putting down the basic elements of a song; I could have different sounds on different channels, and retain all this information in memory. Before using the FB-01, I needed to use a half-dozen other synths to do the same thing—and remember which was playing which sound, and over what channel, when I came back a week later to make another pass at the sequence! Now I just store what I need as a configuration, feed the sequencer into the FB-01, call up the configuration, call up the sequence, and I'm set. Those with Oberheim Xpanders are familiar with this "multi-patch" programming option, and it's great to see this concept implemented in a low-cost box.

Final Approach

I feel that the FB-01 is an instrument that every MIDI system owner could benefit from owning. It's perfect as a quick and dirty "demo doctor" for constructing songs without a lot of bother, as a sound generator for MIDI guitar synth systems (with two extra notes for doubled bass), and as a sensational stereo sound module which is capable of handling a variety of sonic chores (isn't it terrible wasting a DX7's 16 voices on a monophonic glock sound—here's the answer!). It is a great starter module for a small MIDI setup or a super addition to a large one. Onstage or in the studio, you could put together five or six of these little units and create the sound of an orchestra. Its low price (about $350 retail) is also going to make a lot of new friends for Yamaha. All in all, it sets a standard for price versus performance that will be hard for other manufacturers to match—much less beat. CM

Digital reverb prices are tumbling—but that doesn't mean the quality is tumbling too, as two new boxes from Alesis attest.

Alesis MIDIVERB and MIDIFEX

BY CRAIG ANDERTON

We're all used to price and size reductions in electronic gear, but even so, something like the Alesis MIDIVERB still comes as a shock. The price ($399) is small, and the size is small (1/2 rack width by one rack space high, although it is not rack-mountable as is). The sound, however, is not at all small.

MIDIVERB subscribes to the "less is more" school of design. There are 63 preset sounds, two buttons to increment /decrement the preset number (or MIDI channel), a defeat switch (leaves only the straight signal and kills the reverb tail), MIDI channel selection switch, LED program number readout, two level-setting LEDs (green and red), and a rear panel-mounted wet/dry mix control—good for onstage use if you don't have a mixer handy.

Connectors include stereo RCA phono input and output jacks (both the MIDIVERB and MIDIFEX are true stereo units), MIDI In, MIDI Thru, and a jack for the connector from an external AC adapter (provided). Note that these units are designed for line level signals, so guitars, mics, and other low-level instruments will need some sort of preamplification before going into either box.

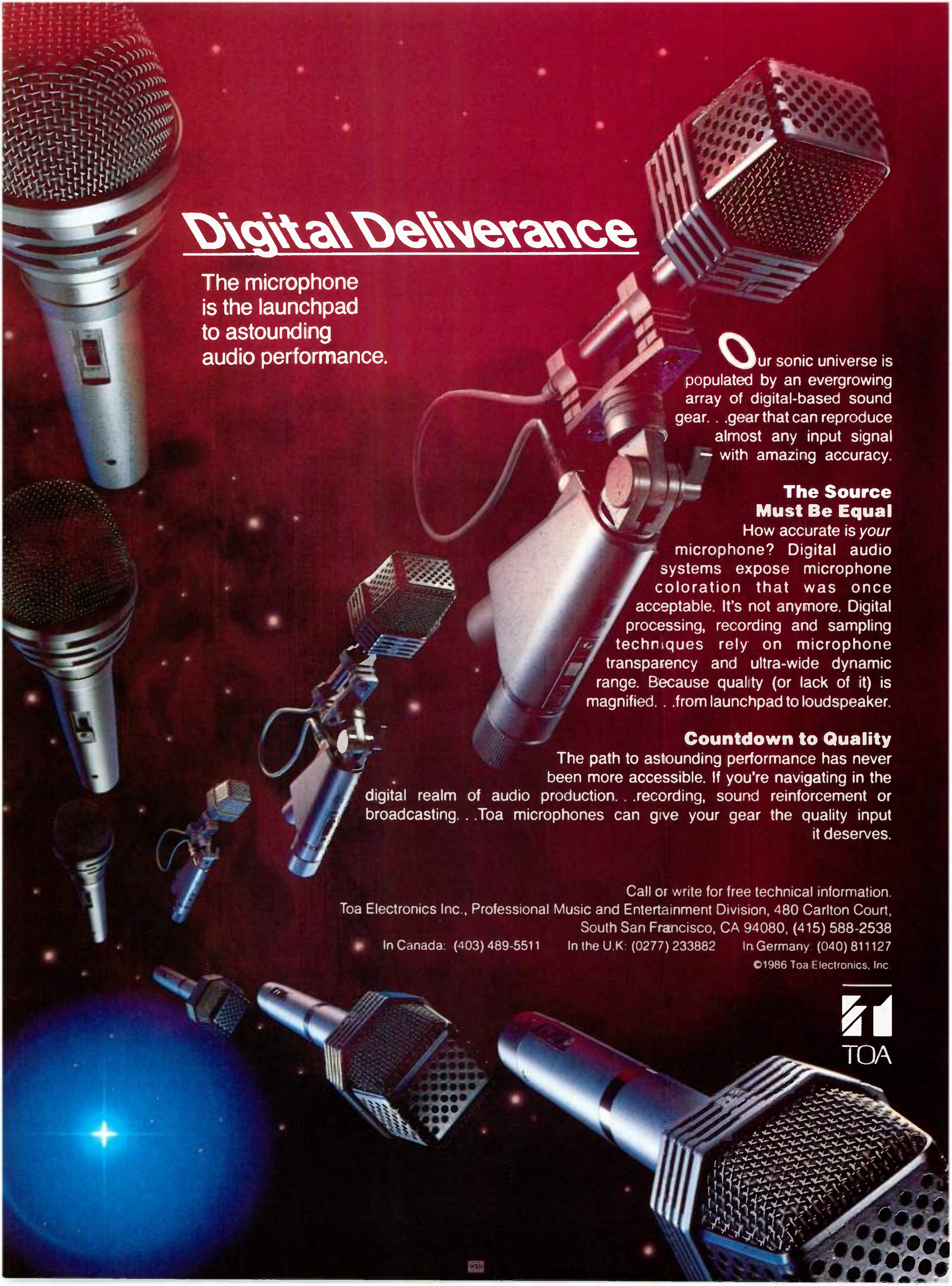
Fifty of the MIDIVERB programs are normal reverb effects; each program features a unique combination of decay time (0.2 to 20 seconds), size (small, medium, large), and character (warm, bright, dark). There are also eight gated reverb programs (100 to 600 ms) and four reverse reverb programs (300 to 600 ms).

