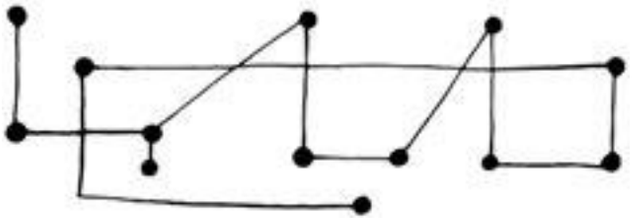

NEW APPROACHES TO ANALOG-STUDIO DESIGN

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THE ELECTRONIC Music Studio of the State University of New York at Albany was established in July 1966, on a grant from The Research Foundation of the State University of New York.

As in so many studios, the primary problem is that of finding continuous and sufficient funds for an adequate development. In a stringent budgetary situation the choice of which instruments to buy becomes more crucial; the instruments dictate the possible sounds as well as studio efficiency in producing them.

Until recently, most of the instruments used in composing electronic music were commercial items, not specifically designed for use in an electronic music studio, which has resulted in a lack of standardization in studio equipment. At the moment, however, both the R. A. Moog Co. and the San Francisco Tape Center offer for sale modules designed specifically for the composition of electronic music and incorporated into more or less standardized systems. If we conceive of a studio as being a super-complex instrument shaped to certain efficiencies by a balance of its components, these systems comprise the essential prerequisite concept to the formulation of a studio design which can become the "standard instrument" from which deviations can be measured. Considering economics and progress, some degree of standardization is clearly desirable. A composer should be able to select from among ready designs the components for his studio so that the studio is always functional and financial waste is minimized by the addition of instruments without replacement.

Whereas waveforms and white noise remain the electronic sound sources, innovations in studio design deal with problems of studio efficiency. The so-called "classical" studio is the "manual" studio, where each sound is produced, recorded, edited, and mixed separately. The work-time to produced-music-time ratio is extremely unfavorable. An alternate conception of studio design is one that incorporates programming devices which coordinate the production, shaping, and mixing, in sequence and before recording, thus minimizing splicing, signal decay from excessive tape copying, and lost time. There is, today, sufficient electronic knowledge to design and construct any studio. The problem

is how to conceive an economically feasible realization of this knowledge in the form of a compositionally useful instrument. I offer the following designs for sequencers, instruments that program a series of sound events in a certain order, that can be used singly or can be integrated, in any combination, into a general sequencing system, as one solution to that problem.

The electronic designs of the sequencing machines described here are the result of conversations between myself and Robert Moog, who was the first to apply the principle of voltage control to electronic music instruments and whose system of voltage-controlled modules provides the essential background for this article.

Each of the three sequencers consists of two sections: (1) the sequencing/control section, which tunes the source and/or determines the timing of each stage, and (2) the envelope-generator/VCA (voltage-controlled amplifier), which produces the event by releasing the signal with an envelope.

Sequencer type one (Fig. 1) is designed to trigger a series of sound events from different sources, each with its own envelope. The duration of the entire series is defined by the time a ramp voltage takes to arrive at a fixed high point from a fixed low point. The sequencing/control section of sequencer type one consists of one ramp generator and as many trigger voltage generators (hereafter TVG) as there are stages. The TVG "on," reacting at a certain percentage of the ramp, generates a voltage that triggers the envelope generator,[1] shaping the signal with an attack and a decay to the sustaining level. At another percentage of the ramp, the TVG "off" terminates the voltage, bringing the signal to zero intensity. Since the TVG "on" and "off" are set independently, the beginning can occur at any moment, and the duration can be any length, within the ramp duration. The stages may be triggered in any order with as many simultaneities as there are stages.

Sequencer type two (Fig. 2) is designed to trigger a series of sound events, each with an independently controlled envelope and duration, from a single source. No simultaneities are possible since the initiation of every stage interrupts the previous stage. The sequencing/control section consists of three horizontal rows of control voltage settings, marked *a*, *b*, and *c* in the diagram. Each row generates a control voltage which changes from stage to stage, according to the settings. In the diagram, rows *a* and *b* are used to tune a dual signal source, in this case two voltage-controlled oscillators (VCO),[2] and row *c* is used to determine the

[1] The R. A. Moog voltage-controlled amplifier (or VCA) performs any amplitude modification, on any signal, by the application of a control voltage, so that a pattern of control voltages modifies any signal into a certain envelope shape. The instrument which generates this pattern is the envelope generator.

[2] A VCO is tuned by the application of a control voltage. As the control voltage is changed, the signal output (frequency) changes.

