Constructing An Arabesque Generator . . . The Analog Shift Register

by Arpad Benares

In the Serge Modular Music System, the module called the Analog Shift Register (ASR) performs the invaluable function of providing a simple means of creating arabesque-like forms in musical space. Arabesque is a word often applied to oriental arts to describe the travel in graphic space of two or more like forms, for example: leaf with leaf, vine with vine, etc. in a perpetually intertwined manner.
Fig. 1

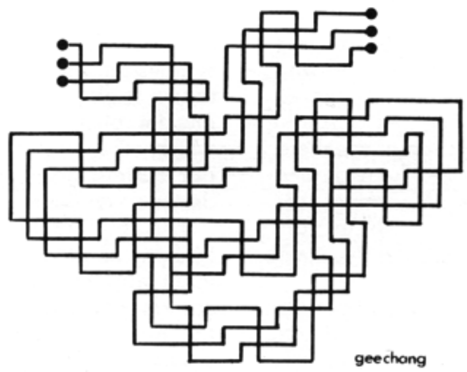

Figure 1: An arabesque design

Contemporary musical examples of arabesque-like forms can be found in the music of Terry Riley, where they arise through the combining of modal-melodic riffs with their tape-delayed echoes. Oriental and Western musical traditions offer an incredible variety of examples of similar or related forms of the process of arabesque: accompanied melody (homophony) as in Chinese music, inter-locked motives as in Javanese music, the canonic and motivic forms in Western music, etc.... What is the ASR? The Serge System catalog description runs as follows: "The Analog Shift Register ... is a sample and hold with a twist. Whenever pulsed, the previously held voltage is sent down the line of three outputs, yielding thereby the electrical equivalent of canonic musical structure. A special pulse output permits linking two or more ASRs together to form longer units." To give a musical example of this operation, let's assume that the voltage output of a keyboard is plugged into the analog input of the ASR, and the keyboard's triggers used to give sampling commands for the ASR. Furthermore, assume that the ASR's three outputs are patched into three oscillators.
Fig. 2

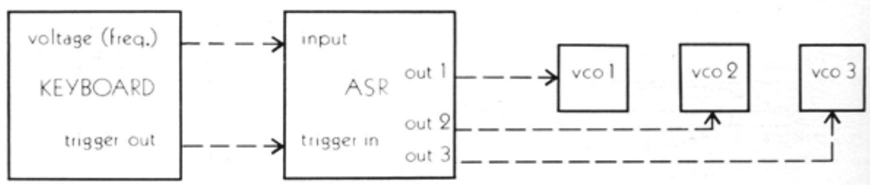

Figure 2.

The results of this patch are shown below, both in terms of voltage levels and hypothetical musical tones:
Fig. 3 + Fig. 4

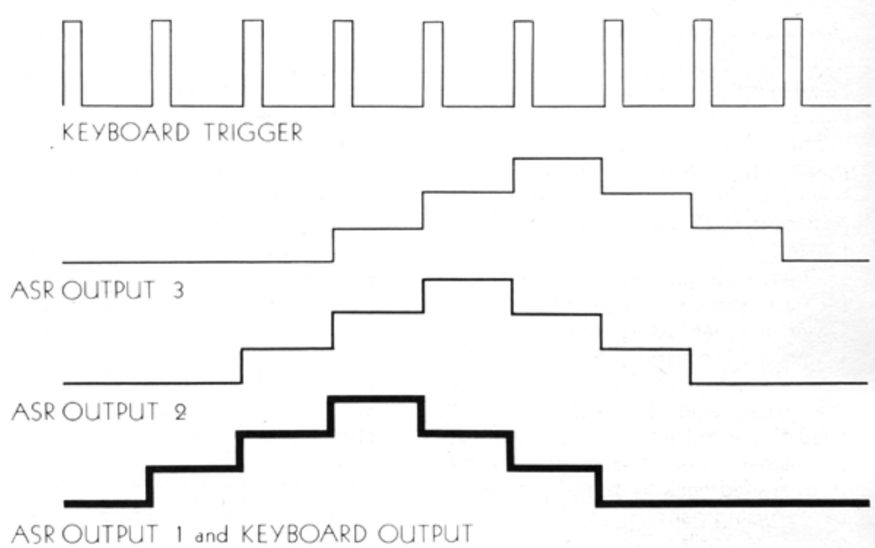

Figure 3.

