The Life and Work of Hugh Le Caine

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Drip, drop – “Dripsody”! – an entire piece of music composed using the sound of one drop of water falling into a bucket. The first voltage controlled synthesizer, called the “Electronic Sackbut”. An early looping multi-track tape machine called the “Special Purpose Tape Recorder”. A controllable Oscillator Bank producing 200 sine wave tones 5 Hz apart. A programmable analog serial music sequencer. These and more are the work of one man – and clearly one with a sense of humor – in the late 1940s, early 50s none the less. Hugh Le Caine was an important pioneer in the fields of early music synthesis and recording and a composer in his own right.

Le Caine's work in both invention and composition was a result of his dual capabilities as both a scientist and a musician. For instance, the electronic components that Le Caine used were not new in themselves – many of the oscillators and filters were used in the radar technology with which Le Caine had worked with extensively. But no one had yet thought of reducing the frequencies to the level of human hearing and using that to create music. Le Caine held a master of science degree from Queen's University, became a member of the National Research Council of Canada (NRC) and did graduate work in physics in England. Le Caine worked extensively with radar at the NRC, but devoted much of his time at home to the creation of new electronic musical devices. Eventually the NRC gave him a studio to work on creating electronic musical instruments.

One of the first and perhaps the most famous of Le Caine's instruments, created in 1945, was humorously called the “Electronic Sackbut”. This novel instrument was in fact the first voltage controlled synthesizer. It was designed to create an electronic tone that would be playable using a keyboard and give the performer control over expression and the considerable musical minutia that was lacking in most realtime electronic instruments. The Sackbut played only one note at a time, but gave the performer the ability to change amplitude and pitch continuously using a touch-sensitive keyboard. On any given key, a vertical motion produced louder or softer attacks, or even crecendi or decrecendi, and a lateral motion produced a smooth change in pitch. Le Caine

described this feature of his instrument:

> …By applying lateral (side) pressure to the key such subtleties of pitch control such as a smooth slide from one note to another, the vibrato or wavering pitch which a violinist produces by rocking his finger back and forth on the string, and the occasional use for musical purposes of sounds which are not on the musical scale or are off pitch can be produced. The extent of pitch change in any direction produced by this later pressure may be made as much as an octave either way.[1]

This flexibility allowed the instrument to convincingly emulate the performance style of a wind, keyboard or string instrument, as well as create the more 'electronic' sounds germane to a synthesizer. The capacity for expression can be heard in demonstration recordings of the Sackbut being played in both jazz and classical styles[2]. Timbre was also controlled in realtime. While one hand could be used to play the keys, the other was use to modulate timbre through a series of controls, including a disc that could be repositioned to change the waveform, generating square, triangle or sine waves and adding or removing harmonics. A separate control switched between several different formants, altering the way in which the sound was represented in the spectrum. Le Caine continues:

> One device produces and effect similar to a rasp in the voice or the buzzing produced by a trumpeter. Another mechanism produces breath tone as sometimes heard in the flute. These effects are of course introduced in only small amount and only occasionally, but they add to the expressive power of the instrument and avoid the monotonous purity of the electronic tone.[1]

Clearly Le Caine was not a Karlheinz Stockhausen. He did not believe that the future of music lay in regimented patterns of controlled partials, but in the amplification and transformation of the expressiveness and feeling of the human performer by means of electronics.

The musical parameters of the sackbut were controlled using a voltage

control method similar to the one used later by Robert Moog and others in the design of modular analog synthesizers. In fact, it is very possible that Le Caine's voltage control designs influenced Moog. In the Sackbut, the performer's actions controlled the voltage of the circuits within the Sackbut. The amount of voltage then controlled various aspects of the sound created including the pitch, amplitude and timbre. For example, the touch sensitive keyboard controlled voltage through the proximity of electrodes on the bottom of the keys to others mounted under them. As the performer pushed down farther on the spring loaded key, the electrodes underneath would become closer and current would be increased. Other components controlled in this manner included the oscillator, filters and frequency and amplitude modulators.

Another innovative musical device designed and built by Le Caine was the “Special Purpose Tape Recorder”, a variable speed multi-track tape machine capable of playing back six mono and later ten stereo tapes at once. Playback speed could be controlled independently for each tape through a several octave keyboard and volume could also be controlled via the touch sensitivity of the keys. If loaded with tape loops, this machine could be used in much the same way as a modern looping sampler. Models of the Special Purpose Tape Recorder were used in the University of Toronto and McGill electronic music studios. Le Caine used this instrument to compose his famous “Dripsody”.

Le Caine, although he did not consider himself a composer, created several innovative works. However, he always maintained that the compositions he produced were little more than demonstrations of his various apparatae, preferring to leave 'real composing' to the 'real composers'. Perhaps his most famous composition is “Dripsody”, an entire musical work created completely from the sound of a single drop of water falling into a bucket. Two versions were created. The first was in Mono and was only about 1 ½ minutes long, and the second was created in stereo and was considerably longer. Through the use of his Special Purpose Tape Recorder, Le Caine looped and processed this very common and extremely short sound into a complex series of harmonized pitches of surprisingly varied durations.

