SYNTHETICS
THE ELECTRONICALLY GENERATED IMAGE IN AUSTRALIA

BY STEPHEN JONES

I am going to explore the evolution of electronically generated images in video and animation leading to the now ubiquitous use of computer generated imagery in feature film production. I am intending to cover the period from the early developments of computer graphics in the 60's through to the ascendency of the Quantel video graphics systems and SGI based systems in the 90's. This is effectively the first two generations of development.

This is a tale of two pathways, the analog and the digital, winding their ways through the forest of technology, sometimes crossing each other, sometimes running together for a moment, often influencing each other and finally the one almost consumed by the other but for the interest of a new generation in the ways of the old.

The two pathways are those of analog representations and digital representations. Analog representations reflect the actual value or amount of a voltage or a brightness while digital representations reflect some number in the range of possible values that the voltage might have, say from 0 to 255. For example, in video the analog of the brightness of a scene is the voltage of the video signal at that point of the image whereas the digital representation of it will be a number where say 0 represents black and 255 represents white. Obviously the difference in style is reflected in the different technologies that carry these representations.

In analog computers a variable is carried on the rotation of a knob or a slider whereas in digital computers a variable is carried as a binary number in a register or store (a memory) and is operated upon by mathematical processes treated as logic. An analogue voltage can be stored on tape and sent down a wire as a voltage and is manipulated in an operational amplifier of some sort, whereas a digital value is a number which can be stored directly in computer memory for manipulation by computer logic. A variable is carried as a symbol. The representation of a low value is not in any way physically less than the representation of a high value. The same 8 bits in memory space can store the value 0 as comfortably as they can store the number 255.

The history of computing is not the history of any particular technology but the history of the use and manipulation of symbols as values, often representing numbers, to do mathematics and to control other machines. The first computer graphics, if you will, (more correctly program-controlled graphics) are seen in the weaving loom controllers built by Joseph Marie Jacquard in France at the end of the 18th century. He took some ideas developed by earlier French inventors and made them robust and reliable so that they could control machines in factories that made ribbons and patterned fabrics with the weaving loom. (Much to the disgust of the weaving guilds of the time and especially to those whose work vanished before them.) Earlier in the century, Jean Falcon had developed a system of punched cards chained together and Jacques Vaucanson built a rotating cylinder cam-mechanism which triggered levers to drive the actions of an automaton. Jacquard combined these two mechanisms and attached them to the top of a standard treadle-loom so that they pulled up specific warps on the loom. This form of control also allowed the loom to produce pictorial images in fabric.

Weaving is a process of running colored threads horizontally through a warp of vertical threads to make cloth. A shuttle pulls the weft threads over or under the warps depending on whether it is to be seen or not at that particular point of the pattern or the image - the weave. The system is still used today though the warps lift mechanism is now largely directly computer controlled rather than using the old lever mechanism. Certain Axminster carpets and in Japan the Obi or sash for the Kimono are still made by Jacquard looms.

In the contemporary language of computing the warps equate to the columns of pixels and the wefts are the lines of pixels on the raster. Thus a woven image is the logical equivalent of a monitor screen. But this story does not appear again until the latter half of the 20th Century.

Video Image Synthesis

Video synthesis was the visual equivalent of electronic music and one of the first truly electronic of the electronic arts. A sort of abstract expressionism gone mobile and fluid, patterns and colors shifting dynamically, driven by music or whim or, if processing camera images, by the image itself.

The history of video art and theory has always engaged two activities: the deconstruction of the role of television in the setting of meanings and agendas in daily life (in those days this was known as "demystification"); and the redevelopment of the visual image in areas where we have never looked, or been able to look, before (i.e. the manipulated image). The new technologies of media access (the porta-pak and low cost editing systems) and of image production (with the aid of the integrated circuit) could be applied to the televisual image and thus the magic (the capacity to carry meaning and the kinds of meanings carried) behind the image could be subverted.

Video extracted itself from television and refused to make the material of television. It saw itself as the primary critical and subverting reflection on television, making programmes that covered ideas and events that tv wouldn't cover, covering events in ways that tv couldn't and generating new styles of image that the engineering attitudes of tv couldn't possibly accept because they were too far outside the parameters of the electronics of broadcasting.

