In Search of the Plastic Image: a Media Archaeology of Scan Processing

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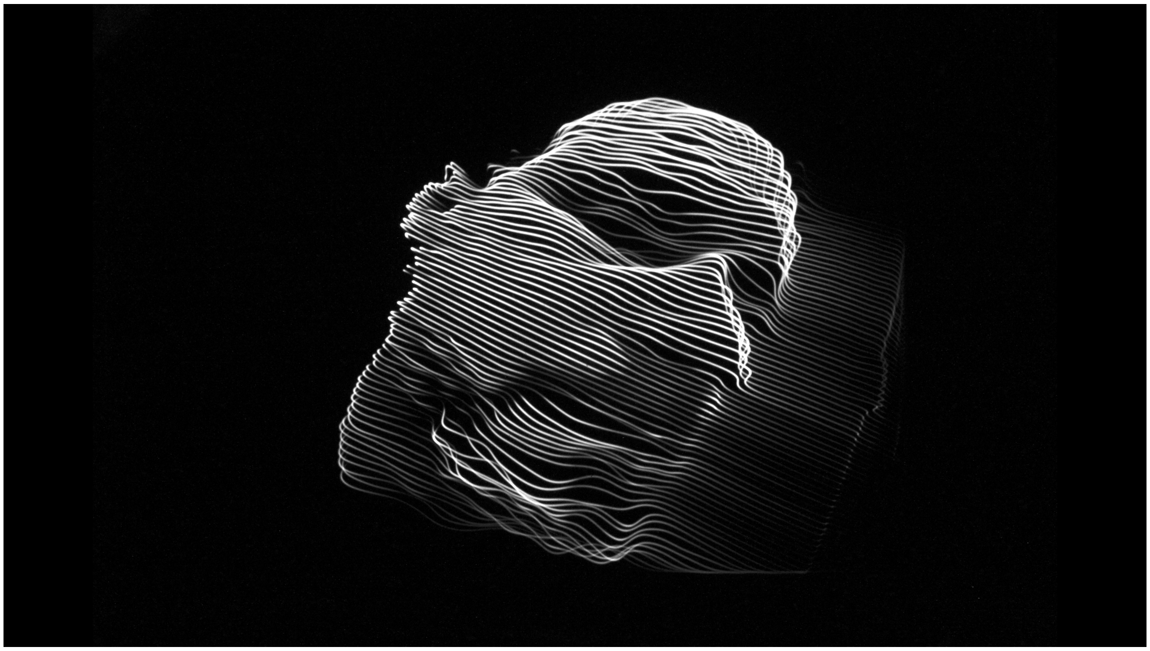

Fig. 1. Scan processed 2D image with 3D contours. [Image: Derek Holzer, 2022]

Scan processing is an analog electronic image manipulation technology which emerged in the late 1960's, reached its apex during the 1970's, and was made obsolete by digital computing in the 1980's. During this period, scan processing instruments such as the Scanimate (1969) and the Rutt/Etra Video Synthesizer (1973) revolutionized commercial animation and inspired a generation of experimental video artists. This paper presents a media archaeological examination of scan processing which analyzes the history and functioning of the instruments used, what sorts of possibilities they afforded their users, and how those affordances were realized with technology of the era. The author proposes the reenactment of historical media technologies as an investigative methodology which helps us understand the relation of past and present, and details a reenactment of scan processing involving the display of digitally synthesized audio signals on an analog Cathode Ray Tube vector monitor.

CCS Concepts: • **Social and professional topics** → **History of hardware**; • **Applied computing** → *Media arts*; • **Computing methodologies** → Image manipulation.

Additional Key Words and Phrases: aesthetics, animation, computation, culture, heritage, media archaeology, sound

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1 INTRODUCTION

A modern-day resurgence of interest in both modular sound synthesizers [Rossmy and Wiethoff 2019] and analog video technology [Collopy 2014] has inspired a new generation of artists to search for inspiration in technologies long considered outdated. This often results in new, contemporary instruments which integrate both analog and digital workflows. The utilization of past technologies to create new instruments can be understood as a process of remediation, where every new medium necessarily reproduces conventions of old media within itself [Murray 2012]. However, discussions of remediation largely focus on the formal characteristics of the medium itself, rather than the social and material contexts from which it arose.

