

On Synthesizers

digital sampling keyboards, part i: a brief history of tape and optical sampling

Bob Moog



JUST A FEW YEARS ago, digital sampling instruments were either laboratory curiosities or super-pricey computer-based studio equipment. Today, stratospherically-priced studio instruments like the Fairlight and Synclavier are gaining in popularity, while a new breed of performance-oriented sampling instruments, from the rack-mounted Akai S-612 to the 88-key Kurzweil, is emerging as the hottest trend in electronic musical instrument design. In this column we'll trace some of the historic highlights that foreshadowed today's digital sampling instruments. Next month we'll have a look at some basic principles of sound sampling, or digitizing. After that, we'll see what some of the distinguishing features of the currently available sampling instruments are.

Optical Recording. Sound sampling is the recording of one or more musical tones in such a way that the tones can be played back instantly on command, usually from a conventional music keyboard. Today's sampling instruments are all digital, and as high-tech as anything you're likely to buy for your own use. But, like so much else in the electronic musical instrument business, sound sampling has its roots deep in the early part of the twentieth century, when virtually all electronic music was experimental.

The first instruments that offered playback of recorded waveforms actually used optical recordings on glass or film. Milton Babbitt, a well-known American composer and one of the founders of the Columbia-Princeton Electronic Music Center, recently told an audience of musicians and doctors about the technology of drawing sound waveforms directly on film for movie score production. This technique was actually used to make the soundtracks for some Russian movies before World War II. Of course, waveforms on film could be played back immediately only in the sense that they could be precisely synchronized and assembled by conventional cinematic editing techniques. Babbitt's account is a fascinating glimpse into the multi-faceted world of experimental music. I'm planning to make it the subject of a whole column in the near future.

Optical sound recording technology was applied to commercial performance instruments after World War II. During the early '50s, when I was a teenager just getting into electronic musical instruments, the Baldwin piano

company introduced an electronic organ containing several rotating glass disks, on which were recorded, on circular tracks, the waveforms of actual organ pipes. There was a light source on one side of the disk and photoelectric detectors on the other side. When you pressed a key, you moved a shutter that allowed the light to pass through the disk at one of the tracks. This design not only provided rich, complex waveforms, it solved the problem of smooth attack generation. Back then, most electronic organs were not able to produce tones with slow attacks, but the experimental Baldwin design tied the shape of the attack to how fast you pressed the key—not unlike the classical tracker organ.

As it turns out, Baldwin's optical organ never made the big time, primarily because the disks had to be made to incredible accuracy in order for the tones to be free of wow and flutter. It was a mechanical nightmare—big, super-precision spinning disks with dozens upon dozens of flexible linkages going to the keys.

The same basic idea surfaced again about twelve years later in the Mattel Optigan. Mattel developed a line of 'fun machines' with short keyboards, tacky plastic spinet-like cabinets, and big flexible transparent disks containing a few dozen waveform tracks. Most of the tracks were of pitched notes, but a few contained rhythms and novelty stuff. The idea was that you could change disks to suit the kind of music you wanted to play—country and western, fox trots, and so on. It was fun to play the rhythm tracks. You could switch rhythms and drop in riffs with one hand while playing chords and melody with the other. Unfortunately, even though the Optigan was scaled to be a low-grade adult toy, the manufacturing problems proved to be insurmountable, and Mattel chucked the project.

David Van Koevering, an enterprising musical instrument salesman, pulled the basic Optigan technology out of the ashes and introduced an instrument called the Orchestron, which he aimed more at the rock-and-roll keyboard player. With an Orchestron, you could play strings and voice choirs, a musical capability that was very salable at the time (and still is!). Once again, however, the realities of manufacturing such a finicky mechanical system conspired with the usual financial and marketing demands that are placed on innovative musical instrument

companies, and the Orchestron, too, passed into history.

Magnetic Tape. Experiments with tape recorders and electronic music began in earnest after World War II. One experiment done in Paris was the Phonogen, a true sampling machine with keyboard control and high sound quality. The Phonogen played a regular magnetic tape, either off a reel or spliced into a loop. Instead of having one capstan to drive the tape at a constant speed, however, there were twelve or thirteen capstans in a circle, all going at once at speeds whose ratios were the same as the frequency ratios of the notes in a chromatic scale. Each capstan had its own pressure roller, and each roller was linked to a key on a little one-octave keyboard. When you pressed a key, you pressed the tape against one of the capstans, thereby causing the tape to play back at one of twelve chromatically related pitches.

With this system, you had electronic sampling (onto tape) and real-time playback under keyboard control. What you didn't have were the ability to start a note at the same point on the tape every time, and the ability to play chords.

Both of these shortcomings of the Phonogen were dealt with in the Mellotron and the Chamberlain. These instruments used a whole set of short tapes, each of which was activated (that is, pressed against a constant-speed capstan, which pulled it past a playback head) by a key of a short but conventional keyboard. In both machines, a tape started from its beginning each time you pressed a key, and rapidly repositioned itself to the beginning as soon as you let go of the key. Thus, you could play the starting transient of a complex sound if you were careful not to repeat a note too rapidly. Chamberlain's machines were well known and widely used by West Coast musicians during the '60s and '70s. The Mellotron, on the other hand, was professionally marketed while rock and roll went through its growth phase, and by the early '70s had become an indispensable staple of the rock keyboard arsenal, despite its mechanical complexity.

Enter The Digital Era. At their best, analog sampling instruments—the Chamberlain and the Mellotron—produce sound whose quality is marred only by the usual tape noise and flutter. You can play any number of notes and hold

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