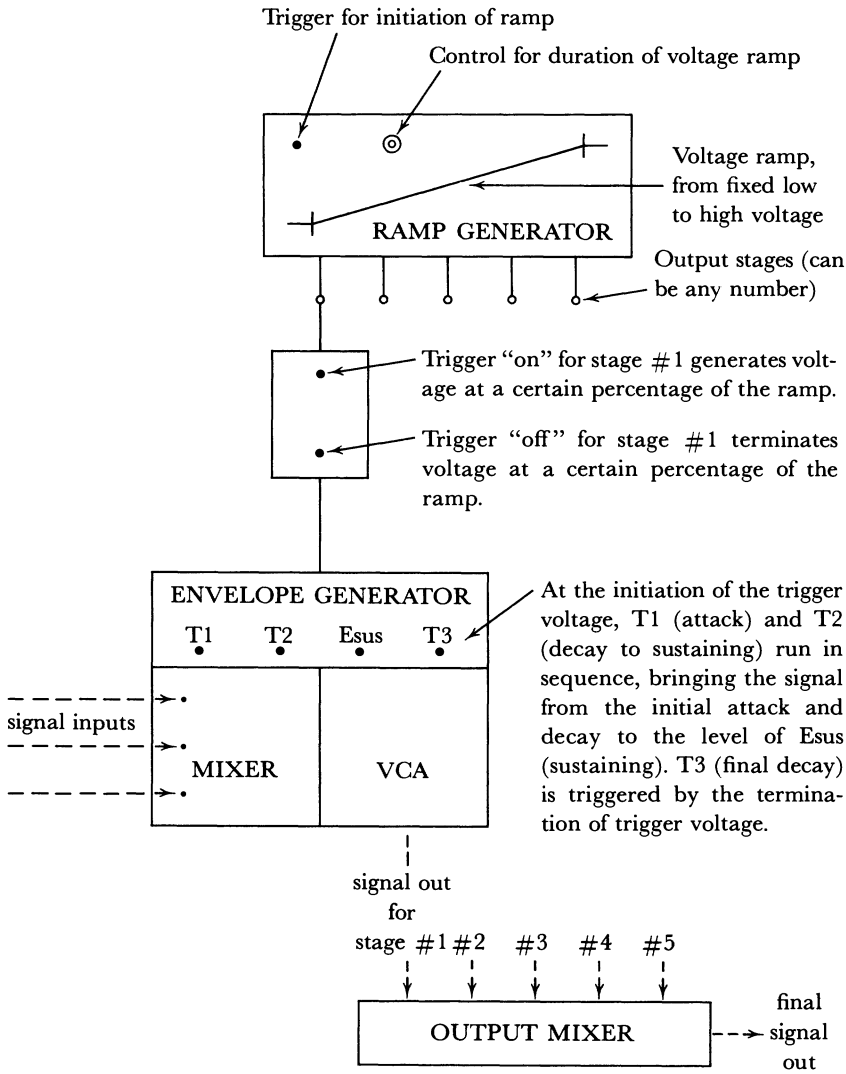

Fig. 1. Sequencer Type One.

speed of succession from one stage to the next by tuning a control oscillator whose frequency triggers the beginning of each event.

Sequencer type three (Fig. 3) is designed to trigger a series of white noise envelopes, each envelope independently controlled, from a single white noise generator. The principle of operation is similar to that of sequencer type one. Added to the envelope-generator/VCA section, however, is a fixed narrow band-pass filter that can be turned to select