On the other hand, discourses within the field of media archaeology recognize the manner in which power and ideologies shape the creation of technology. Consider the influence of Cold War military simulations on the development of computer games [Crogan 2011], for example. Kittler reminds us that the interfaces we use to express ourselves shape the very thoughts we are trying to express [Kittler 1999]. Similarly, Zielinski recognizes that effecting change in a technologically mediated world requires learning and modifying the codes underlying it [Zielinski 2006]. Understanding these codes is not simply a matter of formal or technical analyses. New approaches to the organology of scientific and musical instruments recognize not only the particulars of a device's material construction, but also the intentions of its designers, the social structures to which it related, and the ends to which it was directed [Tresch and Dolan 2013].

I propose that such deeper levels of understanding media can be explored through reenacting the development of early electronic audiovisual instruments. Parikka notes artistic practices within the field of media archaeology involving the creation of art from obsolete objects and practices; the search for "buried conditions" within contemporary media; and the formulation of imaginary future media based on those of the past [Parikka 2012]. These practices echo discussions within visual and performance arts which argue that reenaction is not merely repetition or imitation, nor does it involve a relationship of fidelity between a performer and a score. Rather, a reenactment is an iteration of the original work, akin to a literary citation "tethered" to its source but placed within a new context [Fiske 2009], with personal interpretation allowing for quite different outcomes than the original [Blackson 2007].

What follows are the results of my own reenactment of a very specific analog computer graphics technology from a half century ago: scan processing. During the course of this reenactment, I familiarized myself not only with how this technique functioned, but also why it was conceived, what its proponents hoped to achieve with it, and the possibilities which it offered its users. This paper briefly summarizes these findings, and discusses the artistic framework of the entire reenactment.

2 A CAPSULE HISTORY OF SCAN PROCESSING

Scan processing is an analog electronic image manipulation technology which emerged in the late 1960's, reached its apex during the 1970's, and was largely made obsolete by digital computing in the 1980's. A scan processor functions by manipulating the electronic signals which make up the raster of a video image before it is displayed on a Cathode Ray Tube (CRT). Perhaps the earliest documented use of this technique took place in 1966. Artists Ture Sjölander and Bror Wikström conceived a system with Swedish national television which summed external signals with the horizontal and vertical deflection ramps in a CRT to deform the image [Modin 1974].

At this time, Korean artist Nam June Paik was extremely interested in altering television imagery through unusual scanning patterns [Paik 2019]. Paik went on to develop his Video Synthesizer with Shuya Abe in 1969, which included a Raster Manipulation Unit later named the "Wobbulator". It warped the image through the use of a number of electromagnets placed next to the CRT. Several Wobbulators based on Paik's design were built at the Experimental Television Center (ETC) during the 1970's [Hocking et al. 1980].

Concurrently, inventor Lee Harrison III was developing the Scanimate system, which used analog computer circuits to produce animations at a fraction of the time and cost associated with traditional methods. Computer Image Corporation applied to patent the device in 1969 [Harrison III et al. 1972]. Eight units were manufactured in total for use in professional television production studios. While no unit price for a Scanimate was ever published, one hour with the machine and its crew of operators normally cost a client US$1500 [Kessler et al. 2022].

Inspired both by Paik's Wobbulator and the Scanimate, in 1973 Louise and Bill Etra and Steve Rutt created a scaled down scan processor called the Rutt/Etra Video Synthesizer (RE-4). It was aimed at video production facilities, schools, and independent video artists. Although Bill Etra intended that the instrument would be financially accessible, its final list price of US$12,000 still equalled that of an imported European sports car. Disagreements between the Etras and Rutt [Bainbridge 2017], alongside patent disputes with Computer Image [Furlong 1983], ended commercial production of the RE-4 after approximately 17-21 units had been made.

Parallel developments in video processing technology were also applied to instruments for scientific and industrial visualization. Susanne Gerdes' Optical Electronics Incorporated (OEI) designed their 6100 series of 3D display modules (1972) to render video signals as three dimensional surfaces rather than flat images [Williams 1990]. These modules were used in image enhancement, motion detection, quality control, medical, sonar, radar, and astronomy applications [Optical Electronics Inc. 1987].

