MUSIC & TECHNOLOGY

H.P. NEWQUIST

A USER'S GUIDE TO THE CURRENT SOUND REVOLUTION, FROM MIDI AND COMPUTERS TO SYNTHS, SAMPLERS, AND SOFTWARE

MUSIC & TECHNOLOGY

H.P. Newquist

Billboard Books
An imprint of Watson-Guptill Publications/New York

About the Author

H. P. Newquist is a musician and writer whose articles have appeared in various music and computer magazines. He has been involved in numerous recording projects and currently operates a digital recording studio.

PHOTO CREDITS

Page 109 (Fig. 6-7), courtesy Akai Professional; page 143, courtesy Coda Music Software; page 18, courtesy Electronic Arts Foundation; page 79, courtesy Ensoniq; pages 106, 134 (Fig. 8-4), courtesy Russ Jones Marketing Group; page 78, courtesy Kurzweil Music Systems; page 76, courtesy New England Digital; pages 134 (Fig. 8-3), 145, courtesy Passport Designs; page 74, courtesy RolandCorp US; page 15, courtesy David Sarnoff Research Center; pages 21, 109 (Figure 6-8), Yamaha Corporation of America; page 73, photo by Studio V.

First published 1989 by Billboard Books, an imprint of Watson-Guptill Publications, a division of Billboard Publications, Inc., 1515 Broadway, New York, NY 10036

Library of Congress Cataloging-in-Publication Data

Newquist, H. P. (Harvey P.)
Music & technology / H.P. Newquist.
p. cm.
Includes index.
ISBN 0-8230-7578-8
1. Electronic music—History and criticism. 2. Music—Data processing. I. Title. II. Title: Music and technology.
ML74.N48 1989
780'.285—dc20 89-9818
CIP
MN

Manufactured in the United States of America

First printing, 1989

1 2 3 4 5 6 7 8 9 / 94 93 92 91 90 89

Acknowledgments

There are many people that I wish to thank for the help, support, and assistance they provided during the course of this undertaking.

I most appreciatively would like to single out: Tracy Smith, agent extraordinaire; Tad Lathrop and Fred Weiler of Billboard, whose foresight, persistence, and early morning phone calls brought this book to reality.

Thanks to the individuals in the music and technology industries who shared their time, especially those at Roland, Alesis, BBE, Passport, Opcode, Yamaha, Coda Music Software, EAR Music, Music Maker Publications, Cherry Lane Music, TEAC, Computerworld, and AI Expert.

Certain people made sure that I always found music to be worth the effort. They are: Tucker Greco and family, Barbara Seerman, and also Neil Ferris.

Special thanks to John Gibson at EAR in Phoenix and Doedy Hunter at Apple Computer, without whom much of this information would never have seen the light of day; and to Tom Wojtas, who went with me into the MIDI jungle and helped me live to tell about it.

Thanks also to the teachers that made all the difference: John Kunkel, David Bernstein, and Professor Thomas Werge. Your efforts meant more than you'll ever know.

Credit is due to the residents of Skid Row at the University of Notre Dame, who put up with 3 A.M. experiments in guitar amplification; most especially to Mike and Barb Johnson, who provided me with a place to lay my laptop computer in the final hours of this writing; and to the Boys, Dan Collins and Tim Dunn, who still don't believe that I actually work for a living.

I am grateful to my father and mother, and to my brothers and sisters, Lee, Anne, Bob, Ed, Margi, Jim, and Mike. Without any of them, there would be no love of music, no guitar playing, no new music to be created, no lessons to be learned, and no book in front of you.

And thanks, of course, to Trini. Dreams are always just that—dreams—until someone gets you to chase them.

Introduction

Technology is an easy thing to deal with. Each of us encounters some form of modern technology every day, perhaps every waking hour. Telephones, microwaves, VCRs, new cars, calculators, stereos, televisions, and a host of other products are all examples of devices that we handle easily, without ever thinking twice about it.

Dealing with music technology should be the same way. That's the reason for this book.

Unfortunately, whenever you talk to other musicians about advances in music technology, their eyes tend to glaze over. I can't count the number of times I have been in music stores and listened to people try to understand the techno-babble that comes out of product literature and brochures. On paper, very little of it makes sense. It is like listening to somebody read a description of how airflow and dynamic pressure affect a wing-shaped object to make aircraft fly. Listening to it is not the same as experiencing it.