Le Caine created a tape track demonstrating and discussing the processes he used to compose “Dripsody” [2.] It's creation involved the following steps: After recording about 10 minutes of water drops, Le Caine selected his favorite sounding drop and cut

from the reel. He then spliced it into a loop of non-magnetic tape. Varying the speed of the tape recorder to obtain different pitches and rhythmic patterns, Le Caine recorded 10 minute tapes transposed to different octaves. The piece consists of a multitude of these short sounds that indeed sound like water drops. However the long, sustained notes that the piece is built on top of are also created using the sound of the the drip. In order to make notes continuous notes out of a water drop using variable speed tape, one would have to transpose the drip to the very edge of the range of human hearing (the author of this paper tried it himself using a computer). To avoid this issue, Le Caine transposed the drip down by only three octaves and made many copies of the resulting tape. From there he extracted segments that had nearly constant amplitude, copying and spliced them together to create a loop of continuous tone. This loop was then copied several times and used in creating the final composition. Thus there is a mixture of different durations in the piece. Dripsody is an oft played example of Musique Concréte.

Le Caine continued to invent throughout his life. He is credited with creating 22 new electronic musical instruments. Some of his later achievements include the Touch Sensitive Organ, Polyphone, Spectrogram, Sonde, Oscillator Bank, and the Serial Sound Structure Generator. Although many of these instruments were built for the electronic music studios of the University of Toronto and McGill, none of Le Caine's instruments were ever commercially produced. Many of the advanced features he included in his instruments were not incorporated into mainstream music technology for quite some time. The Touch Sensitive Organ, for example, included, as the name implies, an expressive touch sensitive keyboard. Although the Baldwin Organ company took out a patent on Le Caine's keyboard, it was sat on for many years and Baldwin never built the design into its instruments. When touch and velocity sensitive keyboards were first commercially produced, they used a different method from Le Caine's. It was as if the musical world was not yet ready for the advances Le Cain pioneered. Perhaps if he had been working with instrument manufacturers instead of the scientific community at the NRC, some of his designs could have made it into the market. But he was not overly concerned with this. He showed that things like touch sensitive keyboards were possible.

The Polyphone took the idea of complex, multi-pitch generation to the performance level. It was an early polyphonic performance synthesizer built in 1970, before the technology was commercially available. Each of the 37 keys had its own tone

generator and separate waveform and pitch controls. Foot pedals below and a control panel above allowed he performer to adjust further parameters of the sound. Unfortunately, it was very difficult to learn to play.

The Oscillator Bank built in 1959, and the Sonde, built in 1968, are further examples of instruments with a large number of oscillators. Both were designed to create complex tone clusters and were built in configurations controllable via touch sensitive or printed circuit keyboards or Le Caine's automated control devices such as the Spectrogram and the Serial Sound Structure Generator. The Oscillator bank was built in configurations with 12, 16, 24, and 108 oscillators, all capable of sounding simultaneously. The Sonde could generate 200 tones 5 Hz apart. These sound generators allowed a tape music composer to create complex sections and loops for a composition without reducing sound quality and spending precious time overdubbing every single partial from a single oscillator.

The Spectrogram was basically a bank of photo sensors that could act as a controller for other musical devices. A sheet of 10-inch wide graph paper was fed through it and illuminated from above by a light bulb. Scores were created by drawing with black ink on the thin graph paper. When a section of black passed over a sensor, it would activate the oscillator to which it was wired. Le Caine composed a series of synthesized birdsongs using this device. The results are very convincing. Upon first hearing them out of context, the author of this paper was unaware that they were completely synthetic.

The Serial Sound Structure Generator, created by Le Caine in the years 1966-1970, was a type of sequencer, predating the simpler types found on analogue synthesizers in the 1970s. This sequencer used analog means to sequence pitch, attack, duration and timbre in the style of 12-tone serialism. These parameters were controlled through the use of a switching system similar to that in early telephone switchboards. The composer could manipulate these controls in realtime. This instrument was meant to be a programmable controller for use with other studio instruments designed by Le Caine, including the Special Purpose Tape Recorder.

Common threads throughout all of Le Caine's instruments could be said to be the necessity for playability and expression and a belief that different components should be able to function together as a unit (an idea the author of this paper believes

should be better implemented in today's music software). These concepts are still finding their way into electronic music technology. An average velocity sensitive keyboard today does not have the flexibility that was afforded by Le Caine's designs of 50 years ago. Although the amount of different sounds that we are able to create today and the ease with which we are able to create and edit them is much greater than in Le Caine's days, the human expressiveness of the electronic sackbut, as silly as its name might sound, is difficult to find in most of the instruments used today to create electronic music. And, although Le Caine's designs were never available to the public, his ˙ pioneering efforts helped pave the way for the future of electronic music.

Sources:

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