The Video Synthesizer
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This proposal describes a new kind of video synthesizer which uses the graphic potential of the video medium for a programming language. The instrument, called the Design Device, will perform video synthesis and signal processing under control from a mini-computer which reads a specially formatted picture language. This programming language will permit artists to prepare ideas away from the studio and provide a permanent record on paper of all useful programs.

Below are excerpts from a late 1970's paper by Tom Dewitt describing an enhanced video synthesizer called the "Design Device." This proposal reviews video synthesizers of its day, touching on their principles and limitations in waveform generation, colorizing, signal routing, and image display through XY deflection. The suggested enhancements form a technical sketch, to synthesize a video art tool for use by independent video artists.
J.S.

Review of Existing Video Synthesizers and Ideas for a New One

To free the video artist from the confines of the real camera-recorded world, it is necessary to develop instruments which generate a television compatible signal from raw electronics. A synthesizer is the paint and palette of the video artist, a device which lets the artist construct spaces from the dictates of imagination.

The first video synthesizers began to appear almost a decade after the development of complete audio synthesis systems. There are compelling reasons for this delay. The development of a time variant artform is just now being born in the visual arts, centuries after the establishment of a related set of time variant structures in music. Technically, the video synthesizer is more complex than its audio cousin. Video signals cover a frequency spectrum 100 times greater than audio and must be constructed according to a precise timing synchronization which does not exist in the one dimensional audio signal. Consequently, design concepts and instrument components are now coming together for the first time.

There have been two approaches to video synthesizer design: vector graphics and signal intensity. This split is a consequence of the television system itself which uses a one dimensional high frequency signal to describe a two dimensional field of much lower frequency. The systems developed by Steve Rutt and Bill Etra, Computer Image Corp., Vector General, and others operate on the x and y deflection amplifiers of a cathode ray display. The synthesized or processed images coming from these devices are rescanned by a conventional camera for recording on video tape. Synthesizers, on the other hand, such as those developed by Stephen Beck, Dan Sandin, and EMS Ltd., operate on the intensity or "z" component of the video signal. Their output is made compatible with video standards by a processing amplifier or through a color encoder. The two approaches can be combined in a single device. In fact, Sandin has worked extensively with a computer controlled vector display, and Rutt/Etra synthesizers are invariably teamed with keyers, colorizers and other signal processors. However, no one has come out with an integrated package that incorporates both approaches.

The artist designed synthesizers are "modular," that is, specialized devices are linked by patch cords which are manually inserted to complete a complex program. Modular design is essential in video, because it permits parallel and simultaneous processing of high frequency signals. The chief drawback of the general purpose computer in video synthesis is that it performs one operation at a time and cannot keep up with the video clock. As in the development of the audio synthesizer, engineers have provided artists with functional module building blocks which efficiently accomplish commonly needed functions. Modular design also permits a wide range of interconnections depending on the "patch" made between them. For example, a system of only 8 modules, each with a single input and a single output can be patched in over 40,000 different ways.

While modular systems provide both variety and efficiency, they also can present the artist with a confusing welter of two ended wires which makes live performance difficult and leaves him with no permanent record of his patch. The first step in improving this situation came with the introduction of the matrix switching systems of the Arp and EMS synthesizers, adapted for video by Woody and Steina Vasulka. These systems have manually set crosspoints and permit patchfields to be recorded by graphic notation. Going a step further, Don Buchla and Bell Labs have developed computer controlled patchfields which are notated with a verbal language.

Existing video and audio synthesis systems use a building block called the oscillator. The most common technique for generating forms is called additive synthesis in which the output waveforms of oscillators are mixed to form a wave form which is the sum of their combined outputs. It is theoretically possible to duplicate any natural waveform by summing sine waves of different frequency. This approach has led to the construction of synthesis systems with dozens of oscillators. When such systems became untenable because of the large number of signal paths, a device was introduced by Don Buchla which generated a waveform from discretely set increments. This device is now known as a sequencer. It can be used as an oscillator or a controller in voltage controlled systems. Information is loaded into a sequencer manually by setting dozens of potentiometers. Like the patch cord system, it must be set up from scratch every time it is used. There is no convenient way to notate for this device. The general purpose computer can be used as a kind of sequencer since its memory stores lists of numbers, but again the problem of cycle time limits its use to low frequencies. Recent innovations in semiconductor technology, however, have put digital memory within the reach of the video synthesizer. Using modular design techniques, it is possible to build an oscillator module with a programmable output. The stored waveform is loaded from a sampled graph drawn by the artist and scanned by a conventional television camera. Given that this small memory can serve to store waveforrns, a method must be found to clock out its stored information. Oscillators such as those found on the Rutt/Etra or Stephen Beck's synthesizer must be synchronized to the rest of the synthesizer in order to produce stable patterns. While it is relatively easy to make a voltage controlled oscillator, it is difficult to maintain synchronization for an analog module.

The most common "special effect" available on commercial switchers is the geometric pattern called the wipe. The technique for generating wipes is quite straightforward and is used by Beck and others in artist oriented synthesizers. The pattern of the wipe is formed by the waveshape of an oscillator, and such wipes as diamonds, ellipsoids, and boxes are easily formed with an analog oscillator. The memory oscillator of the Design Device will permit virtually any shape of wipe to be made, and there will be provision for making multiples of any shape.

One of Steve Beck's contributions to video synthesis was a perceptive analysis of spatial composition. By dividing the image into components of point, line and volume he was able to design modules to achieve each objective. Among his inventions were devices that took complex images and reduced them to these spatial elements. In many ways, this paring down of images is important because it allows the artist to simplify complex spaces and combine them inside a single frame. The Design Device will contain an outline generator which will reduce volumes to lines. This will permit many shapes to be seen through each other.

The unique advantage of vector graphic systems like the Rutt/Etra synthesizer is its ability to reposition an image after it is recorded. Among the manipulations possible on such a system are electronic zooming, left-right inversion, top-bottom inversion and rotation. The Design Device will have processing modules which will permit all of the above effects. The rotation function is not normally available with commercially sold Rutt/Etra systems because it requires a low frequency sine-cosine generator. This pair of precisely timed control voltages will be available in the Design Device through its memory oscillators.

At the beginning of this discussion of video synthesizers, I called such devices the artist's paint and palette, and no module better fits this description than the colorizer. There are many designs for colorization devices both commercial and unique. In systems which use a camera encoder to generate the final output, the colors are determined by mixing red, green and blue components. While pleasantly reminiscent of mixing colored paint, this system is less efficient to use than the colorization made possible by video color parameters: luminance, chrominance and hue. With the latter system it is possible to pass a previously encoded color signal through the synthesizer and recover it unchanged at the other end (through the luminance channel). New colors can be added by entering signals into the hue and chrominance channel. Where gray scale encoding is used such as in quantization, the single hue parameter can produce rainbow-like effects. The Siegel colorizer uses gray scale encoding to modulate all three parameters simultaneously. Dividing the inputs into three channels gives an increased degree of control over the final output. The Grass Valley colorizer uses the luminance, chrominance, and hue parameters but is not voltage controlled and hence is not dynamic.