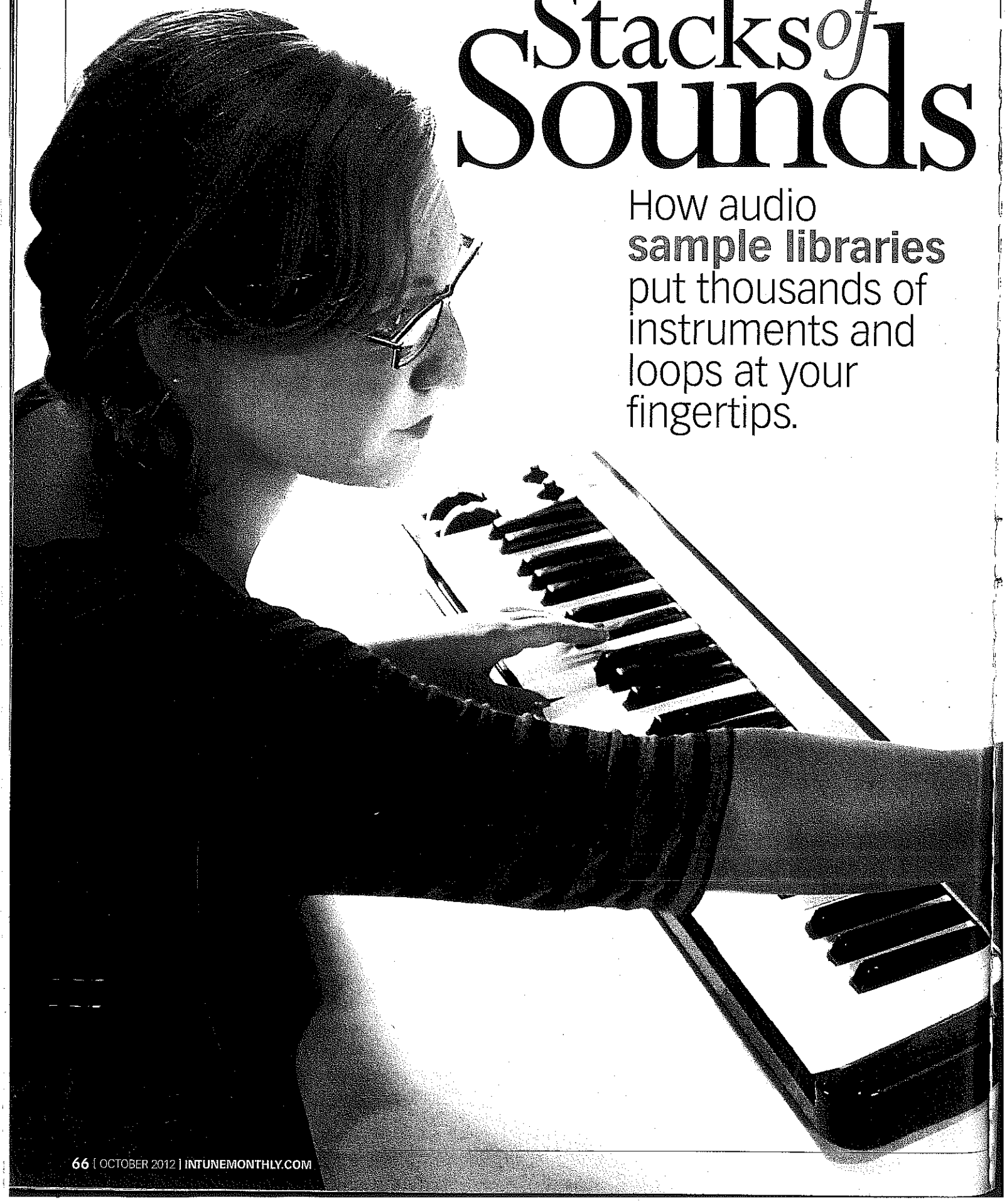