Replacing the keyboard's trigger by a pulse generator (clock) yields an effect very similar to "accompanied melody," since all ASR-controlled

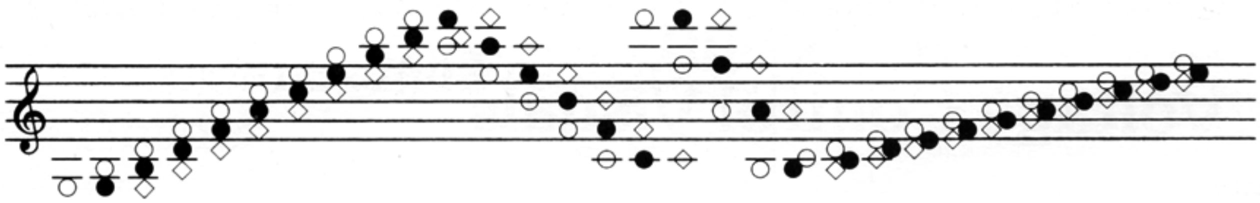

Figure 4.

Figure 5: ASR effect with four voices.

-Clock.

-Two of the four voices in conventional notation.

Diagrams: A. Schill

VCOs always end up on pitch with, however, a staggered and variable delay in time:
Fig. 5

The basic ASR module is three stages long. Two or more ASRs may however be hooked together to provide 6, 9, 12, etc., stages
Fig. 6

These examples show the most elementary and obvious use of the ASR. Other patches using the ASR can obtain a wide variety of patterns, for example, when VCOs are not used at the unison, when the ASR's output is used to control envelope slopes, and in patches where the outputs of the ASR are fed back to its input to create self-recycling patterns. In general, as a source of control voltages, the ASR will perform many of the effects obtainable with an Echoplex or digital delay line, but it has many exotic quirks of its own.

How does the ASR work? Basically it consists of a string of three sample and hold circuits which are sampled sequentially last stage first. In operation, S/H-3 is activated first and acquires the voltage held at SH-2; S/H-2 is then triggered and acquires the voltage held at S/H-1, thereupon S/H-1 is triggered and acquires whatever voltage is present at the ASR's input. This process is performed very fast (about 3 Ms.). The S/H circuits consist of bi-directional gates (CD 4066) configured for minimum leakage, feeding storage capacitors (10,000pf.) read by voltage followers (CA3140s). The triggering circuit consists of a monostable and two half-monostables in series (pulse widths of 1 Ms.) with the remaining amplifier of the quad op-amp (LM3900) being used to provide an end-of-cycle pulse suitable for hooking ASRs in series. The diodes in the schematic function to drop the 12V. power supply voltage to about 10V. which is optimum for minimum leakage of the S/H circuits. Operation off a 15V. power supply is feasible by replacing these diodes with a 4.7 V. zener diode. Note here that the ASR works only with positive voltages from zero to about 8 Volts.
Fig. 7

Construction of the ASR is relatively straightforward. The critical points of the circuits is the meeting point of the gates, storage capacitors, and the voltage followers (pin 3, CD 3140). These points ideally should have a guard band connected as shown in the schematic (to counteract stray leak-

continued on page 30

Light With Sound . . .
Voltage Control Visuals

by Alex Cima

The artistic collaboration between electronic musicians and visual artists often yields surprisingly synergistic results. Broadly defined, visuals may include the actual musicians on stage, dancers, singers, and technicians . . . all of which are seen by the audience during a performance; given the nature of tape concerts, musicians on stage adopt the characteristic of "visuals." In a narrower sense, visual elements include film, film with score, rear projections, slides, and sound sculptures . . . all of which are usually not subject to voltage control. Now technology such as lasers and voltage controlled equipment forecast a new era of increased cooperation between auditory and visual artists.[1]