No, you can't adjust the midrange decay time, or change reverb according to how you play the keyboard, or any of that other PCM70 kinda stuff. What you can do, though, is enjoy really pro-sounding reverb effects at a budget price. At first, I thought I noticed some grit and noise towards the tail of the sound, but this turned out to be due to an insufficiently high input level. Once I got that squared away, and realized the red overload LED could blink a fair amount without audible distortion, the tail was so far down in comparison to the rest of the signal that any noise problems were rendered unobjectionable.

"Alesis has done a real public service to the small recording studio owner"

My only complaints are minor. First, I hope Alesis offers some kind of rack mount kit. While the box is beautifully done in an industrial design sort of way, it seems to crave the permanent home of a comfy rack space. Second, there's no way to assign reverb presets to different MIDI program change numbers; admittedly, that would be asking a lot of a budget item, but as it is, someone with only a DX7 couldn't access almost half of the presets. Finally, I do hear a little periodicity (flutter) in the reverb tail, but then again, this is characteristic of all the low-cost digital reverbs I've ever tested.

However, any criticisms dissipate when you hear the thing and look at the price. Alesis has done a real public serv-


Digital Deliverance
The microphone is the launchpad to astounding audio performance.
Our sonic universe is populated by an evergrowing array of digital-based sound gear. . .gear that can reproduce almost any input signal with amazing accuracy.
The Source Must Be Equal
How accurate is *your* microphone? Digital audio systems expose microphone coloration that was once acceptable. It's not anymore. Digital processing, recording and sampling techniques rely on microphone transparency and ultra-wide dynamic range. Because quality (or lack of it) is magnified. . .from launchpad to loudspeaker.
Countdown to Quality
The path to astounding performance has never been more accessible. If you're navigating in the digital realm of audio production. . .recording, sound reinforcement or broadcasting. . .Toa microphones can give your gear the quality input it deserves.
Call or write for free technical information.
Toa Electronics Inc., Professional Music and Entertainment Division, 480 Carlton Court, South San Francisco, CA 94080, (415) 588-2538
In Canada: (403) 489-5511
In the U.K: (0277) 233882
In Germany (040) 811127
©1986 Toa Electronics, Inc.
TOA

Why Digital Reverb?

A sound's character depends greatly on the acoustic space in which it is heard. For example, the sound of an orchestra in a fine concert hall is much more pleasing that the same orchestra playing in a gymnasium. Much effort goes into designing concert halls and auditoriums for proper acoustics.