In the early 1980's, Michael Scroggins built a "poor man's Rutt/Etra" based on OEI modules for the CalArts Videographics lab, citing the Scanimate's excessive cost and the RE-4's lack of availability as his main motivations [Scroggins 2021]. Dave Jones' Raster Manipulator (1980) also simplified and lowered the cost of a scan processor by foregoing any internal modulation sources. Both instruments rely on analog sound and video synthesizers such as the ARP 2600 or the Hearn Videolab for external control signals.

3 WHAT IS SCAN PROCESSING?

Scan processing allows the scan lines of a video raster to be scaled in size and translated in screen position, enabling a number of image transformations. To accomplish this, a scan processor creates two synchronized ramp waveforms which affect the movements of the electron beam within the CRT. The vertical ramp establishes the field of the image, and a series of horizontal ramps for each field produce the scan lines of the image. Luminance information extracted from an input video signal controls the intensity of the CRT's beam as it travels along the scan lines.

Once the video image has been broken down this way, the introduction of other signals allows control of the image as a function of voltage over time. This manner of working with images as "time/energy objects" [Vasulka and Nygren 2008] allows the artist to work within the temporal bounds of a single video frame (synthesis) rather than at the junctions between them (montage).

Since both video and audio synthesizers share a common heritage in analog computers [Collopy 2014; Sieg 1998], knowledge about one of these instruments can often be transferred to another. Dan Sandin explicitly states that he wanted his Image Processor to be "the visual equivalent of the Moog synthesizer" [Sandin and Schier 1992], and Fred Kessler used his experience with the Moog to learn the Scanimate [Kessler et al. 2022].

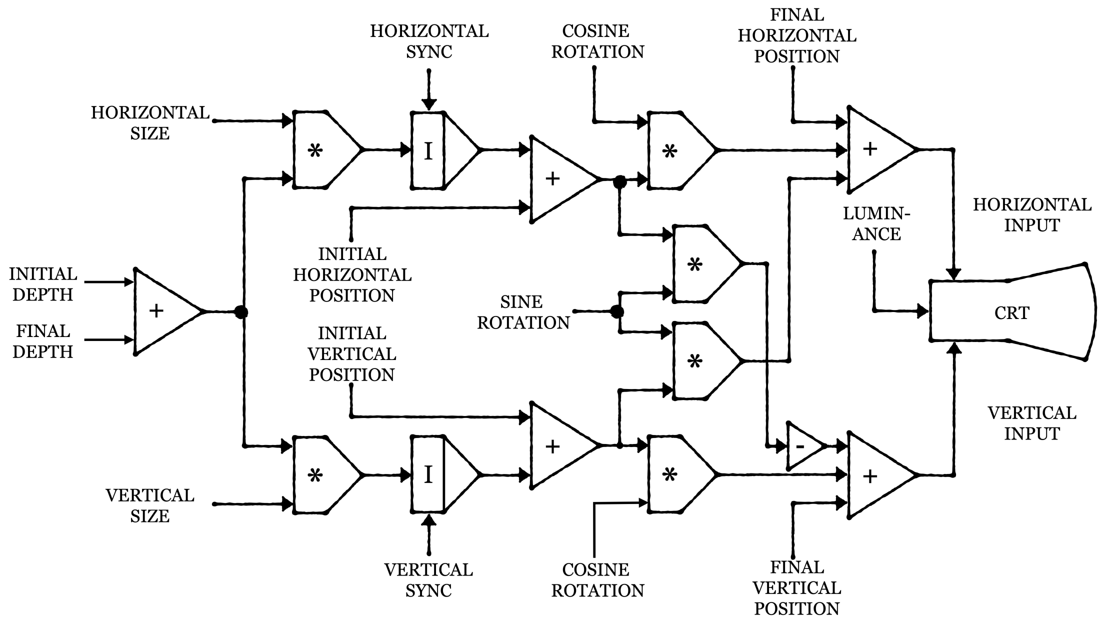

Fig. 2. A simplified analog computer block diagram of the Scanimate, based on a drawing by Dave Sieg. [Image: Derek Holzer, 2022]

Figure 2 shows an example of one such analog computer dedicated to scan processing. Signals summed with the horizontal or vertical ramp will translate the image in that dimension. Multiplying the amplitude of a ramp by another signal will scale the image size in that dimension. A combined multiplication affecting both ramps changes the image's overall size, and can simulate depth-axis movement. Rotation around a single axis is commonly implemented using a sine/cosine multiplier; other dimensions can be simulated through scaling.