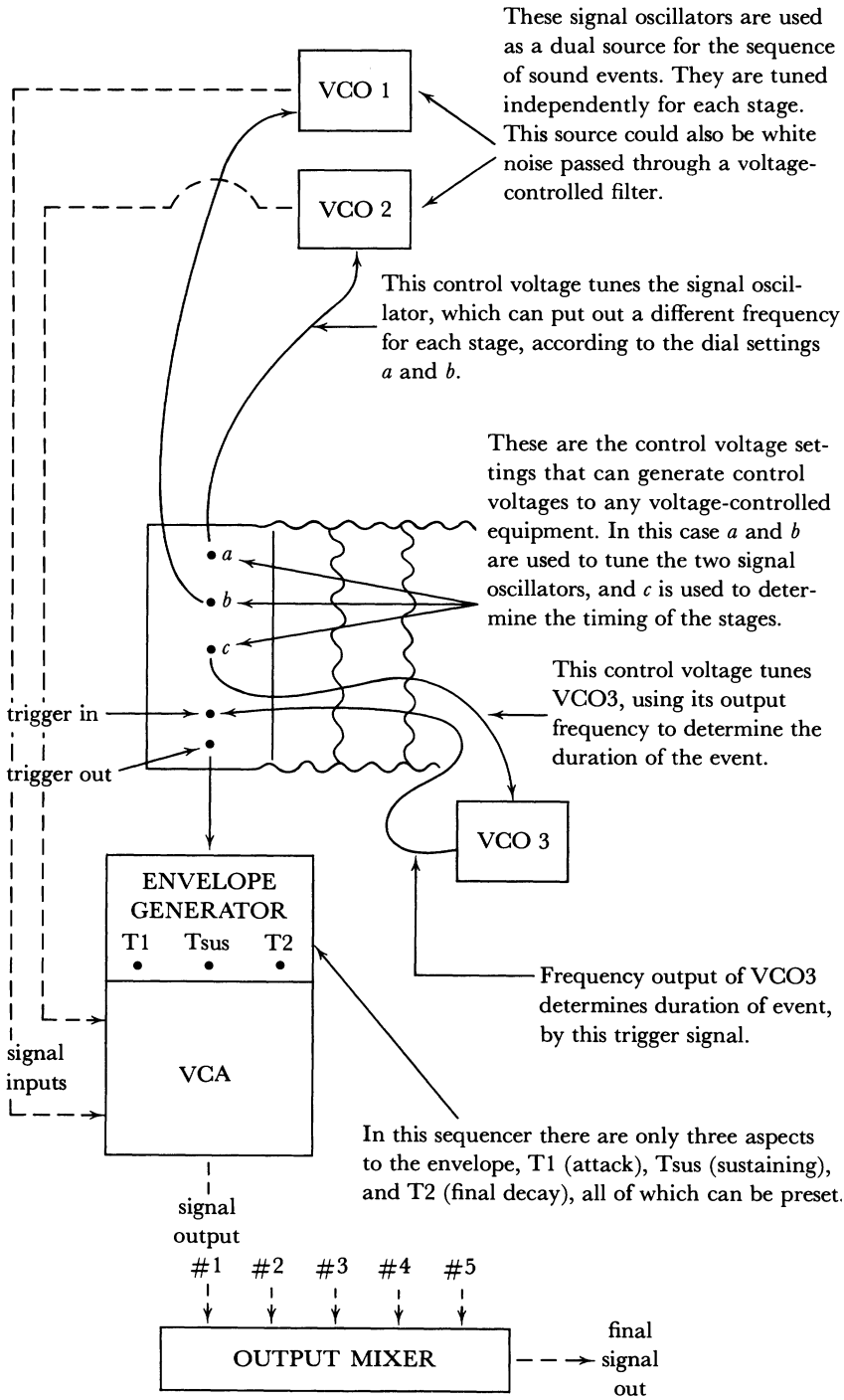

Fig. 2. Sequencer Type Two.