Reverberation devices simulate different kinds of acoustic environments, and are thus useful in imparting a sense of space to instruments and vocals. With so many sounds close-miked in the studio, often room sound is not a part of the tape track. Artificial reverberation added while recording or during mixdown can add some room sound to keep the ambience from being too "dry."

Digital reverberation is particularly useful because unlike mechanical reverberators, which offer at best one or two different sounds, digital reverbs use computer technology to synthesize a wide range of acoustic spaces. By simply pushing some buttons or tweaking a knob, you can dial in anything from a closet to a cathedral—and even specify whether the sound will be bright or dull, and how long its total decay will be. This flexibility, coupled with excellent fidelity and reasonable cost, has made the digital reverb one of the hottest effects available today.

ice to the small recording studio owner—I only wish something like this had been around when I was first putting together a home studio, as good reverb is often the difference between a good-sounding and a great-sounding demo. All in all, this is about as cost-effective a digital reverb as you're going to find right now.

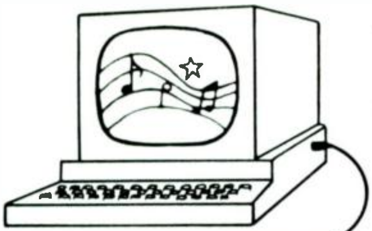
The Midifex

The MIDIFEX is identical to the MIDIVERB in features, size, and price—but not in the 63 programs it offers, which can perhaps best be described as "digital delay's greatest hits." In fact, prior to the new generation of digital signal processors, you would have required multiple digital delay lines to produce some of MIDIFEX's effects. These effects include 21 single-repeat echo programs of various echo times and with various degrees of filtering, 15 two- and three-tap delays (in stereo, natch), six multiple echoes (i.e. delay with regeneration), five different slapback echoes, seven special effect-type reverb settings (including a couple of normal ones), three multitap programs (reverb, pan, and reverse reverb pan), two "thickeners," and four types of stereo generation.

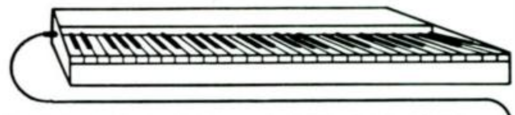
Like the MIDIVERB, the MIDIFEX seems ideal for the small studio but also provides a great deal of utility on stage. To think that you're getting all these sophisticated, and very useful, effects for $399 is astonishing. Here in one box are all those fabulous multiple DDL effects that sound so great on guitar, synthesizer, etc. Whether you want to warm up a string patch or add a cool guitar slap, this is the box.

For onstage use, though, the lack of MIDI program assignability is more problematic than with the MIDIVERB, and you may feel the need for some kind of program change footswitch. A potentially more serious problem is that echo times are not adjustable, thus precluding adjustment of echo time to match the tempo of a song. I know many people don't worry about this, but I'm very much into this technique and missed it on the MIDIFEX. Having said that, since most MIDIFEX echoes are single repeats, and many of them are rather short, timing is nowhere near as critical as it would be for long echoes that use lots of feedback.

Every now and then a product comes along that sets a new standard for price/performance—the Ensoniq Mirage, Yamaha DX7 and SPX90, Korg Polysix, Roland TR-505, TEAC 3340, Fostex X15 and B16, and so on. The MIDIVERB and MIDIFEX now join the club. Both are good enough for studio scrutiny; for live performance, I specifically would recommend the MIDIFEX due to its rich and varied repertoire of effects. With either unit, though, you can't go wrong—it's going to take some effort to come up with significantly better or cheaper alternatives.



Notes from the Dr.



DR. T's MUSIC SOFTWARE • 66 Louise Road • Chestnut Hill, MA 02167 • (617) 244-6954

Algorithmic Composition with MIDI Software

algorithm — "a number of rules which are to be followed in a specific order . . ."
—New Webster's Dictionary

Traditionally, music has been written by composers who work out ideas in their heads or on an acoustic instrument and write them out as a musical score that musicians can read. The composer might also teach other musicians their parts by ear, or work out the final arrangement collectively.

The availability of the computer as a compositional tool allows the composer to bypass some steps of the process. Once the music is in the computer, it can control the instruments, allowing the composer to try new ideas and immediately hear the results.

All but the very simplest MIDI sequencers provide some algorithmic composition capability. Transposing a part up a fifth or auto-correcting to eighth notes are processes that involve "following rules in a specific order." Computers are very good at this, indeed in a sense it is the ONLY thing they are good at.