In Wuppertal, Germany, in 1963 Nam June Paik exhibited 13 TV monitors in which the scanning of the image had been disturbed and heavily manipulated by the addition of magnets to the outside of the box. This caused the image to swirl and wave in ways that TV images were simply not supposed to. "The primary, luminous quality of the image was emphasized, but its televisual appearance of an absolutely veracious and therefore unique image was literally thwarted." [1]

Erich Siegel, in the US, is probably the first to produce an electronic image manipulation device with his "Video Color Synthesiser" first exhibited at the Howard Wise gallery in New York in 1969. Also Nam June Paik and his engineering partner Shuya Abe developed their first video synthesizer in 1969. "Artificial images evolve purely synthetically without a camera, and all existing images can be manipulated and changed in every aspect. The leap into the immaterial has been made: the artificial images become ever less assailable. The apparatus does not give any idea of the images. The computer separates from its message." [2] This was rapidly followed by Stephen Beck with his "Direct Video Synthesizer" and his "Video Weaver". I am not going to pursue this any further because you can find it all in the Ars Electronica catalog *Pioneers of Electronic Art* curated by Woody and Steina Vasulka [3].

If Baudrillard ever really had any need to fear the dematerialization of the image and the materialization of simulacra here is where it began. The synthesized image comes out of "thin air" so to speak, and bears no *necessary* relationship to the "real" world. There is nothing already known to hang it on, from which to extract meaning. And thus dilemma starts, how do we inject meaning into this stuff? How do we use it? To what does it point, refer? What does it signify when there is nothing being pointed at, just the electronic image pointing... It is almost a "one hand clapping" problem, signifier without signified.

The equipment used to produce the images in no way predicted the image or sound that was going to come out of it. Unless you had a thorough understanding of the circuit and what such circuits could do you had no means of knowing what the box might be capable of. Unlike a paint brush or a cello which somehow entails its productions, electronics is just electronics, circuits and wiring, the use of which could be applied to video, sound, computation and so on all with the same basic components and organization. It is this very fact which allows the analog computer to mutate into the electronic sound synthesizer and then the video synthesizer.

At about the same time as the technology of the video portapak appeared in the late 60's the kind of electronics technologies that became available (i.e. the first commercial appearance of integrated circuits) also allowed for a major shift in production processes for new electronic music, e.g. the audio studio test and maintenance facility was put into a box (in the manner of the analog computing facility a decade earlier) and became the music or sound synthesizer. The people experimenting with the new video capability were often also working in electronic music, so it was natural that some of the designers of audio synthesizers also started building video synthesizers. The original sound synthesizers were a mixture of the audio equipment testing laboratory and analogue computer technology. The video synth was really the same piece of equipment but with the output stages set up to drive video monitors and oscilliscopes in various ways.

One of the prime frameworks behind a lot of video experimentation was actually the production of "visual music", a kind of pictorial equivalent to the experimental music of the day. Having its antecedents in the synaesthesia of A.E.Hoffmann and the colour organ of Scriabin. [One supposes that it may also have had somewhat to do with the period of psychedelic drug use in which much was made of the visual patterns internally accompanying the music/sounds being heard.] In its new technological form, this non-referential synaesthesia is the dance of the electron across the screen being driven by the music, often independently of any kind of known visual source or natural image. It was proposed that the artificial image might have as much legitimacy as the electronically generated sound and that the two worked well together, being derived from the same source waveform, even if handled through quite different pathways. It was as though the visual image could be played in much the way one played an analog sound synthesizer. The patching of connections and the twisting and turning of knobs gave the feel of real-time control and the electronics became an instrument as much as any acoustical musical instrument. And this kind of control gave much the same feel for both sound and video synthesis.

Computers and Graphics

Computer graphics and video synthesis have at various stages had convergent lives, while at other times they have been quite independent. This is much like the development and demise of the analog computer as the digital computer was developed and then gained ascendancy. At the end of the 50's John Whitney began using mechanical analog computing technology to "elaborate circular abstractions that he called Permutations" [5, p98]. Audio and video synthesizers were developed out of electronic versions of this analog computer technology. They then slowly hybridized with digital technology becoming pattern generating machines (e.g. Beck's *Video Weaver*, Monkhouse's *Spectre*, Hansen's *Friden Video Synthesizer* or Jones' *pattern generator*).

Computer technology allowed the storage of the data of an image so that it could be played out to the monitor repeatedly without change; or with programmed changes, the trajectory for which was completely predictable. But the gain in informational predictability meant a concomitant loss in real-time control or playability. An equipment which had been real-time and interactive gave way to the need to pre-programme and predetermine. Suddenly interactivity had to be allowed for, being no longer inherent as it was in the systems of analog synthesizers.