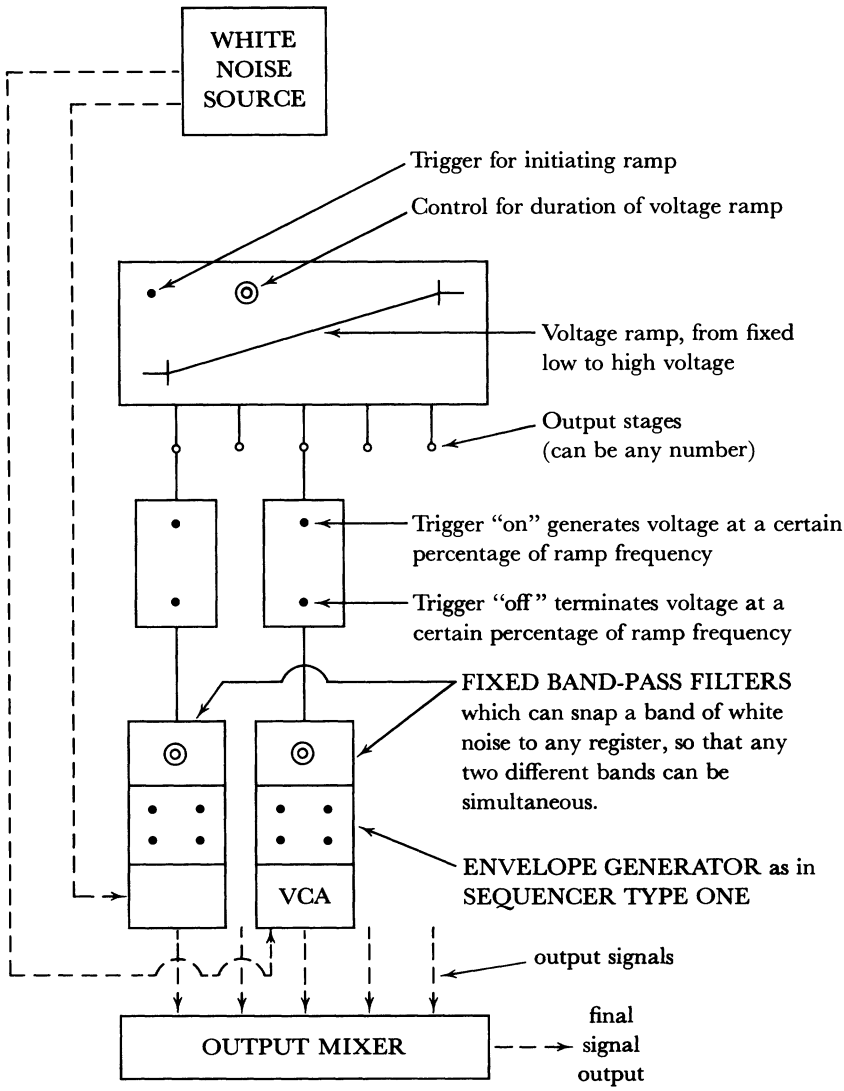

Fig. 3. Sequencer Type Three.

a certain band from several positions. When used with a single white noise source, however, only different bands can be produced simultaneously.

Each of these sequencers can be used individually or integrated into a system (Fig. 4) which is extremely flexible. The integrated system begins with the sequencing/control section of sequencer type one. Using the ramp generator and a TVG for each stage, any sequencer or any stage

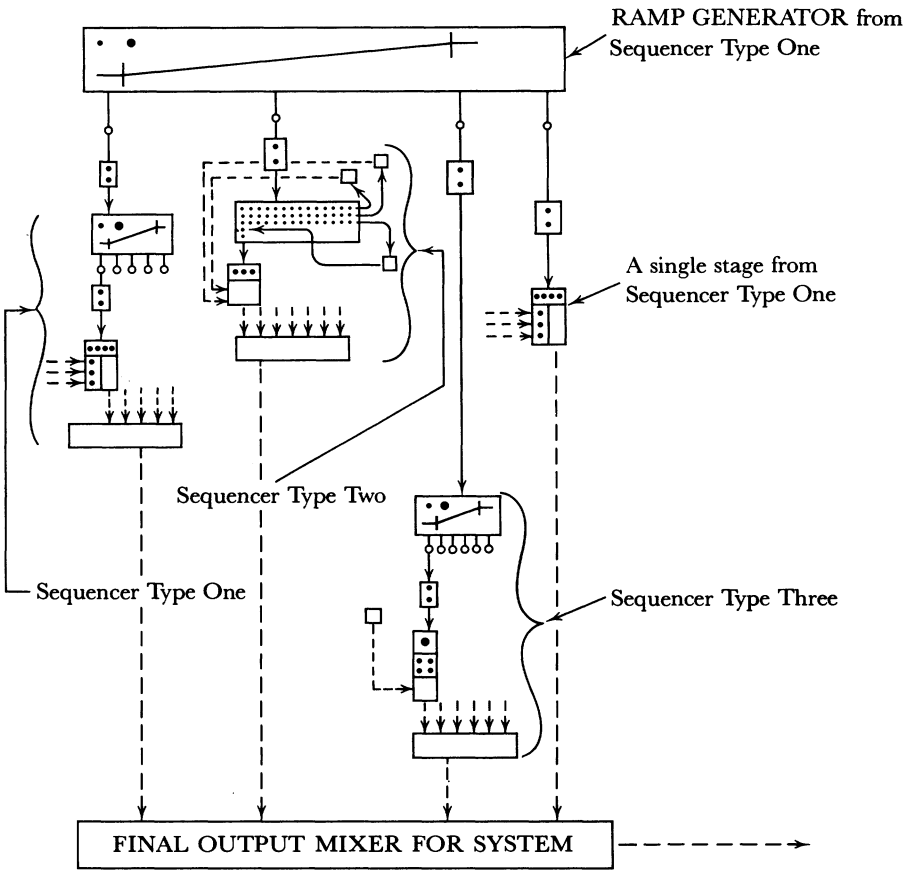

Fig. 4. Integrated System of Sequencers.

from sequencer types one or three can be attached as stages. This allows for a great variety of rhythmically complex sound events to be programmed, and since the components are interchangeable, virtually any piece can be composed. The additive nature of the system makes it practical. An idea of the "finished" studio can provide guidelines for the earliest purchases of equipment to which can be added one sequencer, then another, and so on.

Central to this type of system is the conception of the studio as a basically analog instrument which is controlled without an intermediary information symbology. The composer composes *with* the sound. The vision of a studio as only the first step to synthesizing or computing overlooks this, since in using the synthesizer or computers pre-prepared

information is fed into the machine through a digital intermediary. Paper tape readers in electronic music studios, while not inadmissable, are aesthetically inconsistent because they, too, seek to control an analog production with digital information.

It is not unimaginable that the studio of the future will be controlled from a central console that will be the only instrument with which the composer will come into contact, and that generators will be activated and controlled through a hierarchy of sequencers and switching systems. All that will be necessary, after composing the piece, is to push the button.