For a long time I have been exploring the possibilities of making music using algorithmic techniques. I used to use a system with two analog sequencers and some logic circuitry which enabled me to generate complex patterns that repeated in non-obvious ways. My C64, Apple II, and Atari keyboard controlled sequencers contain a number of features that can be described as algorithmic: cut and paste editing; transposition and inversion of pitch, dynamics or note duration; auto-correction and time-reversal. We also publish a package of algorithmic composition programs that can be used on the C64 or 128. My Commodore 128 KCS contains a great many more such features, all of which (and more!) will be included in the Level 2 Atari KCS, available around the turn of the year. In this essay I will describe some ways in which these tools cab be used in both popular and experimental music.

Computers are very good at processing lists of data. If we treat a sequence as a list of data, we can think of a great many ways in which we could process it. Some are things that could be done to any list, like editing an individual element, deleting a section, or moving or copying a section from one part of the list to another. Others are obviously derived from the musical nature of the list, like pitch transpose, or auto-correction. Others are less obvious, like inverting pitch, or increasing or decreasing the dynamic range of a passage. Some are not obvious at all, like permuting two notes, or doing something (delete, transpose, etc.) to every THIRD note in a passage.

Much contemporary popular music (and a fair amount of "serious" music as well) is based on simple repetitive patterns. Such music can be made more interesting by adding changes to these repetitive patterns. These changes can be subtle, perhaps even barely perceptible. The computer can allow you to experiment with such changes with a minimum of effort.

A simple trick that I have used with all versions of the KCS is to take a short repeating pattern and copy it to itself once or twice. I then make some minor changes to some of the later occurrences of the pattern, perhaps just adding, changing or deleting a note or two. I might then repeat the process. The result is a repeating pattern that contains a shorter repeating pattern that subtly changes with every repetition.

Last year, a customer called and said that he had a two-handed keyboard part that he wanted to "split" over two instruments. Using the C64 KCS, he had to change the channel of each note separately. He suggested that I provide a "keyboard split" mode, in which an edit process could be applied to one half of the keyboard and not the other. This conversation caused me to add a feature to the C128 KCS that I called selection criteria. Virtually all of the "algorithmic" features of the C128 KCS (resetting channel, transposition, setting pitch, timing or dynamics, inversion, deletion, etc.) can be applied to notes selected by any combination from a large menu of such criteria. These include MIDI channel, ranges of pitch, dynamics or timing data, and position on the chromatic scale. Notes can also be selected probabilistically.

The C128 KCS also includes some more complex algorithmic editing functions. These include the ability to match the pitch, velocity or timing pattern of one sequence against that of another, the ability to "redefine" the chromatic scale (e.g. changing a section using the C major scale to E minor), and the ability to randomly permute notes or aspects of notes within a sequence.

These new features enhance the ability to algorithmically "treat" our repeating pattern. We can do something as simple as randomly deleting, permuting, or transposing a small percentage of the notes of the sequence. We can process only part of the sequence, so that whenever the longer pattern is played, the first few cycles of the shorter pattern are unchanged. If we have an extra synth voice available, we can select a sound on it that is similar in character to the sound we are using, and assign some notes to the new voice. These notes can be selected using any of the criteria described above. A feature called ADD SEQUENCE START EVENT allows us to double selected notes on another instrument, or on any drum sound from our MIDI drum machine.

A friend of mine who plays acoustic bass was recently asked why he uses an effects box with his bass. Making the motion of shaking a pepper-shaker, he replied that he did it to add "a little spice" to his sound. The algorithmic editing techniques that I am describing allow us to spice our repeating patterns, adding anything from a subtle touch of herbs to a rousing dose of hot peppers!

Of course, there are many other ways in which these techniques can be used. They provide some ways to get around the 12-tone, equal tempered limitation built into most MIDI synths. They allow the creation of computer generated crescendos and decrescendos. Of greatest interest to me is the ability to make up my own rules of musical structure, and to explore them to see if they are worthwhile. I also often use them as a musical "doodle pad," trying out different possibilities until I find some that sound good.

—from page 69, SOFTWARE CO.
among the first users. But, like your beta-testers, don't leave your early customers holding the bag, or their enthusiasm will turn sour. First, make sure they *know* what they're getting themselves into. Mention any known quirks or bugs and how to avoid them. Most important, when you've improved the software, or finished the manual, or whatever, immediately get those (and any future) upgrades to your early customers. Some people object to a company's using its customers as Beta-testers, but as long as everyone knows the rules, and plays by them, no one will get mad.