At the same time, answers to questions are too hard to come by. Practical working knowledge of how equipment works in real life, and not in the manual, seems almost nonexistent when people look for help. The usual answer one hears for a musician with a technical problem is "I don't know, man. Maybe you've got the thing plugged in the wrong place somewhere." *Wonderful* words of advice. That and 20 cents won't even buy you a Dr. Pepper. And it sure won't resolve your equipment problems.

There is really no one to blame for this state of affairs, however. Many of the people who work on the technical side of developing this software and equipment think that it's pretty obvious to everybody. This attitude also affects other technical people, like some math teachers. These people believe that since it's readily apparent to them, then it must be readily apparent to anyone they explain it to. I had a calculus teacher who used to yell when I couldn't understand certain concepts, "What do you mean you don't know what the percentage of increase of the cubic volume of air is in a hot-air balloon rising at 20 feet per second with an outside temperature of 60 degrees and an internal temperature of 140 degrees? It's as plain as the nose on your face! Are you saying you *still* don't understand?" That's exactly what I was saying. Needless to say, I didn't excel under this man's direction.

Most people who work in music stores are trying to figure this stuff out for themselves just like the rest of us, but they're also trying to sell it. They can't spend a lot of time helping to work out all of your problems while other customers wait. This is also true for company representatives who are constantly trying to understand a never-ending array of equipment produced by their own companies.

This book will hopefully get around some of the obstacles to making the technology work for you. Over the last few years, I have spent too many days and nights fighting with equipment, yelling at software, swearing at manuals, cursing at manufacturers, and weeping openly at cables plugged into the wrong place, trying to get all of these tools to work for my own musical projects. Much of what I learned from those days of frustration is contained in this book. There are three points worth noting that I have learned from all of this:

- All of this neat stuff works—once you get past the fancy terms and names—and helps create music at levels far above what most of us have known in the past.
- If it *doesn't* work, check it again. 90 percent of all the bitching and moaning I did learning this stuff was because I wasn't paying attention—I forgot to plug a cable back in, or set the proper MIDI channel, or even turn something on. You know how you feel when you get into someone else's car and you can't find the door handle or the headlight switch? It's there, all right; you just have to keep looking for it.
- Never *ever* give up. Persistence is going to make you the master of this stuff. It only takes a little bit of time once you get started. If you give up, you lose. And then they send you to technology hell, where even the light switches don't work without a 200-page manual.

Now that you've read that, and committed it to memory for the rest of your musical life, let me go over a couple of things about this book.

With regard to how quickly modern music technology changes, I've tried to keep the description of certain products as general as possible. Too often you'll read about a new and intriguing piece of music equipment, only to find out that the manufacturer *already* has a new and improved version available that you really know nothing about. Or you buy something recommended highly in a book or magazine, and two weeks later, something with more features comes out, and you feel as if you got stuck with last year's model.

For these reasons, I've tried to avoid mentioning specific manufacturers and specific products, focusing more on what products in a certain category can do and what makes them do it. Individual products come and go, but product categories do not. I do single out particular machines and manufacturers in the context of their historical significance.

While refraining from discussing specific products, I do want to acknowledge certain products that formed the basis for much of the information and examples I've used in the following chapters. They include the Apple Macintosh II personal computer; the Alesis HR-16 Drum Machine, as well as the Alesis Midiverb II Digital Effects Processor; Passport Designs' Master Tracks Pro Sequencing Software; Coda Music's Finale scoring software; Opcode's Software Editor/Librarians; BBE's Sonic Maximizer; the Roland GM-70/GK-1 Guitar Synthesizer; Tascam's Series 388 multitrack recorder; numerous synthesizers past and present from just about every manufacturer; as well as assorted pieces of equipment that I've collected over the years, from the Echoplex to the IBM PC.

I've also tried to keep all of this from being too technical. Understanding the technology used in today's music equipment is helpful, but by no means a requirement. There are dozens of other resources—including books, magazines, and video—that will explain the significance of most significant bit data for controllers with assigned numbers of 0 to 31, or will explain exponential and linear-control input of tone oscillators. So if you want to explore any of the technical details that I talk about here in greater depth, there is an abundance of material available. By the same token, I feel that you can operate a car without understanding the relationship between a combustion engine and torsion-bar suspension, or play a guitar without knowing what kind of wood glue was used in the internal bracing.

