Electric Shadows

The daughter of the Greek sculptor Butades traced the shadow of her lover onto a wall, the night before he was going to war. He died on the battlefield and Butades made a sculpture from the silhouette she had drawn. It was placed in the temple and became the object of a religious cult honouring the soul of the young man, a soul captured by fixing the shadow in its vertical position. In this way, Pliny reveals the myth that explains the origin of painting and sculpture.

Another, even stranger story about the origin of images comes from Plato's allegory of the cave. Humans are imprisoned in a dark cave where forms are being carried around to cast shadows on the walls. For the cave-dwellers, these shadows are the only contact they will ever have with the true world. Plato describes what would happen if one of them were to escape: he should first look at shadows, then at reflections and only afterwards at objects. In Plato's allegory, the light of the sun is the source of truth: humans will never be able to look at it directly. Elsewhere he suggests that pictures, like the shadows in the cave, are amongst the lowest categories of being, furthest removed from the light. [1]

These stories demonstrate two radically different ways of thinking about images. For Plato, they are passive copies of a reality that will always remain out of reach. In the story of Butades images are magically active signs that capture the essence of what they refer to: they capture the soul, not the body.

The myths about the origin of cinema often focus on the photorealist qualities of the medium. They emphasize that adding motion, and later sound and color, enhanced the realistic illusion of the static black and white photographic image [2]. The next step in the development of such illusionism would be to enlarge the screen, add smell and stereovision, and physically move the spectator, all of which have indeed been experimented with. Both virtual reality or omnidirectional video add interactivity, in an attempt to further enhance the total illusion. However, it is highly questionable whether the power of film images, or even their realism, ultimately derives from their illusory qualities. This view of cinema firmly places the medium in the Platonic world of miserable copies.

In my opinion, the role of art is to develop new forms of realism, where realism is not understood as some kind of correspondence with an outside world that is already given. Art is a way to actively create the world by making images that somehow 'work'. Picasso reportedly answered to a complaint that his portrait of Gertrude Stein did not very much look like her: *"No matter, it will"*. [3] I would like to explore some facets of an approach to images which emphasizes their artificiality and their power as active, magical signs through which our world is constructed. This approach has been applied to film in a very interesting way, but it did not originate in thinking about film and nor will it become irrelevant when celluloid disappears.

Elements

Euclid's Elements brilliantly condensed the mathematical knowledge gathered by the Greeks up to the third century BCE. Most of what it contained was not seriously challenged until 2100 years after the book was written. Apart from

being the foundation of western mathematics, it also firmly established the idea of reducing a field of knowledge to a set of elements and production rules to make combinations of these elements. His book demonstrated the productive power of an inner machinery of postulates and axioms. This scheme was perhaps even more influential than the mathematics he explained with it. Later in life, Euclid wrote a book of optics with a similar structure, and books following the same method appeared in all areas of human knowledge, even including theology and law.

The first practical handbooks for painters were based on a mixture of the geometry from Euclid's *Elements and Optics*, and were written in the form of postulates and axioms. They explained how to construct forms starting with lines and geometrical shapes in the correct proportions. Later on, such books explored more complex theorems including the reconstruction of the optical rays through the virtual window formed by the painting, which was the basis of creating an image in perspective. Light and shadow were introduced and in the final chapters the knowledge was applied to complex scenes, culminating in perspective drawings of either buildings or complicated mathematical shapes. From the Renaissance up until the nineteenth century, teaching methods for painters became increasingly codified along similar lines. The nineteenth century Dupuis method was based on drawing elementary mathematical shapes first, and only after drawing body parts and natural motifs could the aspiring artist start thinking about more complex compositions.

The Dutch artist and theoretician Humbert de Superville was one of the precursors of what is now called the psychology of perception. In his approach, the elements of drawing were taken as the basic elements of aesthetic meaning. He based his theory of the 'Unconditional Signs in Art' of around 1830 on the intrinsic meanings he attributed to the direction of lines. By relating the direction of lines to the upright position of the human body, he derived four basic meanings: active vertical lines, neutral horizontal lines, uplifting 'expansive' lines and depressed 'convergent' lines. He also related these categories to colors and architectural styles. A generation later, De Superville's ideas were taken up by Charles Blanc, whose *Grammaire des Arts du Dessin* of 1867 influenced a number of early avant-garde artists.