Control signals with a frequency slower than the field rate will produce different types of visual animation such as images flying across the screen, turning in space, and zooming in and out of the background. Control signals with frequencies at or above the field rate produce images which pinch in perspective, roll into tubular shapes, or distort in size (e.g. [Pepto-Bismal 1983]), as seen in Figure 3. The image can also unravel into abstract "spaghetti" patterns (e.g. [Children's Television Workshop 1971]). Modulations of the luminance produce repeating light patterns (e.g. [Sorensen 1979]). One of scan processing's signature effects involves a vertical displacement of the horizontal scan line according to the luminance of the image, which has been dubbed "the Vasulka effect" [Schier et al. 1992] due to its association with the works of Steina and Woody Vasulka.

The richest possibilities of scan processing come through real time interaction through voltage controlled parameters, providing artists a more direct relationship of their bodies with the electronic image [Rudolf 2014]. Studios such as ETC, Signal Culture, and CalArts all provided methods of bringing external audiovisual signals into their scan processing equipment, shifting voltage levels as needed for compatibility. "Violin Power" [Vasulka 1978], for example, demonstrates the visual effects produced by injecting amplified violin signals into the RE-4.

Since the deformed raster is no longer a valid video signal, it must be displayed on a vector monitor or oscilloscope which accepts the horizontal, vertical, and luminance signals independently. The image on the CRT is converted to a