Digital computers were initially constructed to speed up the repetitive solution of mathematical problems, particularly the compilation of firing tables for military artillery during the 2nd World War. In the 50's (long foreshadowed by Ada Augusta [6]) the computer began to be used as a tool for making music. The Cathode Ray Tube (CRT), originally developed for electronic waveform display and subsequently adapted for television, was first used as a storage medium (known as the Williams Tube, [11]) in several early computing systems. The CRT was used as a means of storing data and instructions so that computing machines could have high speed access to instruction sequences and data sets, which would allow the supply of data to keep up with the speed of the electron tubes which did the work. Up to this point the first couple of electronic computing machines had been severely restricted as the program had to be set up on the machine by patch connecting modules and setting up rotary switches.

Computer displays were an offshoot of these attempts to create storage devices for early computing machines. With a CRT attached to the computer it was seen that the data display actually had pictorial elements and [I surmise] some bright spark decided to actually make the computer draw pictures. (At night of course, during the off hours.) Thus was computer graphics born, but it could not be said that they were interactive. Everything had to be laboriously pre-programmed, treating the CRT display surface as an addressable block of picture elements.

A turning point occured in 1962 with Ivan Sutherland's Ph.D. thesis "Sketchpad: A Man-Machine Graphical Communications System" [7]. From this computer graphics was given a consistent basis and many large corporations began to use computer graphics to design products and to simulate their behavior in what amounts to data visualization. The light pen, which allowed one to interact with the graphical display, appeared about the same time. Computer graphics could also be plotted and printed as Ken Knowlton and others showed. This was done by translating grey scale values from a scanned image into graphical "characters" which could be output onto a micro-film plotter [5, p99; 19]. Knowlton made the first computer graphic films with Stan Vanderbeek in 1964. In the early 70's, Charles Csuri developed 3D graphical displays of mathematical abstractions which he could draw and move around the screen using a light pen. About 1970 Sutherland invented the head-mounted display and virtual reality simulation was begun. For a useful description of the processes involved in making a computer graphics system of this period see Doug Richardson's report "Computers in the Visual Arts" [8].

The work in the 60's was done on what is known as a vector display: in which many line segments can be drawn by directly shifting the electron beam in the CRT. Complex images could be drawn by dividing up a curve into a series of short straight lines, trading off curve accuracy with drawing time and computer power. In the early 70's the changeover to the raster display (the television type display process) enabled character graphics type displays (images based on character blocks). Later, as memory became cheaper, faster and larger, bit-mapped color graphics and much more complex images could be produced. The desktop kit computer of the later 70's, with a tv attached, brought about much greater accessibility to computers and made for a sudden explosion in the exploration of computer graphics.

The electronically generated image in Australia

The electronically generated image had its first appearance in Australia in the last years of the 60's, depending on what one might actually call the electronic image. I'm allowing a pretty wide basis here. One can trace the use of electronically generated imagery in experimental video to Mick Glasheen's 1970 production *Teleological Telecast from Spaceship Earth*, perhaps the first experimental video-production made in Australia. This work demonstrates an approach to the video post-production that sees the system as a "synthesizer" of images though here it's is more about the combination of imagery accompanied by the electronic pattern generator (the video wipe in a vision mixing desk) than it is about the direct electronic generation of the video image. At about the same time Doug Richardson, and no doubt others, were experimenting with the computer generation of images, in the development of scientific visualization, particularly at Sydney University.

Interest in these two streams, represented on the one hand by Mick's experimental video making and on the other by Doug's early computer graphics, met in the setting up of the Bush Video group in 1972. It was in Bush Video that so much of the first real experimental video was produced in Australia.

So, in introducing the early work to you I will start with Doug Richardson.

Doug Richardson

Doug's family immigrated to Australia from the US in 1961 while Doug was still a school student. He went on to study science at Sydney University, with computer science in the last year of the course.

In 1967 he was asked to write the programs to convert the results of a mathematical model of the behavior of gas molecules against a moving aerofoil in a low density atmosphere (ie. in a rarefied atmosphere at the edge of space). This work was part of early R&D work on precursors to the Space Shuttle done at the Aeronautical Engineering Department of Sydney University. The usual means for studying the flow of gases over a wing - using smoke streams in a wind tunnel - doesn't work under very low atmospheric pressure, so it was necessary to present the data as a visualization.

Once the mathematics had been done on the university's mainframe (an English Electric KDF-9) the results were visualized on a DEC PDP-8 minicomputer with a vector line drawing display (the DEC 338 display). The visual display was then recorded to film frame by frame, with the color being produced by exposing the film to a fast phosphor screen through a set of color filters which were switched in front of the lens by the PDP-8. This was Australia's first computer animation (as far as we know).