Another precursor following a somewhat comparable approach was philosopher Theodor Lipps, who based an elaborate aesthetic theory on the concept of 'Einfühlung' (empathy). According to Lipps we enjoy geometrical forms in as far as we can relate them to the positions and movements of our own body. As a consequence, the meaning of abstract shapes is ultimately dictated by the 'general mechanical laws' that we know intimately through the inner experience we have of our own muscles and joints. [4] Like Superville, Lipps did not just relate the

elements of geometry to the human body. Since he was interpreting these forms in the framework of elementary Newtonian physics, he could also apply a host of physical concepts to analyze the meaning of relationships between shapes in more complex configurations.

Early abstract art was heavily influenced by these ideas. Both Paul Klee's *Pedagogical Sketchbooks* and Wassily Kandinsky's *From Point and Line to Plane* begin by discussing elementary geometrical forms. Their interpretations are closely related to those of Theodor Lipps: for instance, Paul Klee considered curved lines as traces of forces acting on a moving point. In a way similar to the old handbooks on perspective, both artists proceeded to build increasingly complex compositions from primary elements. In order to arrive at combinations of multiple shapes, Klee primarily used the notion of pictorial balance developed by Lipps. He demonstrated this concept using diagrams of weights and moments resembling those from high-school physics textbooks. Kandinsky explained similar compositional methods, yet he deplored their lack of sophistication and envied music for its articulated theories of harmony and counterpoint.

At the beginning of the twentieth century artists and perception psychologists were both working from the assumption that complex meanings or effects could be constructed from the meanings of a limited set of pictorial elements. Ultimately, these elements were derived from Euclid, but they had changed in character; they had become elementary visual sensations or elementary entities of paint on canvas, seen as exercising an active influence on the viewer. The artist could engineer the total vibration of the work by making compositions, starting from his inner experience.

Configurations

The pioneers of abstract art were acutely aware of the revolutionary nature of what they were doing, and many testimonies exist to their own doubts as to whether or not they were following the right path. By abandoning the traditional representation of objects and people, these painters discarded an enormously rich heritage of pictorial codes and compositional tools. This left them to their own devices in solving the problem of finding other types of signification. It did not necessarily imply a blank rejection of all kinds of representation; on the contrary, abstraction was often seen as a logical consequence of the desire to represent ideas that went beyond the outer skin of things.

Most of the early abstract artists went through a preliminary stage of Symbolism inspired by Theosophic and other esoteric beliefs. Theosophy, founded by Helena Blavatsky, tried to show the unity of all world religions by fitting them into a framework consisting of a small number of fundamental concepts. Blavatsky often explained the relations between these concepts through graphic diagrams, for which she scoured different religious traditions. The elements of 'the sacred geometry' in these diagrams were thought to convey very specific meanings. The Theosophic movement was sufficiently open to furnish artists with a comfortable context for their quest for a deeper sense, while the detailed interpretation of geometric forms provided a framework for exploring new constructions.

Piet Mondriaan explained his approach to abstraction: "The special – which distracts us from the principle – is annihilated, and the general remains; the imaging of things makes way for the pure imaging of relationships." And in the context of his very reduced graphic language he wrote: "Through the progress of art the laws have reached more and more totality, and they are the great, hidden laws of nature which art establishes in her own way." [5] To express the nature of these relationships, Mondriaan used the terminology of Dutch philosopher Schoenmaekers, with whose ideas he felt a close affinity. Schoenmaekers developed a 'Positivist Mysticism', dealing with the inner essence of reality, while aiming to be verifiable and accessible to the uninitiated, notably through geometric imagination.