The point I'm making is that this book is designed for those of you that want to get up and do something with this technology, make it work for you, and spend as little time as possible reliving your high school science class in the process.

There are terms, phrases, and concepts that I explain because they are so often used when referring to equipment. Again, I've tried to make it as painless as possible, and have addressed it from a nontechnical standpoint. We're all musicians here; there's no need to get scary by talking about the technical ecstasy of equations for determining the composite gain of amplifiers and attenuators. As great men throughout history have been known to say, "Shut up and play your music."

It's time. Starting now, there is no turning back without everybody else passing you by. So always remember to keep moving forward, and the technology will soon be as much a part of your music as your fingers are. Ready? Set?

Go.

Contents

1

Sound

This chapter is going to tell you everything you needed to know, but never got around to asking, about the very essence of music—namely, sound. Sound is little more than the movement of air in a particular formation. Even though you don't feel it, air is pressurized around you. Without it, you would explode from the inside out, which is a pretty nasty thought. Every time you make a sound, the movement that causes that sound makes vibrations in the air pressure, which results in sound waves. When you clap your hands, yell at the top of your lungs, or strum a guitar, you are making waves in the air pressure around you. These waves are very similar to the ripples and waves that you see in water. If you're standing next to a very still pool of water and dip your finger into it, ripples emanate smoothly out from that point to all edges of the pool. Think of this as a whisper.

Now, if you drop something big into the water—like a Cadillac—then the ripples become waves that slosh all over the place and create quite a pronounced effect. Think of this water-wave movement as the sound-wave equivalent of someone screaming bloody murder, or that lady you know who has the high-pitched hysterical laugh that makes you cringe whenever she's in the room. These are major air pressure disturbances resulting in major sound waves.

In the case of sound, air is what ripples and waves, not water. Interestingly, though, if you make noise in or near water, it travels a lot more clearly and faster than it does through the air. This is because water molecules are closer together than air molecules, and thus more of them move when they are disturbed.

As the sound waves move through the air because of a vibration and the resulting air pressure, they must be picked up by a sound receiver, which in our case is the ear. Our ears (and their internal workings like eardrums, cochlea, etc.) pick up the air pressure and, in conjunction with the brain, interpret them as *sounds.* No ears around? Then there are no sounds, just air pressure. Sound waves exist only as air movements until something translates the air pressure into actual sound. If a tree falls in the woods, and nobody is around to hear it, does it make a sound? No. That's right, *no.* Sorry to break this to you, but it's true. The tree makes sound waves, but unless something is there to interpret them as sound, they just move through the air until they fade out. Of course, this doesn't count if you include birds and bears, or somebody leaving a tape deck (another sound interpreter) recording all by itself in those same woods. Those animals can hear it because they have the proper ear mechanisms, and the tape deck has manmade sensors which pick up sound waves and convert them to actual sound.

Different types of hearing devices can pick up different types of sound waves. This is why dogs can hear certain high-pitched sounds, like whistles, that we can't hear. Our sound interpretation apparatus just isn't sophisticated enough to detect those types of changes in air pressure. The same is true of recording devices. Some can detect sound that we can't, and others don't pick up all the sounds that we hear. This is usually true in the high-frequency range of sound, where a recording device or microphone may not be delicate enough to capture those high sounds, leaving us with a sense of missing brightness or clarity in a recording.

Speaking of frequency, it is one of three physical attributes of sound waves, the other two being wave shape (or wave form) and amplitude. First, frequency defines the pitch of a sound, what musicians call the "high" or "low" of a sound. Second, the wave shape represents the timbre of a sound, also called its color or tone. Finally, amplitude corresponds to how loud or soft a sound is.

An additional and very important aspect of the physical nature of sound is not physical at all. It is time. Now before we embark on a Philosophy 101 discussion of the nature of man in relation to space and time, let's look at time practically. Sound is one of the only things that man deals with which is "time-bound," meaning time is an inextricable part of sound. You can't freeze an actual sound at a particular point in time and expect to be able to recognize that sound. You always have to view sound as a segment of time. For example, we can take a picture of an event and freeze it in time with a photograph, without regard to time. The photograph captures the specific essence of that event without any difficulty. More specifically, think of the movies. A film is actually a series of still photographs run in quick succession (24 frames per second), one after another. Each still captures an exact moment in time.