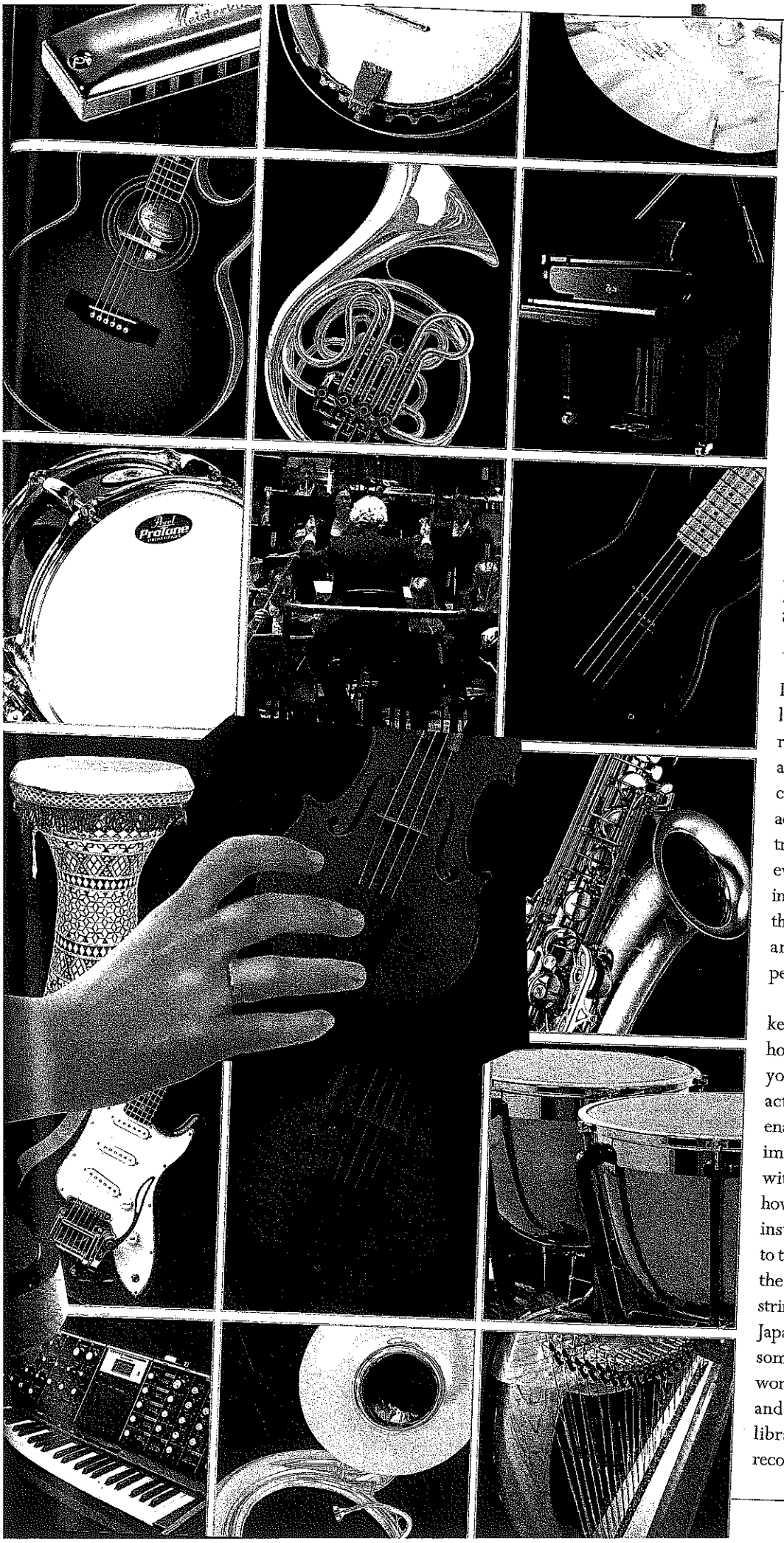
# Stacks of Sounds