Towards the end of his career Oskar Fischinger recounted his motivations for making abstract films, remembering a lecture he gave when he was 19 and first becoming interested in abstraction. He had made a kind of graphical interpretation of two plays: "On large sheets of drawing paper, along a horizontal line, I put down all the feelings and happenings, scene after scene, in graphic lines and curves. The lines and curves showed the dramatic development of the whole work and the emotional moods very clearly." [6] Further on in this text he suggests that the films he later made were in many ways a continuation of this fascination with the purely visual communication of moods and concepts. His early films often invite a symbolic interpretation, the different shapes representing energies or principles interacting on a stage formed by the screen.

Although the general motivation of most abstract filmmakers is similar to that of abstract painters, a major difference is, of course, the element of motion. This shifts the emphasis from more diagrammatic 'static' meanings to the depiction of processes that unfold during a period of time shared with the spectator. Fischinger wrote: "The poetic language of the film must become as flowing as speech, so a visual vocabulary could develop which would allow us to do some thinking in those terms." [7] Filmmaker James Whitney attempted to develop such a vocabulary during the early 1950s when he "experimented to try to codify an ideographic vocabulary or alphabet for the expression of visual ideas. Finally, he was aesthetically and spiritually satisfied only by the reduction of all building components to their simplest form – the dot or point." [8] The dots in masterpieces such as *Yantra*, *Lapis* and *Wu Ming* suggest many possible interpretations including atoms, bits of energy or individuals.

Many abstract painters and filmmakers believed that the configurations or moving compositions they showed had some kind of direct influence on the spectator. In some respects this returns to the kind of esoteric symbolism discussed above, which in turn goes back to much older, magical ideas that signs do not represent concepts or things by pointing to them, but actively embody

the spiritual force of what is signified. In the lucid and eminently non-magical universe of philosopher Nelson Goodman, paintings or scientific works have the power to create a world by establishing new connections between concepts, or by mapping existing networks of connections to new realms. In the case of abstract art this often happens by way of exemplification: a work of art represents concepts that apply to it. [9]

Entoptics

If there is one overall trend in the discontinuous history of abstract cinema, it is the gradual shift from symbolic, dynamic constructions to the exploration of purely optical phenomena. The pioneers Ruttmann and Fischinger made this shift within the span of their own career, culminating in the flickering color rhythms of Fischinger's *Radio Dynamics* in 1942. James Whitney also made expert use of afterimages and other retinal effects in his later films, and Tony Conrad and Paul Sharits more radically explored such phenomena in an artistic context that was very different from the artists mentioned thus far. Tony Conrad's *The Flicker* of 1965 consists only of totally black or white frames, reducing cinema to an orchestrated stroboscope. The actual filmstrip containing the rhythm of black and white images is just one element of the work: when projected and viewed, onlookers have widely varying visual experiences due to the interferences caused within the retina by light flashing at certain frequencies. This produces subjective color phenomena such as in the films of Paul Sharits, whose projected color rhythms are enhanced, supplemented or counteracted by retinal colors caused in the eye of the beholder. These films were made at roughly the same time that Bridget Riley painted her first op-art canvases. Op-art also plays tricks on our visual system: the finished work does not exist on the canvas or the screen, but in a very literal way it comes into being somewhere between canvas and the mind of the observer.

These pieces attacked the notion that works of art are somehow transparent channels conveying representations. The structure of our perceptual system is part of both the subject matter and the material of these works, and because of the active contribution of the viewer they have been considered a precursor of interactive art. [10] They emphasize the opacity of our sensory organs by triggering them to become producers themselves. This works best using the most basic elements of the medium: graphic rhythms consisting of minimal, geometric shapes, or rhythms constructed with the single film frame as its temporal atom.