Try doing this with a sound—*any* sound. You cannot point to a frozen moment of time as you can with a photograph and say, "Oh, there's that sound." A sound has to be re-created at another point in time to be captured, and that re-creation involves making or playing that sound over a few seconds or minutes or hours of *time.* I hope all of this makes sense, because it tends to be fairly obvious. If it isn't, one method of proving this is to find a defective compact disk or CD player. On a defective disk, a segment of music only a fraction of a second long tends to loop itself continuously and very quickly. The resulting piece of music does not capture any of the essence of the song and is usually unrecognizable as a part of a particular song. This is because it requires a period of time longer than a fraction of a second for you to even recognize the resulting noise as music in the first place.

Do the same thing with a tape deck. Clip a length of tape about $^1/_8$th of an inch long and splice it onto a blank segment of tape. When playing it through the tape deck, see if you get anything other than a quick "bleep" of sound that doesn't make much sense. Even though this is a primitive example, it's almost like taking a snapshot of the sound or music. Yet you're still playing that sound through time, whether it's one second or $^1/_{100}$th of a second; you're still using time to get even a snapshot level of sound. You see the difficulty in extricating sound from time? It's impossible.

We can, however, look at representations of what a moment of sound looks like. These representations are positioned along a normal X and Y axis diagram like you might have used in grade school to measure the growth of populations per year, or how tall you grew every year. The X axis represented years (time) and the Y axis represented amounts of growth or population at each point in time—literally, the *what* that happens over time.

Here are some quick examples. In Figure 1–1, the difference between the two pictures is the number of waves created over time, or the frequency. Note that these are examples of tones which do not change over time. Although such kinds of frequencies can be generated with electronic

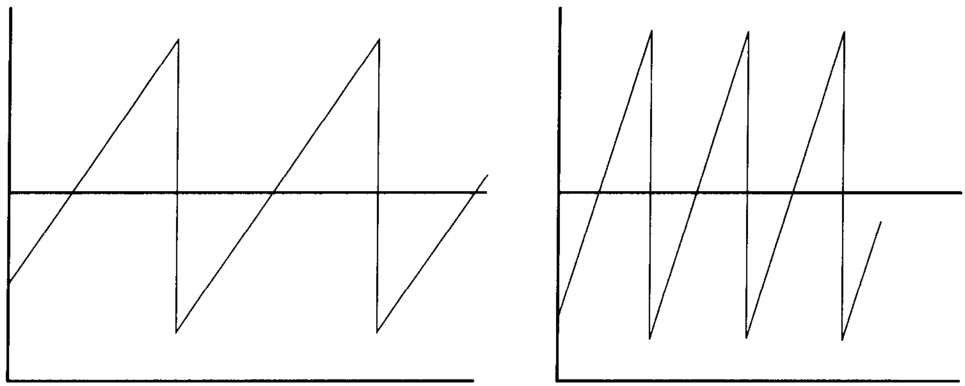

Figure 1–1. Variation in frequency (pitch) of a sound wave.

equipment, natural sounds all fade (decay) or change over time (an in-depth discussion of this occurs in Chapter Five).

In Figure 1–2, the difference is the timbre, or actual shape of the waveform over time.

The only difference in the two pictures in Figure 1–3 is the amplitude, or how loud the sound is.

Finally, the two diagrams in Figure 1–4 differ in every respect; there is no sameness in frequency, wave shape, or amplitude between the two.