Know The Competition—But Don't Fight With Them

If your product is better than theirs, know why that is so, and be able to demonstrate why simply and clearly. Emphasize the strengths of your product; putting down other companies diverts too much attention to them, and if you do nothing but criticize, people will start wondering what's wrong with *your* product. Some customers may not even know about the competition—why tell them?

Companies who spread nasty rumors about competitors give the impression that they're desperate, and that their products won't stand up in a fair comparison. Always take the high road, and customers will respect you for it.

The Press Is Silver

Good reviews in music trade magazines can add credibility to a product like nothing else. Writers for computer magazines are important, too; they're often active in users' groups, and if they have a keen interest in music, chances are so do the people with whom they associate. If someone writing a review of your product calls to ask a technical question, answer it right away: writers need all the help they can get to maintain accuracy in the face of tight deadlines.

If you get a bad review, don't be afraid to write a letter to the magazine refuting the reviewer's points, if you can do it without sounding like sour grapes (a sense of humor helps a lot). An articulate letter will be printed, and because it will appear in a different issue than the original review, you'll get that much more free exposure. And speaking of free exposure, many publications will print a well-written press release and an attractive picture. Put as many magazines and newspapers on your mailing list as possible—it's a very cheap way to advertise.

Reprints of reviews can also be useful. Should you want to reprint a review, obtain permission both from the magazine *and* the original writer; many writers are freelance, and by law own the reprint rights to their articles.

A word of warning: you may get a call from someone who says, "I'm a freelance writer and I want your program so I can write a review and sell it to a magazine." Beginning freelancers sometimes don't realize that magazines almost never accept unsolicited product reviews; professional authors usually work in conjunction with the editor when obtaining products for review. Be nice to writers starting a new career, and send them lots of literature, but unless you know an author's work, don't send any product unless the writer is willing to pay for it. (Editor's note: EM asks authors to query first about any reviews, and prefers reviews written by people who bought a product over-the-counter, use it in their work, and are very familiar with it.)

Your Dealers Are Golden...

Once you set up a dealer network, treat everyone in it like your best friend. Supply good sales materials, such as brochures, reviews, counter displays, and demo programs (i.e. programs that show off the program and give a feel for how it works, but lack some important function such as saving to disk). Inform dealers of program updates and upcoming price changes (and avoid dropping prices while your dealers still have large stocks). Set realistic terms or minimums, and keep the margins healthy.

> **"Always take the high road, and customers will respect you for it"**

Dealers are fickle. Getting them interested in carrying your product is only half the battle; you also must *keep* them interested. If you're going to miss a ship date, notify dealers as far in advance as possible, and give them a realistic estimate of the new ship date. Don't make a commitment without delivering, or your dealers will look for more reliable companies.

Your Customers Are Platinum

Word of mouth is all-important, so treat your customers right. For starters, keep your phone lines open. A customer trying to solve a problem in the studio at $200 an hour does *not* want to hear a busy signal. Get extra phone lines if you have to, and a WATS line or two if possible. A good communications system is just about the best investment you can make. If you don't want to be constantly interrupted by support calls, tell your customers that you will only accept calls during certain hours, then cover the phones without fail during those hours. This also lowers phone bills, because there will be fewer people you need to call back. A few companies now give electronic customer support through PAN, Esi, Music-Net, or other public database services. A surprising number of electronic musicians have modems, and one well-written answer to a customer's question on a public bulletin board can save dozens of phone calls.

Don't appear arrogant. If someone can't figure something out, patiently and sympathetically walk the caller through the problem. Make sure the customer is at the computer with the program running; if not, ask the person to call back. You might think that someone who calls up and says, "I haven't read the manual yet, but I have a few questions," is a jerk, but that doesn't give you the right to hang up. Answer any questions calmly and succinctly, and say politely with each answer, "That's in the manual," citing chapter and verse if you can. Pretty soon your message will get through, and the customer will go away thinking not only that you know what you're doing, but also that you're a nice person.

If whoever answers your phone can't handle a particular technical problem, transfer the call to someone who can. If no one is available, take the customer's number, find out the answer, and call back—don't make the customer call twice.

Don't be paranoid. If someone asks you a highly technical question that treads on proprietary ground, don't assume you're dealing with a software pirate. Find out what the caller *really* needs to know, and tell as much as you can. You'll have a friend for life, who might turn out to be an important ally somewhere down the road.