Doug then started playing with mathematical visualizations of various kinds on the PDP-8, representing different formulae as waveforms by arranging lines on the display. Some of this work was shown to various people including the head of the Fine Arts Department at Sydney Uni, Prof Donald Brook, who encouraged him to make a system that artists could use.

For the most part artists and computers didn't mix in those days. This was largely because computing consisted in writing a program, converting it to punch cards and handing it in to the computer operators. They would run it as a batch at some later time, and if it worked at all, you would get your results back the next day. Not exactly compatible with the artistic process. So Doug's approach was to try and get over this problem by building a system of hardware and software that would draw on the display screen and allow the artist to manipulate it in real-time.

He built a system in which the computer-time consuming functions (the multiply function and the analog-to-digital conversion of the input controls) were handled by specially built hardware. Also the 338 display was capable of direct access to the PDP-8's memory to get the numbers that it then digital-to-analog converted for voltages to drive the deflection coils which pull the display beam, as vectors, across the screen. He built a couple of special input control devices as well. One could patch various sliders or input connectors to control values in the software so that images could be moved about the screen in real-time under the artist's control. So images were drawn with a light pen on the screen and then pushed around the screen under manual or audio synthesizer control. Doug called this machine the Visual Piano and invited various artists to come and try it out. He also ran a course for artists to learn to use the system. The results were mixed but some people did take to it well. These included:

Frank Eidlitz who built up images from a few geometrically placed lines which were then moved about the screen to produce essentially wire-frame shapes. These were photographed to large format transparencies and collaged onto colored papers to make up the final colored image.

Peter Vogel, who went on to establish Fairlight Instruments and build video synthesis devices including the Fairlight Electric Paintbox (which was a colouriser) and the Computer Music Instrument (CMI), used the system to explore video feedback.

Ariel

Ariel was a member of Bush Video at the time. He used Doug's system to build up a collection of moving mandala and yantra shapes based on the Hindu tantra which he, and subsequently others including myself, used in multitudinous ways in video mixes which he made in the Bush Video studio.

Ariel was mainly interested in the electronic generation of video images while with Bush Video. Along with various audio oscillators that he built he also built a sort of emulation of the Rutt Etra rescanning video synth using a standard monochrome monitor and eplacing the deflection coil signals with amplified audio to twist and curl the video image according to music and audio synth waveforms.

The other synthetic image process available for Ariel and the Bush Video group was video feedback. With a CoxBox colouriser that was occasionally available and many an evening spent with cameras and a small video mixer many kinds of performance and synthesis processes were explored.

Ariel then went on to develop his own computer graphics system based on an Imsai S-100 buss, system using a Z-80 as cpu and 32Kbytes of static ram under the CPM operating system. The graphics display used three Matrox ALT-256 video boards

Australia '75

In Australia all this happened in the same period as the re-inspiration of modern dance, a strong interest in experimental and independent video production and a period of great fecundity in the presentation of new and electronic music as well. The combining of the various forms was a desirable and elegant thing to do.

In 1975 Doug Richardson set up an exhibition of called "Computers in the Arts" at *Australia '75*, a big arts festival held in Canberra. He managed to draw just about all the people actively involved in technological arts together into the ballroom of the Noah's International Hotel for a week. Plus, he talked various companies, particularly computer companies, into putting their equipment into the site for us to play with. And these were the days of large mini-computers. The desktop machine was still really only science fiction, especially for graphics.

The *Computers in the Arts* exhibition turned into the single most important meeting place for all the people involved in electronic arts in Australia (other then the Fairlight people, peter Vogel, who couldn't make it). Doug organized it and showed some of his work, Bush Video, including Ariel and myself, was there, John Hansen and Stephen Dunstan came up from Melbourne. The ANU Department of Engineering Physics (the first computer science group within ANU) were involved, Philippa Cullen and her dance company, Stan Ostoja-Kotowski showed off his Laser Chromoson and there were several other people with various synthesizers and computer music composition devices also there.

I remember entering a darkened cave full of the screeches and rumbles of electronic music, the hum of computers and the luminous evanescence of video displays, dancers working the floor and the floor driving the computer to control the sound (this was a very special floor). Bush Video had a wall of monitors, Philippa Cullen and her company were the dancers, and John Hansen had his video synth and his electronic jewellery. "The place to jive in 75" And then we had the coup and support for all this experiment went down the gurgler. It might not have been till TISEA in 1992 that anything this wonderful happened again in Australia.

John Hansen

John Hansen had built a video synthesizer based on the concepts utilized in the Pong TV game coupled with various device gleaned from the video mixer.