Embodied Vision

On numerous occasions the experimental filmmakers Stan Brakhage and Jordan Belson have stated that they consider their films to be faithful records of perceptual experiences. In the words of Brakhage: "I really think my films are documentaries. All of them. They are my attempts to get as accurate a representation of seeing as I possibly can. I never fantasize. I have never invented something just for the sake of making an interesting image. I am always struggling very hard to get as close an equivalent on film as I can, as I actually see it." [11] Most often his 'equivalents on film' resemble phenomena within the visual system, phenomena

we are intimately familiar with because they arise in our bodies. Peripheral vision and phosphenes generated by fatigue or pressure on the eyeball are human universals. In our goal-driven practical vision of everyday life such phenomena are ignored because we need a specific frame of mind in order to consciously experience them, just as finding 'equivalents on film' necessitates sidestepping that technical structure of the medium engineered for standard pictorial codes. Brakhage cites as examples the perspective inherent in the camera lens, the tonal range of film stocks and the range of speeds limited by the 24 frames per second timebase. The innocence of what Brakhage called 'the untutored eye' has to be conquered by a painstaking process of re-appropriating the medium. In this respect the cinematic achievements of Brakhage can be compared to what Cézanne realized in painting.

It is a small step from such re-appropriation to an extension of the medium. Jordan Belson built his own machinery to produce images of processes and flows, claiming that this machine enabled him to visualize his mental states. [12] By way of his optical set-up he could formulate images of his inner experiences and demonstrate his perceptions to an audience through film. Between 1961 and 1977 Belson made a series of about twelve films in which he built up a vocabulary of processes, acquiring meaning through their appearance in different combinations in different films.

The video experiments of Steina and Woody Vasulka are part of wider research into the nature of the space opened up by video technology. Their lesser-known early tapes and *Reminiscence* from 1974 are based on video footage of places from Woody Vasulka's childhood in Moravia. Using a Rutt-Etra scan processor, the video image is transformed into an abstract web of lines indicating brightness gradients, resembling "visual impressions, like distant memories ... in which some elements remain vivid and others fade." [13] The result is a stunning space unfolding in unexpected ways out of completely unfamiliar imagery, while remaining unified by the bodily movement implied by the moving camera. In both these works the continuous soundtrack indicates that the video deals with some kind of real-time representation. In a similar way, some films by Brakhage and Belson employ short irruptions of photorealist imagery to anchor the images to our world.

The works mentioned above aim to be records of perceptual experiences, 'demonstrations' of a certain mode of perception made possible through machinery and offering a different perspective on the world. One step further in this line of reasoning would be to make sensory interfaces for the public that interactively mediate such experiences. The most extreme indication of the potential of this approach is the research being carried out into sensory substitution. The field was mainly established by Mexican neuroscientist Paul Bach-y-Rita, who was

interested in neural plasticity, the ability of our nervous system to remap itself and adapt to radically new sensory situations. His most famous experiments were those in which he attempted to restore the sight of blind people by training them to perceive images through what is called 'tactile projection'. A low-resolution video-image was fed to a 40 x 40 matrix of vibrating pins on the skin, and after many training sessions the blind test subjects reported truly visual sensations. They were not feeling through their skin anymore, but were actually seeing. A similar line of research was started by Leslie Kay, who investigated the possibility of sonar vision interfaces. Both investigations still continue and have led to many proposals for interfaces to restore sight to the blind, some of which are gradually being adopted as equipment gets smaller. [14] Wearable computing pioneer Steve Mann is one of the few who seem to realize the potential of such research for augmented perception, and the invention of new sensory organs. Developing sensory interfaces of this kind could be an artistic enterprise. Instead of multimedia spectacles based on dreams of immersion and totalitarian control over the spectator, this would be an art based on enabling discovery and new kinds of interaction with the real world and its inhabitants.

Artificial Life

Between 1930 and 1935, Laszlo Moholy-Nagy developed his *Space-Light-Modulator*, one of the most important early kinetic art pieces. The work is mostly interpreted as a key example of the artist's preoccupations with space-time, a new vision of space entangled with motion. Yet there is also another angle present. Throughout his writings Moholy-Nagy stressed the idea that many ways of using technology are anti-biological. Therefore, one of the roles of the artist is to contribute to a humanist reflection on technology. These thoughts were triggered by a small book called *Die Pflanze als Erfinder (Plants as Inventors)* written in 1920 by the botanist and philosopher Raoul Francé. One of Francé's ideas was that all biological mechanisms, as well as artificial, are made up of seven basic 'biotechnical elements', each incorporating a basic function. These elements, such as the sphere, the plane and the screw were a major inspiration for the shapes revolving in the *Space-Time-Modulator*. The shadow display generated by the kinetic sculpture makes it a kind of model of the cosmos: a combinatorial machine that continuously produces new constellations of elements.