Do Well By Doing Good

People who write music software do so because they love it, and because they want to design new tools to help the creative process—not because they want to retire at age 25. Unless you believe that, get out of the business and take a real estate course. Sure, it's no sin to make money, and there are those in the field who will be able to live very comfortably on the fruits of their efforts. But music is a funny business—there are no hard rules to live by, and it's every bit as subject to trends and fads as the fashion world. If you want to do well in the business, look around at what people are using, and think of what you can do to make their lives easier and more comfortable. Then do a good job, and keep doing it. If you're lucky, you'll earn some money, and if you truly do your job right, you'll earn something more valuable: respect. EM

Advertiser Index

How do you put musical energy into drum programming?

"Whether or not you're a drummer, a drum machine should play like an <u>instrument</u>, not a machine. These pads respond dynamically in smooth and realistic increments. Until now, I haven't seen a machine with these features in this price range."

Jimmy Bralower,
Studio Drummer/Programmer
(Steve Winwood, Billy Joel, Cyndi Lauper)

Start with a great set of PCM digital sampled sounds, developed with leading players, producers and engineers. Then assign them to 14 long-throw pads that respond to your touch. Program dynamics, tuning and decay for every drum on every beat, or edit them with the data slider in real or step time.

Set cymbal, drum or percussion sounds to retrigger with each hit or to overring and decay naturally. Then bring those sounds to life. The DDD-1 is designed with powerful, responsive, easy controls that let you cut through mechanical programming to build massive beats or supple grooves — spontaneously, while your ideas are fresh.

For building blocks, use any sound you can think of. Korg's growing library of "credit card" ROMs covers any musical situation, every musical attitude with a full range of acoustic and electronic drumsets and percussion instruments, many sampled with state-of-the-art effects. The DDD-1's internal memory and four ROM card slots hold up to 48 sounds, each one assignable to any pad. The optional 3.2 second sampling card lets you add your own sounds.

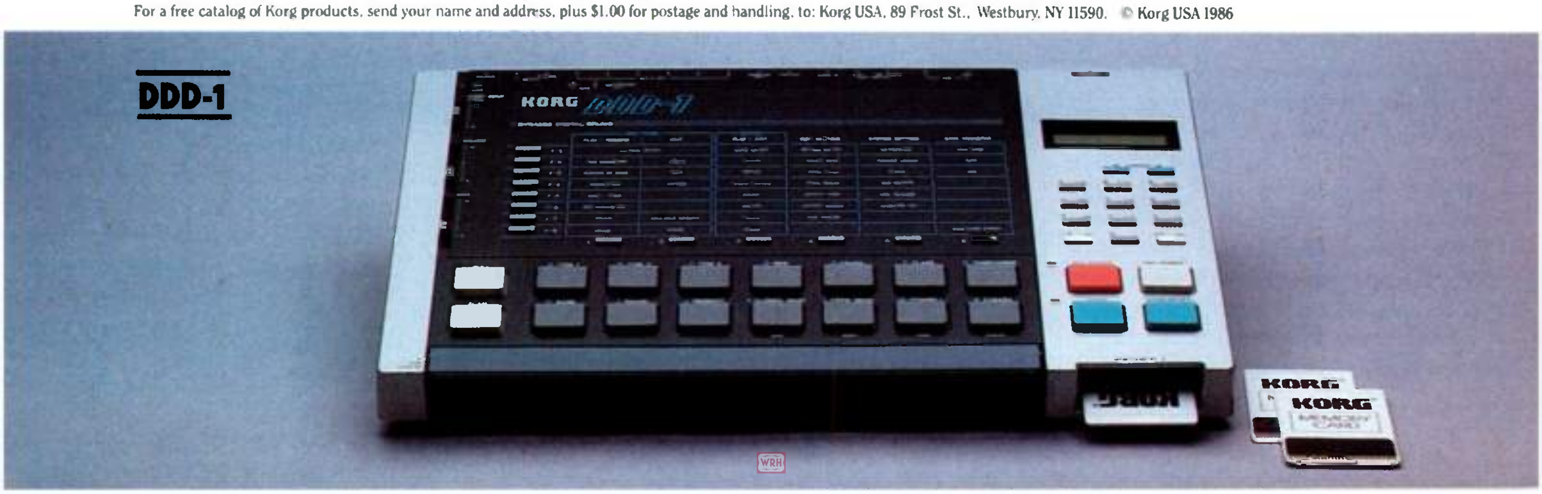
Program and play the DDD-1 from MIDI keyboards or drum electronics, or use the assignable audio trigger input. Store program memory (including 100 patterns and 10 songs of up to 9999 measures) on tape, on RAM cards or via MIDI System Exclusive to Korg's disk-based SQD-1 sequencer. On playback, assign any sound to stereo outs with seven step sweepable panning, or to one of the six assignable programmable multi outs.