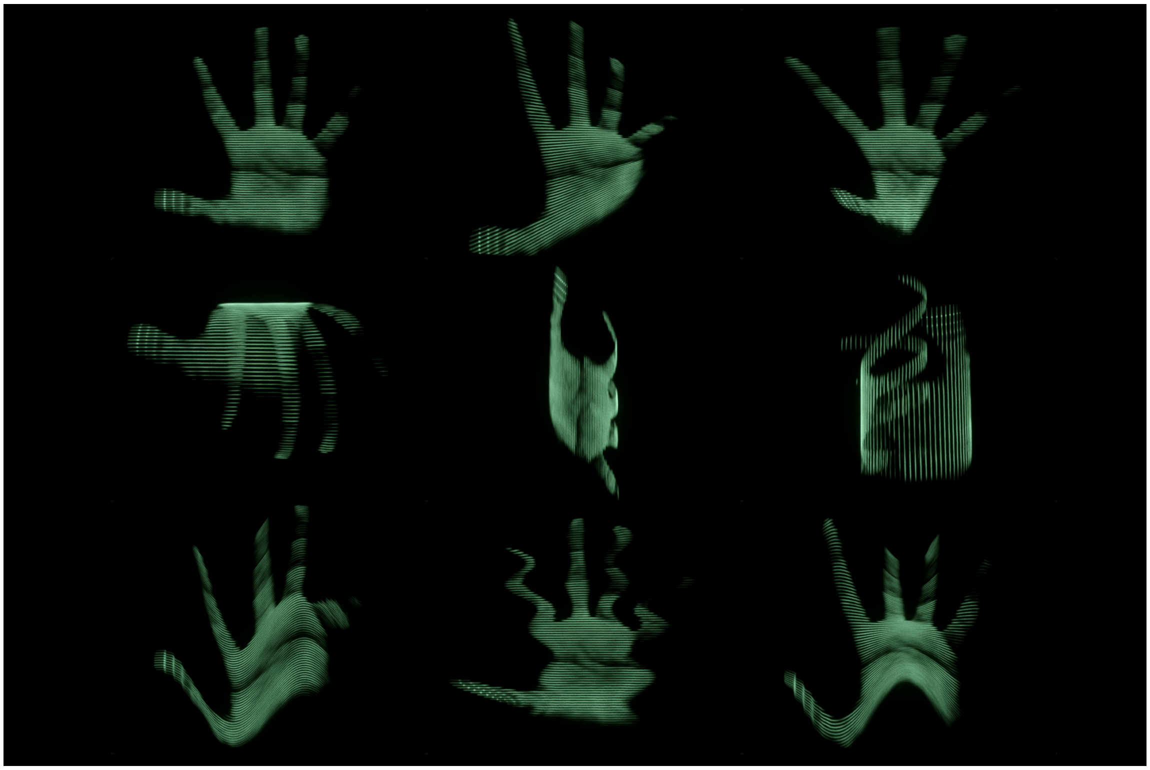

Fig. 3. A demonstration of various pinches, rolls, and distortions, based on a Scanimate programmer's notebook archived by Dave Sieg. [Image: Derek Holzer, 2022]

signal which can be colorized, recorded, edited, and broadcast by "rescanning" the monitor with an additional film or video camera [Hocking 2014]. This optical coupling produces a characteristic glow to the image, and allows the introduction of visual treatments such as glass or reflective foil between monitor and rescanning camera.

4 REENACTING SCAN PROCESSING

For many, the future of analog computer animation was establishing digital control over the multitude of parameters. The Etras experimented with linking the RE-4 with a PDP 11 computer [Katz and Etra 1976], while Computer Image achieved this control with their later Caesar (1975) and System IV (1981) animation systems. Several recent computer applications reproduce various scan processing effects through digital video. The most significant of these is the v002 Rutt-Etra 2.0.1 plug-in for Quartz Composer, a continuation of Bill Etra's dream to "prepare visuals like a composer composes music" [Etra and Marini 2008]. This application, and others created later [Bernagozzi and Souther 2014; Ragan 2014; Souther 2019; Turner 2011], benefit from the digital management of parameter settings. However, a true signal-based workflow allowing sound and image to directly affect each other can only be simulated.

To address this shortcoming, my Vector Synthesis scan processing application [Holzer 2022] implements an analog computer environment within a digital computer context. Here, audio signals corresponding to the horizontal and vertical ramps are used to look up the brightness value of the pixels within a frame buffer. Other internal or external