From the very beginning, pioneers and inventors of the computer were interested in investigating biological processes by devising numerical models. Alan Turing looked at how cells differentiate in embryos, Stanislaw Ulam modeled growth processes, and Johann Von Neumann was the first to formulate a theory of self-replicating machines. In 1987 this field received an enormous boost when Chris Langton organised the first conference on Artificial Life, uniting many strands of research from various disciplines barely aware of the similarities in their respective approaches. One of these strands is the (utterly unscientific) work undertaken in procedural animation, where sophisticated modeling techniques are used to produce animations and special effects for films. In 1983 William Reeves of Lucasfilm developed Particle Systems, a simplified kind of simulated matter consisting of streams of particles that can be pushed around by virtual forces. This has been used to convincingly simulate clouds, explosions

and other complex shapes and textures. Also in 1983, Craig Reynolds developed the Boids algorithm, a simulation of the processes governing the flocking of birds and the movements of herds. And since the late eighties L-systems, another set of algorithms inspired by biology, are widely used to realistically model the morphology of plants and trees. [15]

In computer art this interest in complex processes inspired by biology came relatively late. Most early algorithmic art dealt with arrangements of picture elements in a systematic, centralized way. The source of complexity was either information that was fed to the system from the outside, or a stochastic factor within the algorithm. It was not until after the particle systems and boids algorithms were invented that artists developed an interest in such approaches to complexity. Morphogenesis became a major inspiration: biological processes of growth in which complex patterns emerge from simple, local interactions between agents. At the beginning of the nineties computer artists such as William Latham and Karl Sims started to use simulated evolution as another source for emergent creativity. Perhaps partly because of the popularity of coding tools such as Processing, most recent computer art projects seem to be based on interacting swarms or other populations of elements.

Artificial Life is one of the few scientific disciplines open to artists, giving rise to a new breed of scientist/artist able to make meaningful contributions to both fields. With his work on evolved creatures, Karl Sims has been a prime example of this. But visualization and simulation permeate this field at a deeper level too. At the basis of Artificial Life stands the idea that life is essentially a kind of algorithm, an information process that is to some extent independent of the material nature of its support. According to this view there is no reason why life could not exist in a computer or any other medium with the ability to perform calculations. As yet, there is no agreed formal definition of life and for the time being the only life-defining criterion is a variant of the Turing test: if a human observer cannot distinguish between the responses from a human and an artificial entity, then the artificial entity has to be called intelligent. In the same way it is assumed that if a computer algorithm shows 'enough' of the properties of an organism, it actually *is* an organism. This argument is based on mimicry of life, not on analytical understanding that can be crystallized into a scientific theory. [16] Another point is that simulation is not the same as realization, or as Howard Pattee has put it: "We are not warmed by the simulation of thermal motions." [17]

A notion that is especially relevant to much recent biologically-inspired algorithmic art and to artificial life in general is what Jon McCormack has called 'the computational sublime'. Similar to the romantic attitude to nature, 'the computational sublime' instills "simultaneous feelings of pleasure and fear in

the viewer of a process realized in a computing machine. A duality in that even though we cannot comprehend the process directly, we can experience it through the machine – hence we are forced to relinquish control. It is possible to realize processes of this kind in the computer due to the speed and scale of its internal mechanism, and because its operations occur at a rate and in a space vastly different to the realm of our direct perceptual experience." [18] Such feelings of pleasure and fear are the subject of *Simulacron-3*, the first novel dealing with the idea that simulated entities could actually be autonomous, sentient individuals if the simulation is detailed enough. [19] Artificial Life is motivated by the dream of the ultimate magical sign: a sign that is not just animated or active, but alive and beyond our control.