Stephen Jones

I had met the Bush Video people in 1973 and then after I finished Uni I spent about 6 months with Bush Video in 1974 and became deeply involved in experimental video as a result> I was interested in Cybernetics and they were the only people I'd come across who knew much about that at all. Uni had not been helpful here. I was introduced to video feedback and the other synthetic imaging processes that they were using and became intrigued. I'd always been interested in electronic music and these video processes seemed like just the thing to go with it.

Later I learnt about technical processes in video and then electronics and went on to build several video synthesizers. This lead to doing the work with Severed Heads and also to setting up a small post-production facility called Heuristic Video were I modified lots of equipment and assembled quite an interesting editing/mixing facilities with various computer graphics and analog synthesizer capacities.

Post-1980

But as things developed the generated image, this image without signified, this image which referred only to itself, became intolerable to many artists. As was said to me by people looking at some of my early work, "Great effect, now what are you going to do (or say) with it?" Thus the desire arose amongst artists working with electronic forms for greater figurativity and meaning in the imagery. What had in its earliest days been considered a formal medium only, seen in the same way as experimental music, now had to become a carrier of content, a vehicle for the expression of ideas, no longer simply the expression of certain ideas in itself. More control was needed, especially over the shape of the result and so emerging desktop computer technology was readily embraced.

The further development of the electronic visual image could be characterized as a search for ways of adding meaningfulness to the essentially disembodied image. The generation of more realistic images and the use of the synthesized image as part of a more complex collaged semi-realistic image conveying layers of meaning can be followed through the use of devices like the Commodore Amiga and the Fairlight CVI. A language of visual fragments can be seen, as in all collage work where the image, as a partial, is re-contexted by its neighbors, its surrounds. New signifieds are extruded from the cross-connection of meanings carried in these fragments, to stimulate new thoughts in the viewer or, at least for some videomakers, to show the cross-currents of thought already abroad in the world through the similarity of this collage form with the nature of TV as montage of non-sequiter meaning, news about one thing and then another leading to a string of commercials leading to some melo-drama. All for the entertainment of an increasingly confused audience. The video collage is a kind of compressed evening's tv viewing, so much appropriation being remodeled and recombined for the work.

The Synthetics symposium

dLux Media Arts initiated two days of seminars on this history, which were held at the PowerHouse Museum in Sydney on July 19th and 26th, 1998. As curator of this event I invited eight of the people who were greatly involved with the development of electronic images in Australia to talk in these sessions. The contents of this exhibition derives from those talks.

Doug Richardson developed what is probably the first computer graphics system for artist's use at Sydney University in 1969-74. He made his system as easy to use and as available as a room full of complex mini-computer equipment could be.

Ariel was a member of Bush Video and used Doug's system as a source of video images and then went on to develop his own computer graphics systems with S-100 Buss kit computers. He then branched through arcade computer game enhancements into multi-media production.

Stephen Jones was led to image synthesis through Bush Video and then built several devices with help and advice from Ariel and John Hansen. I set up the post-production facility Heuristic Video in 1982 where many people came and went using whatever electronic facilities I could get hold of.

John Hansen was working in Melbourne building electronic sculpture and a couple of video synthesizers which hybridized in to computer graphics systems. He developed the Conjure system which was Australia's first (and only?) locally developed computer graphics system.

Warren Burt was also working in Melbourne at the Latrobe University Music Department and bought the English video synthesizer Spectre to Australia. Warren was intricately engaged in composing music and image which had the same harmonic bases.

Sally Pryor went from commercial computer progamming to 3-D computer animation via Swinburne Institute of Technology in Melbourne and Cranston-Csuri productions in the U.S. She was one of the founding members of the Video Paint Brush Company, which was the place were commercial computer graphics for television really took off in Australia.

Peter Callas is a video artist who perhaps more than anybody else made the Fairlight CVI show what it was really capable of. Taking off from there he has been making complex graphical "video comix" with Quantel's PaintBox and Silicon Graphics equipment and is Australia's most internationally respected video artist.

Tom Ellard is the mainstay of Severed Heads. He started playing with the domestic end of computing, the Commodore Vic 20, in the early 80's and went on to devbour the Amiga and 3-D animation. He and I combined to produce the visual feasts of Severd Heads live performances through the 80's.

References:

[1] Fagone, Vittorio. (1993) "Nam June Paik and the Fluxus Movement. Europe and America, the origins and development of Video Art." in an appendix (p12) to Nam June Paik: Eine Data Base. ed. Klaus Bussman, Edition Cantz. Catalogue of the German Pavillion at the Venice Biennale, 1993.