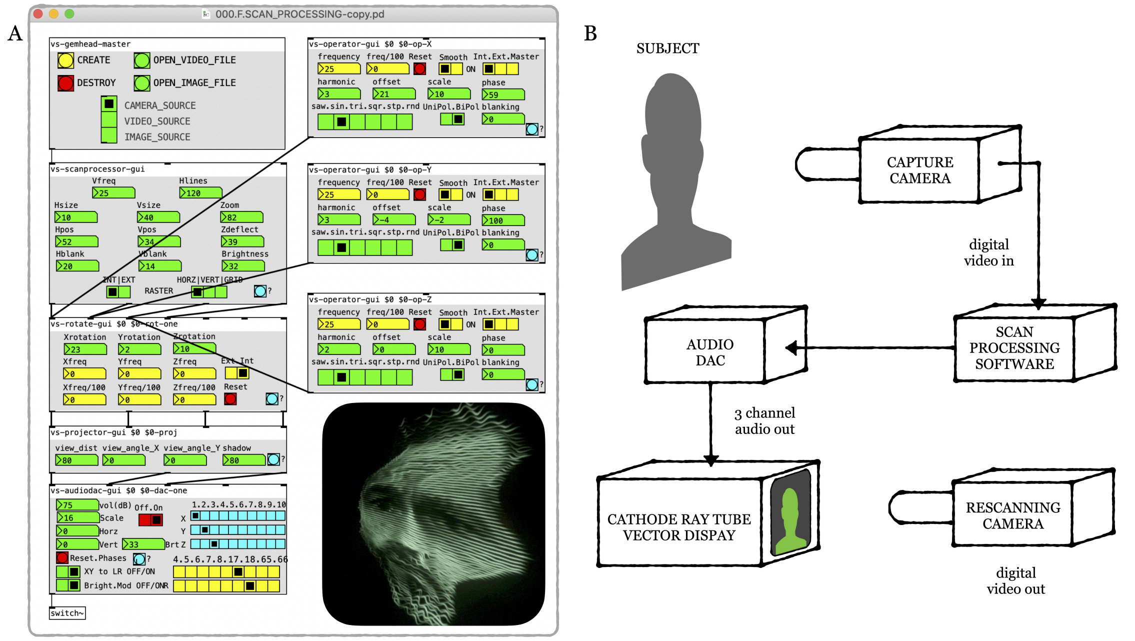

Fig. 4. An overview of Vector Synthesis scan processing. A: the software interface in Pure Data, with a still from the rescanning camera at lower right. B: a block diagram of software-based scan processing. [Image: Derek Holzer, 2022]

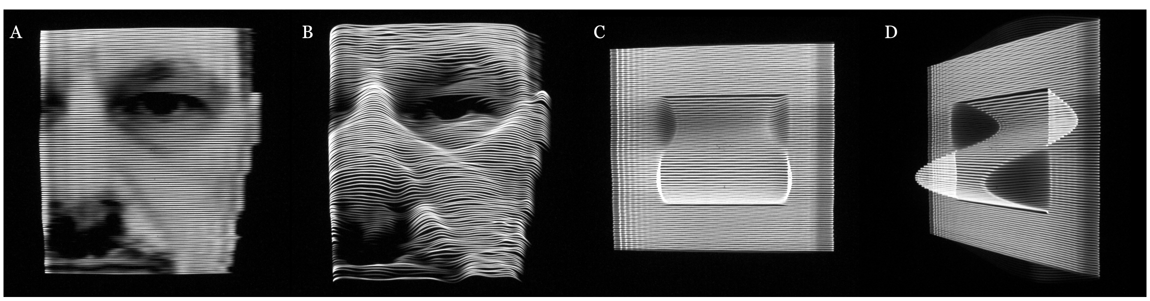

Fig. 5. Two approaches to 3D representation with scan processing. A&B: the pseudo-3D "Vasulka effect", C&D: 3D rotation of an abstract "time/energy object" constructed from basic waveforms [Image: Derek Holzer, 2022]

audio signals further manipulate the image raster. The brightness becomes a third audio signal, which is sent along with horizontal and vertical signals to the inputs of a CRT vector monitor through a Digital to Analog Converter (DAC), as seen in Figure 4. The CRT is rescanned with a 4K video camera, and the raster signals are available as a soundtrack as well.

Because none of the signals are dependent on synchronization from the video, arbitrary field rates and numbers of lines, or even "abnormal" deflection patterns such as spirals, are all possible. While bandwidth of the system is limited to the audio sampling rate, it still renders sufficiently detailed images, particularly when the subject of the image is easily recognizable (such as hands and faces). Figure 5 shows two approaches to three dimensional visualization. The video sample accompanying this paper [Holzer 2020] demonstrates a number of faster-than-field rate audio modulations, resulting in glitches, rippling, and block-like extrusions of the scan processed image.

Real time interaction was prioritized in the design through the use of graphical onscreen and physical MIDI interfaces; periodic and programmed internal control signals; and external audio and video inputs. Development took place in conversation with Ivan Marušić Klif, who has developed a similar implementation of scan processing [Klif 2017] using Max and Jitter.

5 DISCUSSION

A vast majority of Woody and Steina Vasulka's video art works feature the artists exploring a variety of electronic instruments which enter their studio. These tapes stand as works of video art rather than documentaries because of the emphasis the Vasulkas place on the self-reflexive process [Spielmann 2010] as the main component of their artistic output. I would like to see my own reenactments in this light. Instead of focusing only on the material outputs of this action, such as the software along with the images and videos which emerged through its use, I encourage the reader to consider the performance of this reenactment as an iteration through an entire historical process.

This project reproduces a key historical affordance – a completely signal based workflow with real time control over image plasticity – through modern means. It also extends several of the early innovators' aspirations and long term goals, such as computerized control, non-standard raster shapes, and a mingling of sound and image composition. While my work remains tethered to the contexts, ideas, and motivations of those who created and used the first scan processing instruments, personal interpretation and contemporary context have led me to results which are clearly my own.

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