Put your hands on the new DDD-1 Digital Dynamic Drums at your authorized Korg Sampling Products dealer. And discover how you can make drum programming a performing art.

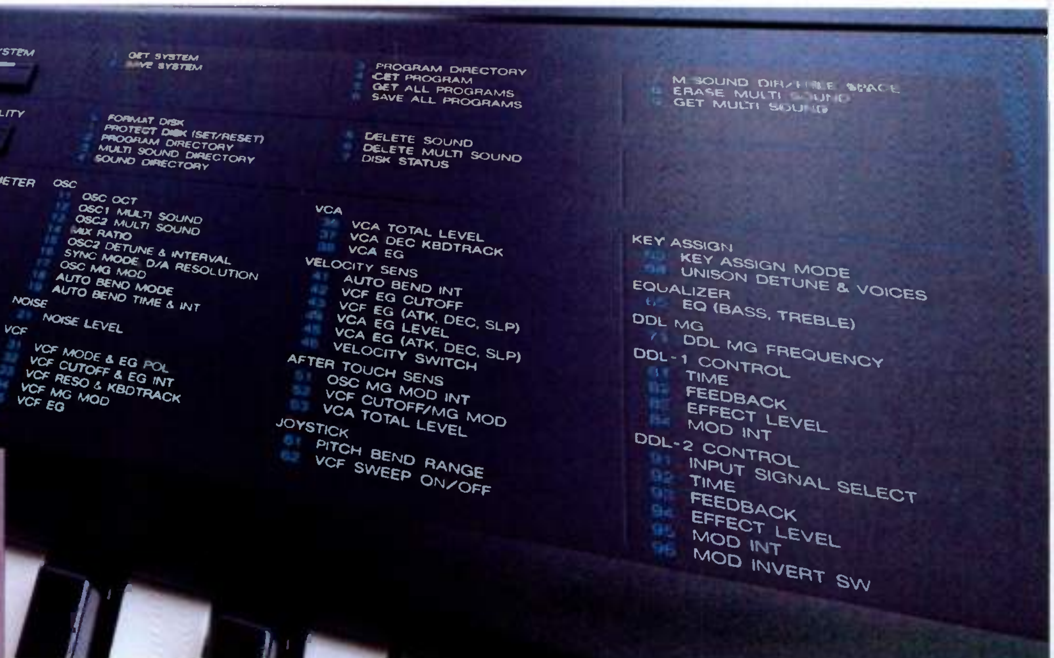
KORG® Sampling Products Division

SAMPLING IS ONLY THE BEGINNING

For a free catalog of Korg products, send your name and address, plus $1.00 for postage and handling, to: Korg USA, 89 Frost St., Westbury, NY 11590. © Korg USA 1986



Why should a sampler and a synthesizer be combined? Experimentation.



I need to get to my sounds quickly and also create new patches when I'm on tour. The DSS-1 gives me that flexibility. It's a very responsive instrument.

Steve Winwood
Multi-Instrumentalist, Vocalist, Composer

Korg combines the realism of sampling with the flexible control of synthesis to create a new kind of keyboard with unlimited possibilities for musical experimentation: the DSS-1 Digital Sampling Synthesizer. The DSS-1 recreates sounds with digital precision. But it also shapes the complexity and variety of sampled sources into new dimensions of sound.

Exceptional Range The DSS-1's extraordinary potential for creating new sounds begins with three sound generation methods. Digital oscillators sample any sound with 12 bit resolution. Two sophisticated waveform creation methods — Harmonic Synthesis and Waveform Drawing — let you control the oscillators directly. Use each technique independently, or combine them in richly textured multi-samples and wavetables. You edit samples and waveforms with powerful functions like Truncate, Mix, Link and Reverse, plus auto, back and forth or crossfade looping modes. Then apply a full set of synthesis parameters, including two-pole or four-pole filters and Korg's six-stage envelopes.

Exact Control Choose from four sampling rates between 16 and 48 KHz, with up to 16 seconds of sampling time. Configure the keyboard with 16 splits assignable over the full 127 note MIDI range. Layer or detune the two oscillators on each of eight voices. Then process your sounds with a complete synthesizer architecture and two programmable DDLs.

The DSS-1's power is easy to use, so you can work with sound and music, not programming manuals. The backlit 40 character LCD display takes you through the total sound generation process with options and instructions at every step. Software that talks your language and a logical front panel menu help you go beyond synthesis, beyond sampling — without dictating your direction.