[2] Herzogenrath, Wulf. (1993) "Nam June Paik's Paradigm Change: from Materiality to Immateriality to Illusive Materiality" in an appendix (p14) to Nam June Paik: Eine Data Base. ed. Klaus Bussman, Edition Cantz. Catalogue of the German Pavillion at the Venice Biennale, 1993.

[3] Vasulka, W., Vasulka, S. (curators) and Dunn, D. (ed.). (1992) Eigenwelt der Apparatenwelt: Pioneers of Electronic Art, Linz, Austria, Ars Electronica.

[4] Baudrillard: I don't know the reference

[5] Davis, Douglas, (1973) Art and the Future. A History/Prophecy of the Collaboration Between Science, Technology and Art. London, Thames and Hudson.

[6] Ada Augusta, Countess of Lovelace: in the Translator's Notes to the Sketch of the Analytical Engine invented by Charles Babbage, Esq. By L.F.Menebrea, of Turin, Officer of the Military Engineers. reprinted as an appendix in Bowden, B.V. (1953) Faster than Thought, London, Pittman.

[7] Sutherland, Ivan. (1965) SKETCHPAD: A Man-Machine Graphical Interface. MIT Lincoln Lab Tech. Rep. 296. May 1965.

[8] Richardson, Douglas (1972) Computers in the Visual Arts: A Progress Report. Basser Department of Computer Science, University of Sydney. A copy of the report is here.

Further Reading:

[9] Youngblood, G. (1970) Expanded Cinema, New York, Dutton.

[10] Newman, W.M. and Sproull, R.F. Principles of Interactive Computer Graphics McGraw-Hill, 1979.

[11] Williams, F.C. and Kilburn, T. "A Storage System for Use with Binary-Digital Computing Machines" Proc. IEE, pt 3, 96:81, March 1949.

[12] Brown, Paul, "It ain't what you do, it's the way that you do it" Proceedings: Ausgraph '89, pp107-112. [personal recollections and some history]

[13] Pryor, Sally, "Women, Art and Technology" Proceedings: Ausgraph '89, pp123-124. [re her Artist-in-Residency at Performance Space]

[14] Crow, Judith, "Creative Image Processing" Proceedings: Ausgraph '89, pp151-154. [re artist's use of image processing]

[15] Voss, Richard F., "Fractals in Nature: from characterization to simulation" Ausgraph 89, (separate publication)

[16] Ausgraph '89, Film and Video Show catalogue

[17] Ausgraph '90, Film and Video Show catalogue

[18] Davis, Douglas. (1973) Art and the Future: A History/Prophecy of the Collaboration between Science, Technology and Art. London, Thames & Hudson.

[19] Reichardt, Jasia (1968) *Cybernetic Serendipity: the computer and the arts*. A Studio International special Issue. Catalogue of an exhibition called "Cybernetic Serendipity" held at the ICA London, Aug 2 - Oct 20, 1968.

Primer of Image Synthesis

For the purposes of this show, my definition of electronically generated images is, basically, anything that contains electronically generated image material that was made largely for display on a monitor screen of some sort.

Computer graphics and video synthesis had, for a while, somewhat parallel lives. This was similar to the development and demise of the analog computer as the digital computer was developed and then gained ascendency. Video synthesizers were basically developed out of the analog computer technology. They then slowly hybridized with digital technology becoming pattern generating machines.

Digital computers were initially constructed to speed up the repetitive solution of mathematical problems, namely firing tables for military guns during the 2nd World War. In the 50's (long foreshadowed by Ada Augusta) the computer began to be used as a tool for making music.

The Cathode Ray Tube (CRT), originally developed for electronic waveform display and subsequently adapted for television, was first used as a storage medium in several early computing systems. Early in the 60's, Ivan Sutherland invented a CRT display called "SketchPad", and the light pen, which allowed one to interact with the graphical display, appeared about the same time.

Computer graphics could also be plotted and printed as Ken Knowlton and others showed. This was done by translating grey scale values from a scanned image into graphical "characters" which could be output onto a micro-film plotter. Knowlton made the first computer graphic films with Stan Vanderbeek in 1964.

Many of the big US industrial corporations started using computer graphics for design and engineering development. In the early 70's, Charles Csuri developed 3D graphical displays of mathematical abstractions which he could move around the screen using a light pen to draw and move the drawing around the screen. About 1970 Sutherland invented the head-mounted display and virtual reality simulation was begun.

The monitor screen

A Cathode Ray Tube (CRT), and any of the display devices which evolved from it, is essentially a glass bottle containing a vacuum.