Evolving Eyes

Mikhail Matiushin and his friend Kazimir Malevich were both convinced that our sensory organs are still at a rather primitive stage of their evolution. Therefore artists should train their perception to achieve the potential of their senses more fully, and art could offer a glimpse into these new perceptual realms. At the time of his black square, Malevich proclaimed that he had "transformed himself into the zero of form and gone beyond '0' to '1'", meaning that it was necessary to go back to the basic elements of visual reality and make a fresh start. While Malevich was the director of the GINKHUK Institute for Artistic Culture in Leningrad, Matiushin was the head of its 'Section for Organic Culture'. Matiushin conducted detailed investigations into the interdependence of form, color and sound: "But these perceptual and physical experiments – completely formalist in nature – had a more fundamental purpose: the probing of the under-edge of the visible world, the narrow space in which spirit can be detected in matter and in which the laws that govern both are manifest as modifications of form and color. An artist who had learned to observe such transformations carefully and regularly, and to understand them as the products of natural law, could hope to give visual form to the true nature of reality." [20]

Part of artists' fascination with the medium of film derives from the idea that film also carries the possibility of a perspective transcending human limitations, the perspective of a machine, showing us something new about our world from an alien vantage point. The most famous example of this vision of cinema is Dziga Vertov's concept of the 'Kino-Eye'. Variations on this attitude were later expressed by artists such as Michael Snow in his magnificent film *La Région Centrale*, and by Steina and Woody Vasulka in the context of their 'machine vision'-projects.

A criticism of the current approach to Artificial Life is that it implies a unique, godlike perspective, a reductionist ultimate view of reality that is essentially the same as the clockwork universe put forward by Laplace in 1814. It is a universe in which all parts and movements are known. In essence, the working principle of such a machine is the same as the conceptual machinery invented by Euclid in his Elements: an algorithm that generates all statements through logical combinations of the postulates. Since the computer was designed to embody these very same combinatorial principles, it is the perfect machine to simulate such a universe.

After 2100 years of unquestionable authority, Euclidean geometry lost its monopoly when alternatives for its fifth postulate were proposed, at first hesitantly by Saccheri around 1733, but then finally by Gauss, Lobachewsky and Bolyai around 1820. By questioning Euclid's definition of parallel lines they discovered an infinite series of non-Euclidean geometries among which the geometry of Euclid was only a special case. It is a good example of how change is seldom caused by rearranging existing primitives, but more usually by discovering a new one. In the same way, creativity in art or science is rarely characterised by finding new combinations of known symbols, but by constructing new meanings for them: discoveries are semantic rather than syntactic in character.

If Artificial Life is to really offer new perspectives on our world, biologist Peter Cariani suggests: "We will need devices firmly embedded in the real world which construct their own semantic relations, their own primitive features and actions, their own sensors and effectors. If we want them to be creative, thereby enriching and enlarging our own semantic repertoires through their operation, we must give them the structural autonomy necessary for transcending our specifications. When this happens, our devices will have emergent properties relative to us, functions not reducible to what we already know. Our devices will afford us a means of enlarging the basic observables of our world." [21]

The artists I have mentioned were all investigating our world through formal investigations of visual elements. In a sense the history of abstract art could be interpreted as a cultural history of observables, a history of the different types of meaning given to the building blocks of the world. The aim of these artists was to change our perceptions by developing new pictorial codes demonstrating new primitives of meaning. These codes and the new kinds of realism they facilitated were always presented as works-in-progress. In these works the viewer witnesses an open process of the construction of meaning, a meaning which is not derived from a higher entity such as Mathematics, God or Hollywood, but from an autonomous dialogue with the world. Such images are active in the sense that they enable a new construction of the world to happen; images can be 'activist' in the sense that they can invite the viewer to construct their own world and forge their own realism. To have machines create their images for us implies that we need to build devices as limited, open and expandable as we are.