Scriabin's last orchestral composition called for piano, organ, chorus, orchestra, and color organ (Prometheus: The Poem of Fire). However, not until the dissemination of electronic concerts throughout the world, has the adoption and concern of a visual element become a crucial factor. Sound sculptures may involve the simplicity of a structure small enough to be carried by one person, or the complexity of a Nicholas Schoffer work such as the 150-foot cybernetic tower for which Pierre Henry wrote a score in the 1950's. The Los Angeles Triforium is an example of a far more complicated structure for which the "performer," in addition to music skills, must possess knowledge of computer programming in order to run this exotic sound producing sculpture.

In view of the strengths of voltage controlled equipment, compatible visuals: those which could be subjected to voltage control of some parameters of the visual product offer unique opportunities. A familiar example is the color organ predominant around the 1960's and popular in discos, where the glow of the colored lights follows the amplitude of the music. These type of visuals are commercially available and are generally quite expensive considering their function.[2]

A relatively simple voltage controlled visual is a neon laser beam projected on a small mirror attached to the cone of a speaker, when the speaker is activated the push and pull of the cone reflects the light in such a way that the patterns created on the wall or screen follow the sound. More elaborate designs such as Laserium incorporate tape and voltage control devices which operate on similar principles, but are far more sophisticated and expensive since they utilize a multiple color laser system. The recent Exploratorium show in San Francisco offered a number of unique sound/visual works.

Two voltage controlled visuals used by LEM are the Electro-Rotary Optical Sculpture (EROS) developed by Courtenay Heater and Jim Yurchenco, respectively, an engineer and sculptor from Stanford University. These instruments consist of a tripod on which are secured a motor and an arm about 40 cm long, the arm rotates like a fan at a rate of 10 Hertz (600 rpm); at the tip of the arm, a ping pong ball with a xenon lamp inside will flash when energized by a pulse wave. The oscillator can be one built in the system or one from a synthesizer . . . the rate of flashing will depend on the rate of the vco, the pattern produced by these flashes depends on the rate of the vco, its waveshape and modulation products, and the rotation of the arm. In a darkened room, once the arm is rotating, flashes can be induced to create a spherical object rotating against a dark background, when the rate of the vco is increased, fusion (similar to the effect created by motion pictures) will create several interesting patterns moving in space. These patterns are now being placed under micro-processor control so as to develop a dictionary of patterns which can then be easily retrievable during a performance. The color assumed by the ping pong ball depends on the bulb, and in this case they have chosen a bright orange . . . phosphorescence created by the ball adds a dramatic blueish/green trail to the pattern. The diameter created is approximately 60 to 70 cm, the circular pattern often distorted by the eye into an ellipsoid . . . they are currently working on an EROS with a 1.5 meter diameter.

Another voltage controlled device is a phtoresistor patched to the triggering device in a synthesizer. When light of the appropriate intensity hits the photoresistor, an envelope is triggered allowing whatever is patched into the vca to be heard . . . LEM uses this device to trigger programmed source material from a distance, by darkening the room and using special flashlights with a powerful collimated beam.

The coming video revolution parallels the development of computer music. Several video systems have been designed with music in mind. For example, the video synthesizer built by Electronic Music Studies, London, or the video systems developed by Nam June Paik. Color, shape, modulation, and integration of previously recorded images are now possible. Such systems prognosticate an incredible development in the integration of audio and visual arts. In the near future, video and sound synthesizers may well be common sights at concerts. The computer graphics developed by John Whitney prove that the future has a clear area waiting for the full exotic use of the digital computer as the ultimate sound/visual instrument.