An electron beam is generated by a "cathode" or piece of wire in the neck of the bottle which is heated to produce a stream of electrons. The base of this bottle is covered with a surface of material which produces light (photons) when stimulated by an electron beam. By placing a positive charge on this "photo-electric" material the electrons from the cathode are drawn towards it. The base thus becomes the face plate, or screen, of the CRT which is used in the oscilliscope, the television screen, the radar display and eventually the computer display. Electronic voltages are sent to densely wound coils of wire around the neck of the bottle. These coils direct the electron beam around the screen thus producing images on the face plate. By modulating the currents which control the coils or the electron beam various kinds of displays can be produced.

There are basically two classes of display:

1. Vector type displays such as the oscilliscope, the radar display and early computer displays and
2. raster type displays such as the television screen and modern computer monitors.

1: Vector displays are those in which the beam directing coils are driven by varying electronic voltages and push the beam around the screen. This is the basis of an oscilliscope. When driven by, say, an audio synthesizer these produce the kind of display known as a "Lissajous figure" [this is how ABC TV's logo is made]. The vector display also forms the basis of the first computer graphics displays in which strings of numbers from the computer are translated into voltages by a digital-to-analog converter and used to drive the deflection coils of the display. We also saw them in use in some early video games such as "Asteroids".

Fig.n: Oscilliscope display showing a video (feedback) waveform

2: Raster displays drive the deflection coils with a specific waveform which moves the electron beam from side-to-side progressively down the whole surface of the screen. The image is then generated by changing the current at the cathode thus modulating the brightness of the electron beam and the scanned image. These are the ubiquitous television and computer monitor.

Video Synthesis

The first of the video synthesizers were video image manipulation devices which worked with the images of television and then scrambled and videotape images in various ways. Eric Siegel developed his first video colouriser and Nam June Paik and his engineer Shuya Abe developed their first video synth in 1969. They were closely followed by Stephen Beck with his Direct Video Synthesizer.

Several levels of synthesis and image manipulation exist:

1: Lissajous figures are generated by applying varying voltages to the "X" and "Y" coils of an oscilliscope to drive the beam into line drawing (vector) type images. These are among the earliest forms of image synthesis and could easily be produced in the sound lab by analog audio synthesizers. Lissajous figures have to be rescanned by a video camera to be used for video production.

Fig.n: Lissajous figure from Jetlag by Severed Heads

2: Direct manipulation of the video display by adding extramagnets to the display tube or by mixing audio signals onto the deflection waveforms. The image will twist and squirm over the screen producing strange distortions of the tv image. These effects have to be reshot to bring them into the video production process. This is where Nam June Paik started in his earliest tv manipulation installations (in 1963). The most sophisticated version of this approach was a system known as the "Scanimate". Ariel also produced a monitor that worked this way.

3: Video feedback is generated by pointing a camera at a monitor which is receiving the output of the camera as the signal for display, ie. the camera is looking at its own output but delayed slightly by cable length and electronics. Spinning, looping video oscillations which have a self-sustaining "life" result. Rotating the camera with respect to the monitor produces rotated and multi-petalled feedback patterns. The camera output can be mixed with other camera or video-tape images to make very complex patterns and echoes of the source image.

Fig.n: Highly intricate single camera video feedback made for Greater Reward by Severed Heads

4: Colourising: The varying brightness (or luminance) of a video image can be used to control a color modulator giving glowing pure color transforms of the original image. The first video synthesizers were essentially colourisers. See the notes on the Cox Box and Fairlight Instrument's Electric Paintbox.

Fig.n: The main electronics pack of the Cox Box

5: Pattern generationand direct synthesis of the video signal. The basic video pattern generator is a set of oscillators running at frequencies which are consistent with the scanning frequencies of a video monitor. To get stable patterns the oscillators are synchronized (restarted) by every vertical (frame) or horizontal (line) synchronizing pulse. These oscillator signals are then mixed together (summed or gated) and the whole signal switched out during the blanking between the lines and frames of video. To get colors from these signals some patterns could be assigned to the red channel, some to the green channel and some to the blue channel of the monitor or into a color encoder.

Fig.n: Stephen Jones' video synthesizer, colouriser, Serge audio-synthesizer and vector monitor at Heuristic Video

Computer Graphics

Computer generated imagery also takes two forms. The earlier was the sort of system developed by Doug Richardson in which the computer does calculations in real-time to draw lines on a vector display (a sophisticated version of the oscilliscope). Using early minicomputer systems such as the DEC PDP-8, artists were able to use vector displays to draw connected series of straight lines on the screen to produce drawn images. This is also the beginning of computer aided design for engineering and architecture in the design of 3D objects.