How audio **sample libraries** put thousands of instruments and loops at your fingertips.





By R. C. Hudson

From accordion, bass fiddle, and clarinet to xylophone, yodeling, and zither, digital sample libraries enable electronic instruments, computers, and even mobile devices to reproduce the sound of any instrument in the world. But how do sound libraries work? How are they created? And how can you use them to make and learn about music?

Let's start with a definition: A sound library is any collection of digital recordings that can be triggered with an electronic musical instrument or computer. Sound libraries can include acoustic instruments and voices, electronic synthesizers, nature sounds, and even crazy sound effects. The sounds in such libraries fall into two categories: those that can be played as instruments and those that use pre-recorded performances known as loops.

If you've ever watched an electronic keyboardist hit a chord and wondered how it could sound like an orchestra, you've seen an *instrument library* in action. These collections of sounds enable performers and composers to imitate any number of instruments without necessarily having to know how to play the real things. A familiar instrument (like a keyboard) is used to trigger single notes and chords using the sound of anything from piano to strings, drums, synthesizers, pan flute, Japanese taiko drums, and more. If someone plays it somewhere in the world, you can bet it's been sampled and included in at least one sound library. Composers can write and record complex arrangements and try

out many different instruments just by choosing among the various sounds in a library. In fact, many of the strings, drums, horns, and even choirs you hear on professional recordings are actually digital sounds from a library.

There are literally hundreds of libraries available. Some specialize in one category. For example, XLN Audio's Addictive Drums and IK Multimedia's Vienna Strings devote gigabytes of memory to offer as many variations in sound as possible. Others offer a broader range of instruments, though each may have fewer variations. If you play a workstation keyboard like the Casio WK-6500 or the Roland GW-8, for example, the library at your fingertips includes percussion, winds, strings, piano, organ, choir, guitar, and more. Similar collections can be found in programs like the notation-based Notion (which includes samples of the London Symphony Orchestra), production software like Ableton Live and Apple Garageband, and computer-based instruments like Kontakt. All of these programs are designed to allow users to expand and customize their available sounds by adding "volumes" to their libraries.

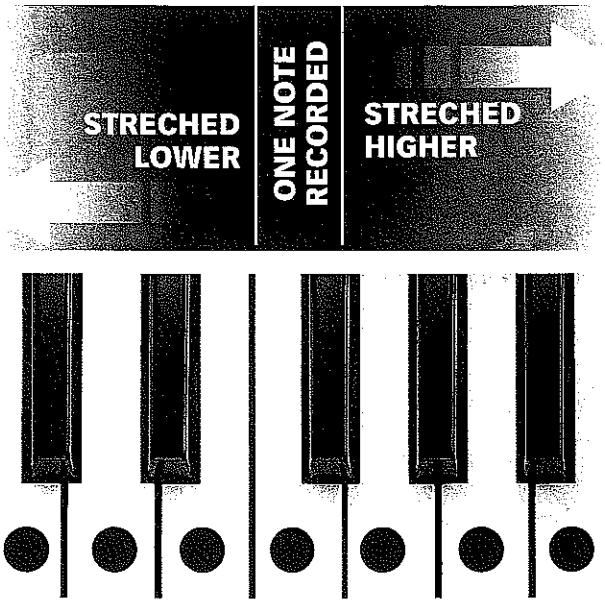



**Figure 1** Using a technique called "stretching," an F is sped up and slowed down to play every note in an octave.

## How Do Instrument Libraries Work?

We can answer that question by comparing what happens when you press the middle C key on an acoustic piano vs. a digital keyboard. On the real piano, the key moves a lever inside the instrument. The hammer at the end of this lever hits the piano's strings. The strings vibrate to produce a sound you can hear in the room. A digital keyboard's middle C doesn't move a hammer; it touches an electronic sensor. The sensor sends a message to a computer inside the instrument, telling it to call up a digital recording (known as a *sample*) of a real piano playing the note C. The sample gets processed by the instrument's internal circuits before you can hear it though a loudspeaker or headphones. Here's the cool part: The same sensor can be used to trigger any sound stored in the instrument's memory. So instead of piano, you can have middle C sound like a trumpet, kettle drum, or kazoo. All you have to do is load the sounds you want to hear.