Expression The DSS-1's five octave keyboard is velocity- and pressure-sensitive, for precise touch control of Autobend, VCF, VCA, envelope rates and other parameters. Velocity Switch lets you play completely different sounds as you change your attack.

Unlike other samplers, the DSS-1 lets you access 128 sounds without changing a disk. Each disk stores four Systems of 32 sounds. Within each System, your programs combine up to 16 sample groups and/or waveforms with complete sets of synthesis parameters and keyboard setups. In effect, the DSS-1 becomes a new instrument every time you call up a System. The library of easily available 3½" disks is already substantial and growing fast. Four disks — each with 128 sounds — are supplied with the DSS-1 to start your comprehensive Korg sampling library.

By combining the best of digital sampling with familiar and flexible control of synthesis, the DSS-1 allows the modern synthesist to experiment with new sounds never before available.

Start exploring the fusion of sampling and synthesis now, at your authorized Korg Sampling Products dealer.

KORG® Sampling Products Division

SAMPLING IS ONLY THE BEGINNING

For a free catalog of Korg products, send your name and address, plus $1.00 for postage and handling, to: Korg USA, 89 Frost St., Westbury, NY 11590.

DSS-1

TRUTH... OR CONSEQUENCES.

If you haven't heard JBL's new generation of Studio Monitors, you haven't heard the "truth" about your sound.

TRUTH: A lot of monitors "color" their sound. They don't deliver truly flat response. Their technology is full of compromises. Their components are from a variety of sources, and not designed to precisely integrate with each other.
CONSEQUENCES: Bad mixes. Re-mixes. Having to "trash" an entire session. Or worst of all, no mixes because clients simply don't come back.

TRUTH: JBL eliminates these consequences by achieving a new "truth" in sound: JBL's remarkable new 4400 Series. The design, size, and materials have been specifically tailored to each monitor's function. For example, the 2-way 4406 6" Monitor is ideally designed for console or close-in listening. While the 2-way 8" 4408 is ideal for broadcast applications. The 3-way 10" 4410 Monitor captures maximum spatial detail at greater listening distances. And the 3-way 12" 4412 Monitor is mounted with a tight-cluster arrangement for close-in monitoring.
CONSEQUENCES: "Universal" monitors, those not specifically designed for a precise application or environment, invariably compromise technology, with inferior sound the result.

TRUTH: JBL's 4400 Series Studio Monitors achieve a new "truth" in sound with an extended high frequency response that remains effortlessly smooth through the critical 3,000 to 20,000 Hz range. And even extends beyond audibility to 27 kHz, reducing phase shift within the audible band for a more open and natural sound. The 4400 Series' incomparable high end clarity is the result of JBL's use of pure titanium for its unique ribbed-dome tweeter and diamond surround, capable of withstanding forces surpassing a phenomenal 1000 G's.
CONSEQUENCES: When pushed hard, most tweeters simply fail. Transient detail blurs, and the material itself deforms and breaks down. Other materials can't take the stress, and crack under pressure.

TRUTH: The Frequency Dividing Network in each 4400 Series monitor allows optimum transitions between drivers in both amplitude and phase. The precisely calibrated reference controls let you adjust for personal preferences, room variations, and specific equalization.
CONSEQUENCES: When the interaction between drivers is not carefully orchestrated, the results can be edgy, indistinctive, or simply "false" sound.

TRUTH: All 4400 Studio Monitors feature JBL's exclusive Symmetrical Field Geometry magnetic structure, which dramatically reduces second harmonic distortion, and is key in producing the 4400's deep, powerful, clean bass.
CONSEQUENCES: Conventional magnetic structures utilize non-symmetrical magnetic fields, which add significantly to distortion due to a nonlinear pull on the voice coil.

TRUTH: 4400 Series monitors also feature special low diffraction grill frame designs, which reduce time delay distortion. Extra-large voice coils and ultra-rigid cast frames result in both mechanical and thermal stability under heavy professional use.
CONSEQUENCES: For reasons of economics, monitors will often use stamped rather than cast frames, resulting in both mechanical distortion and power compression.

TRUTH: The JBL 4400 Studio Monitor Series captures the full dynamic range, extended high frequency, and precise character of your sound as no other monitors in the business. Experience the 4400 Series Studio Monitors at your JBL dealer's today.
CONSEQUENCES: You'll never know the "truth" until you do.

JBL

JBL Professional
8500 Balboa Boulevard
Northridge, CA 91329