When IC level digital technology became more available a hybrid of the video synth and computer became common. Various synthesizer builders started using chip memory to store more complex patterns in, and by playing out this memory pattern at different speeds more complex patterns could be produced. Some aspects of this are seen in the EMS Spectre used by Warren Burt, and in John Hansen's synthesizer.

Computer generated imagery went over to the raster display in the mid seventies. As raster monitors became more available and chip memory became cheaper, the frame store (or screen memory) was developed. This device allowed the storage of a full frame of a video image which could be readily modified by a computer and could be endlessly re-read for display on a monitor. This is the basis of computer graphics. At bottom most computer graphics software consists in algorithms for drawing lines and surfaces coupled with a vector-to-raster converter which writes the image or pattern into the frame store. The first commercially available frame storage devices for computers were the Matrox (ALT-256) which were 256 pixel x 256 line by 1 bit deep video storage planes which could be made up to 8 bits deep by buying 8 cards.

Fig.n: Matrox ALT-512 S-100 buss graphics card

Originally designed for scientific image processing work they became available on the S-100 Buss format in the late 70's. This is what Ariel used for his earliest work with his own S-100 Buss kit computer (the Imsai). The Matrox boards (produced in Canada) improved as chip memory became cheaper and more dense. They were followed up rapidly by boards from other companies and with the advent of the IBM PC and its clones the first generally accessible graphics systems appeared.

Initial developments in graphics software were driven by two needs: Computer aided design (CAD) in engineering and architecture; and Image Processing in scientific analysis (eg. electron microscope analysis). CAD systems needed to have discrete image primitives like lines, rectangles and circles which could be readily moved about the screen and resized. This was derived from the vector style drawing of the earliest systems. Image Processing didn't really start till the raster display became available because its need was to know where something was in relation to other things on the screen and how many there were and how to detect them.

The most interesting equipment that came along combined the best of these approaches. This is represented here by the Conjure system from Vision Control in Melbourne. The design of Conjure took the CAD approach and combined it with some image processing capability, such as the capacity to fill areas with color, and placed it on a raster system which also had the great advantage of being able to be turned into a video signal. You can see a similar approach taken in Corel's Draw software.

For the poorer artists without the capacity for roll-your-own hardware or leasing arrangements things didn't really get going until the appearance of domestic computers which presented their display on your tv screen. These are the Commodore machines such as the Vic 20 and the Commodore 64. Tom Ellard talks more about the pleasures of the Commodore 64 in his article. Of course, the Commodore Amiga suddenly got it right. An architecture which used main computer memory as graphics memory and a custom chip set which would display the graphics from wherever the computer felt like putting them. In real-time and with a sequence of frames placed in memory it would animate your graphics as well. Alas the Amiga. It got everything right including real multi-tasking and nobody except the aficionados would buy it.

Meanwhile Kia Silverbrook at Fairlight Instruments was developing a purpose built computer video synthesizer called the CVI. It was based on a very flexible display memory system which could be written to and read from alternately during any pixel. The address generators for the display memory could start at any point on the screen and count up or down as requested by the operator. To make it usable to non-technical people it had a control panel of switches and sliders which controlled the color treatments and address generation for the display. It also had a drawing pad through which images could be drawn onto the display. These images could then be moved about and coloured. Pattern making was easy and fast. This was the system that Peter Callas used for many of his works.

Eventually the Mac and the IBM clones got good graphics capability though it took years for the VGA output of the IBM architiecture to be capable of recordable video. This is largely because the desire for high resolution, flickerfree images meant that frame refresh rates are far to high for video signals.

The commercial market took up with computer graphics for television through making clips for bands and through the vast amounts of money that advertisers seem willing to pay. So the Quantel PaintBox appeared and subsequently Harry and Henry. One of the first companies in Australia to use Quantel's Paint Box for commercial and art production was the Video Paint Brush Company in Melbourne and later Sydeny. Sally Pryor, Andrew Quinn, and Jill Scott were some of the first users of this facility. VPB Sydney later became Animal Logic which now is one of the main film computer graphics houses in Australia. Following Quantel other computer graphics system makers started to get into the act, much to Quantel's annoyance. Silicon Graphics made huge inroads via the production of computer animation for the movies using Alias, Wavefront and SoftImage software. Flame was developed in Melbourne by Garry Tregaskis and sold to Discrete Logic of Canada. But all of this is another story which I shall not pursue here.