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[1] Mumma, Gordon. "Live Electronic Music." In J.H. Appleton and R.C. Perera (Eds.) *The Development and Practice of Electronic Music.* New Jersey: Prentice-Hall, 1975, pgs. 286-335.

[2] Roctronics, 22 Wendell St., Cambridge, Mass. 02138.

Build It: A Seven Stage Frequency Divider

by John Blacet

This simple circuit will produce seven octaves of square waves below the input frequency and allow you to select which ones you want as well as mix them with the regular output. This is accomplished with a single low current CMOS I.C. along with a few other components. The square waves are a pleasant sounding 50 percent duty cycle.

Although the instructions here are for the PAIA "Gnome" micro synthesizer, it should work with any other device having a square wave above ground available. More on this later.

The circuit works by taking the VCO square wave directly from the collector of the transistor producing it, and dividing it by 2, 4, 8, 16, 32, 64, or 128. These are selected by the dip switch and attenuated by the miniature pot before being fed back into the VCA.

If you want to add the frequency divider to another synthesizer, connect it internally to the square wave source. The CMOS device requires direct coupling. You can also use a schmitt trigger between your VCO and the frequency divider. The Cd 4024 will operate from 3 to 15 volts.

Construction:

1. Remove the top section of the Gnome. Carefully drill and file holes for the pot and dip switch as shown in the photo (Fig. 1).
2. Using the pattern shown (Fig. 2), fabricate the p.c. board. Resist lacquer or pen is the simplest method. Etch the board and drill component holes.
3. Observing polarity of capacitors and I.C., mount components on the board and solder, using a 25 to 35 watt iron and rosin core solder.
4. Connect a 4½" wire to the p.c. board +9. Also a 5" wire to VCO in, and a 3" wire to VCA out.
5. Because space is limited inside the Gnome, it's a good idea to wire the p.c. board, pot, and switch together outside.

The miniature pot will mount with the lugs oriented toward the dip switch. Connect the top lug to the p.c. board ground. Also attach a 2" wire to the top lug. This will attach to ground at lug 5 of TSZ. Connect the center lug of the pot to the p.c. board (Fig. 3).

continued on page 31

Figure 1: Gnome with pot and dip switch.

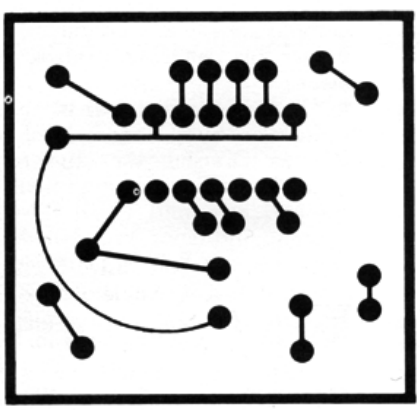

Figure 2: Foil side of p.c. board.

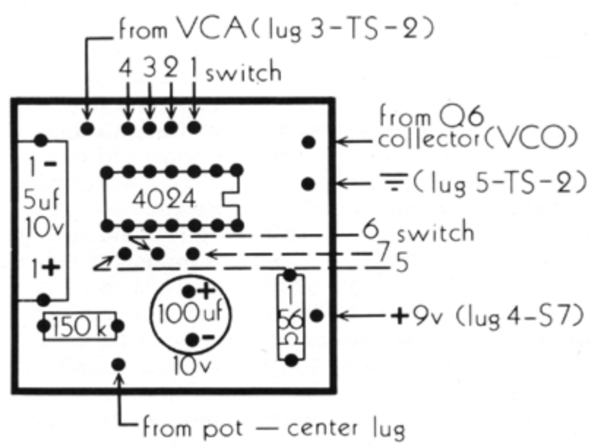

Figure 3: Top view.

Diagrams: A. Schill