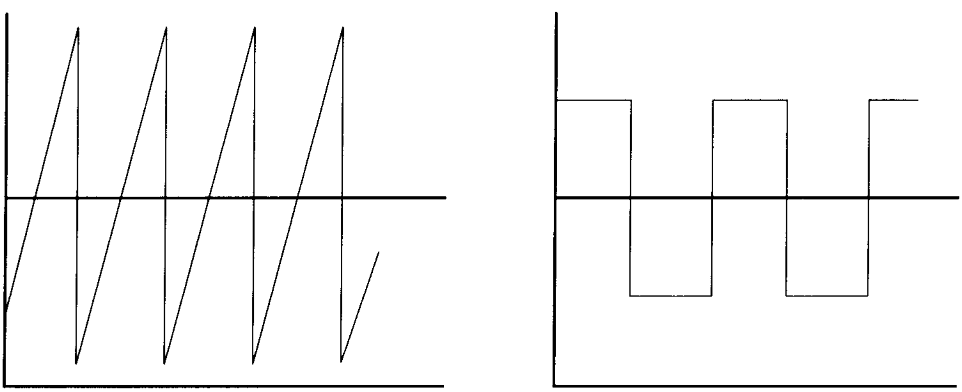

Figure 1–2. Variation in shape (timbre) of a sound wave.

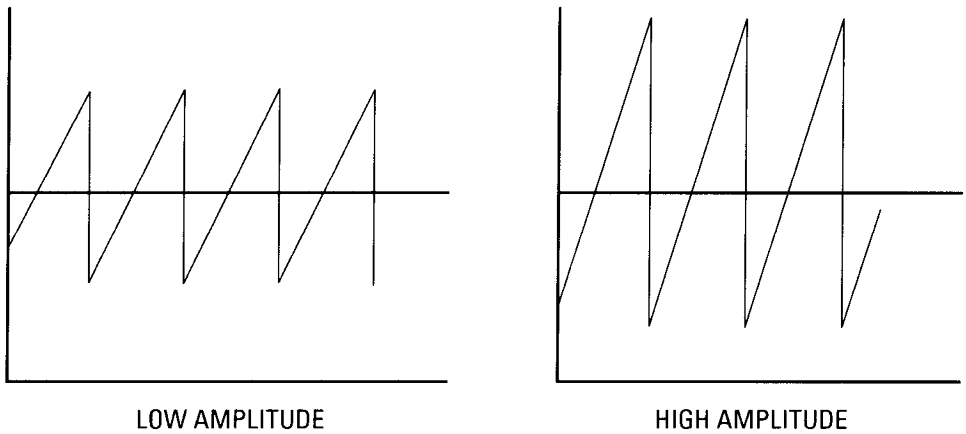

Figure 1–3. Variation in amplitude (volume) of a sound wave.

How do we get these nifty diagrams? They are really graphic representations of sound taken as electrical response to the air pressure of sound waves. When a microphone or pickup is hit with sound waves, either a diaphragm (in the case of the microphone) or a sensitive magnetic field (in the case of the pickup) is vibrated, much like the pool of water described earlier. Only instead of water ripples, these mechanisms send electrical impulses in response to the waves. The impulses are sent to an amplifier which in turn strengthens these pulses and sends them to

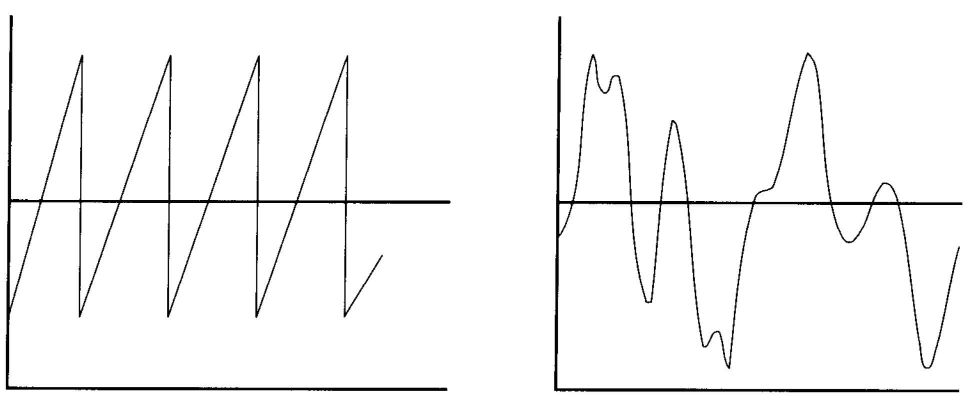

Figure 1–4. Variations in all properties (frequency, shape, and amplitude) of two sound waves.

a speaker. The speaker then vibrates in sympathy with the strong electrical signal it receives and pushes that sound *back* into the air. Then—ta da—your ear picks up these speaker waves as sound. A good way to examine this is to take the front screen away from a stereo speaker, and watch how sound (especially very strong and very low bass notes, like a kick drum) will force air out of the speakers and create very noticeable air pressure.