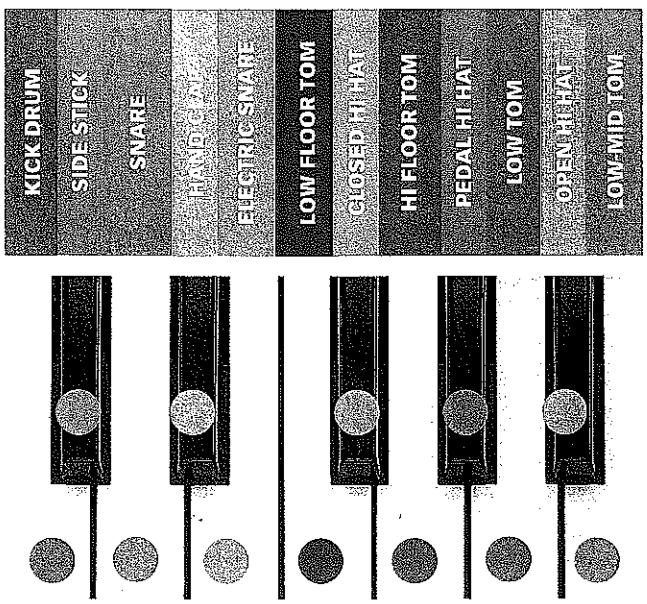



**Figure 2** In this drum library, each key plays an individual recording: kick drum on C, snare on D, etc.

## How Many Samples Are in a Library?

Good question! When sampling technology first appeared in the 1980s, memory was *very* expensive. Digital instruments couldn't hold very many recordings. Engineers would record one pitch, like middle C, and use electronics to "stretch it" and make it play a range of notes. It sounded pretty fake, but it was better than nothing. The recordings were usually really short, too. They used fancy editing tricks to get a note to sustain for more than a couple of seconds. But today, one digital instrument might include hundreds or even thousands of separate sample recordings, each capturing a variation in the sound.

## How Do the Instruments Play the Right Sounds?

They follow a *map*. But instead of showing which turns to take on the road, this map tells the instrument's memory banks which sample (or samples) go with each note. Remember when we explained how early instrument libraries used one recording to cover a range of different pitches? Look at Figure 1: One sample (the note F) is *pitch mapped* to cover the octave from C to B♭. The instrument's internal computer automatically adjusts the sample's speed to play the correct pitch. Because really wide stretches can sound unnatural, a different sample would be mapped to each octave.

Stretching can work when every note comes from one source (like a piano). But to capture the different parts of a drum kit, we need to map a different sample to each key. In Figure 2, we see that C plays kick drum, D snare, and F♯

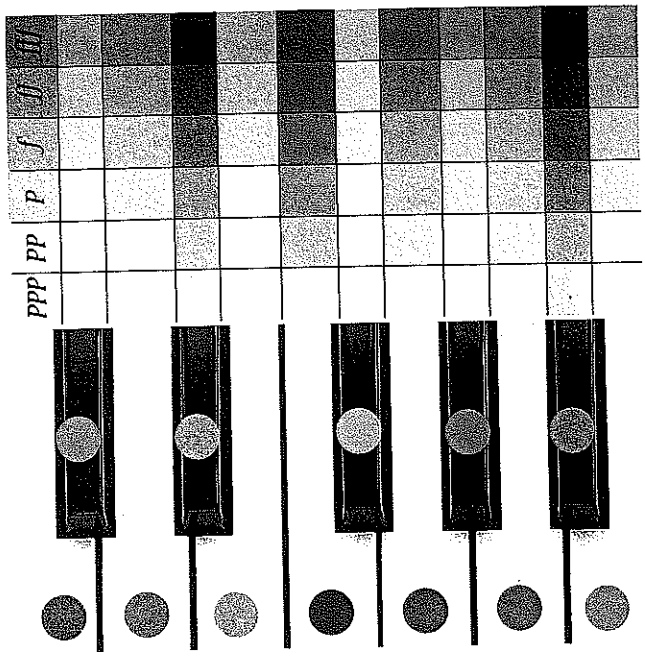
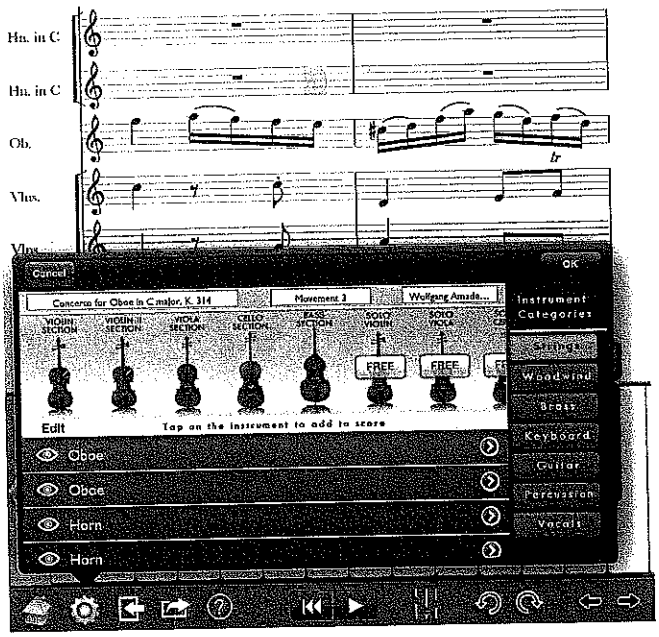
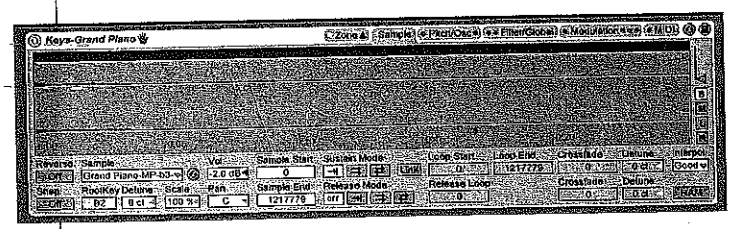