All of this can be observed with an oscilloscope—a device that creates visual representations of waveforms, like those shown in Figure 1–4.

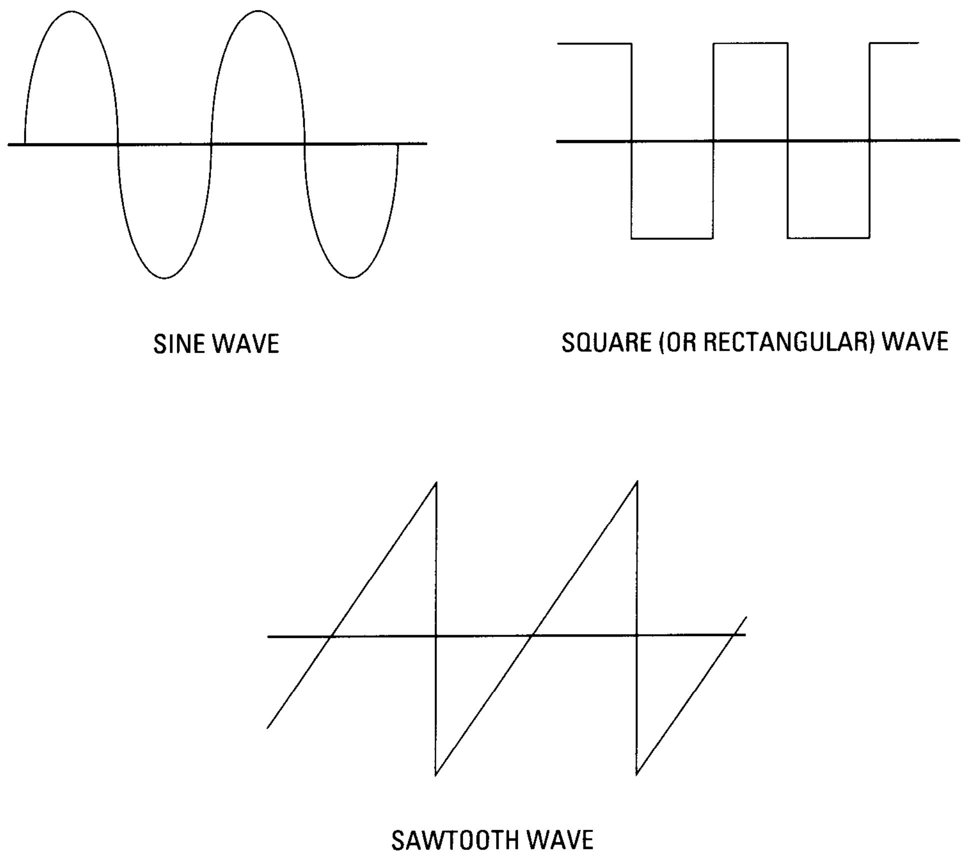

Figure 1–5. Variations in waveform.

And the properties of sound represented on the X and Y graph can be described with very scientific-sounding terms. For instance:

- *Hertz* is a measure of frequency, one Hertz being equal to one complete cycle per second. It is called Hertz simply because it is named for the man who defined the measurement, H. R. Hertz. It's abbreviated as Hz. The lower the Hertz, the lower the frequency, the deeper the tone. Low Hz levels produce bass tones, high Hz levels produce treble tones.
- Amplitude is discussed in terms of *decibels* (dBs), or loudness units. Unfortunately, the measurement of exactly what constitutes a decibel is based on a bizarre algorithm that even most physics professors have a hard time understanding. Suffice it to say that normal conversation occurs at about 60 dBs, planes taking off create a roar of about 120 dBs, and your eardrums are in serious danger of meltdown around 160 dBs.
- Waveforms are usually defined by their shapes, or obvious and regularly occurring characteristics. Those shapes are sine waves, square waves, and sawtooth waves (Fig. 1–5).

Those are really the basics of sound. Although you didn't expect to get a crash course in the physics of wave formation and movement, don't you feel better about everything now that you've learned all this neat stuff? Everything you read from here on, though, is devoted to the whys, whats, and hows of making sound into music with modern equipment. And no more physics lessons.