**Figure 3** Today's sound libraries use many recordings per key to create realistic variations between loud and quiet notes.




**Notion's** iPad app uses a sophisticated sample library to let users compose and play realistic orchestral scores.




**A window in** Ableton Live's Sampler instrument offers a range of editing options for each note.

triggers a hi-hat. There's no pitch stretching, but there's still something slightly unnatural about the sound because just one sample is used to play the loud and soft notes.

Now check out Figure 3. Each key is mapped to six different samples—some loud, some soft, some in between. The sounds are mapped to follow something called *velocity* (which measures how hard you hit the keys). Hitting the key hard triggers a recording of a loud note, which has a brighter tone than a quiet note.

Samples can be mapped to other performance factors, too. A saxophone library might be set up so that extra pressure on the keyboard (known as *aftertouch*) produces vibrato. A string library might assign a foot controller to change bowing techniques. Other controls let you adjust things like loudness, sustain, and tone. You can even make a sample play backwards and combine samples from different kinds of instruments to create sounds that would be impossible in the real world.

## What About Loop Libraries?

Loop libraries aren't all that different from instrument libraries, only instead of isolated notes, they sample short performances (usually one or two measures long). A loop may be of a single instrument (e.g., a drum or bass), or it might capture a full ensemble. While you *can* trigger them with a keyboard, you don't have to be a player to use loops: With the right music production software, computer (as well as tablet and smartphone) users can import, arrange, and edit prerecorded loops, which may come in libraries based on genre (EastWest's Modern Pop), instrument (Sony's Blues Guitar), or the work of a specific player (drummer Erik Harland's Looped).

## How Are Sound Libraries Made?

The digital sounds in your electronic instruments, computer, and mobile devices involve a lot of human labor. First, there are the people who design the hardware and software needed to run the instrument itself. Then there are the musicians who actually perform the parts used in the library. Their work is captured by expert recording engineers and producers in some of the world's best recording studios.

Good sound libraries may include hundreds of thousands of samples and take years to produce. "Most people feel that doing one note at a time is easy, but those who have recorded sample libraries know otherwise," explains Jim Boitnott of Notion Music, which includes extensive libraries in its computer and iOS music creation software. "Consistency is tough to maintain through hours of recording. You don't want the first note sounding one way and the next sounding different, and even the slightest change can affect the way the samples work together. So the engineer, musician, and all the other ears in the studio must pay close attention."

Engineers use computers to edit each sample to be the correct length, volume, and tone, store the sample in the correct format, load it into memory, and then adjust the sounds even more to create the presets. "The goal is always to make the music sound as good as possible," Boitnott concludes, adding that such precision is as valuable for students as it is for professional composers. "You can learn how instruments sound, their ranges, articulations, and more. Loops can teach you new rhythms. A quality sample library gives your performances more expression and helps you grow as a musician."