

Becoming Digital

by R. Bruce Elder

For the past fifteen years I have been working in a sort of digital cinema, that is (to be precise about my meaning) a cinema that incorporates digital images. I work with digital images at a fundamental mathematical level. In one sense, I embarked on this work with a certain reluctance: I did not hanker for the mathematical challenges that this work has required that I face. But in another, it seemed fated that I would undertake this adventure: I began my university studies in science, my philosophical training and my early philosophical endeavours were strongly influenced by mathematical logic, and, willy-nilly I found employment at a university of technology. Moreover, my native Platonic proclivities, reinforced by my encounter with the Canadian Platonist George Grant, my studies with the renowned Plato scholar R. E. Allen and the emphasis at the time on logical analysis, led me (despite Grant's lack of interest in the mathematical dimensions of Plato's thought) to read rather deeply in the history of mathematics. As early as the late 1970s, I became convinced (as I remarked recently to your festival organizer Hang Jun Lee) that that mathematical structures are homologous to structures of consciousness, and that cinematic elements can be configured in forms that are isomorphic to mathematical structures—and these beliefs suggest (if not entail) , according to a postulate that the study of Euclidean geometry led many of reflect upon, that some cinematic forms are isomorphic to the structures of consciousness.

I convinced myself, then, that a judicious selection among mathematical principles could reveal important insights into the working of the mind. Applications of algorithmic theory in artificial intelligence, I came to believe, could be a guide to making that judicious selection. The irony of the historical process was not lost on me: I realized that in the last decades of the twentieth century, we had arrived a new way of understanding Plato's claims that the study of mathematics leads to insight into the nature of reason itself. But another potent factor was added to the complex: using processes deriving from set theory, field theory group theory and

representation theory, cinematic elements could be organized into forms isomorphic to mathematical forms—and so cinematic forms, configured by judiciously selected mathematical principles, could provide models for at least some mental processes. I saw the challenge that lay ahead: that of pursuing this insight to the limit, in order to discover how wide a range of mental processes could be modelled by arrangements of cinematic elements organized into forms isomorphic to mathematical forms.

But the transition to digital cinema was not straightforward. I understood, even as a ventured into this new challenge, that aesthetic convictions I had developed in the decade and a half before I took up digital imaging could not be incorporated easily into this new belief structure. Until the mid-1980s I worked in long forms that were grounded in montage. I found exemplars for these forms in Ezra Pound's *Cantos*, Louis Zukofsky's 'A', and the longer poems of Kenneth Rexroth, especially *The Phoenix and the Tortoise* and *The Dragon and the Unicorn*): Pound taught me how the montage could offer an imitation of thought processes, Zukofsky taught me how a montage of quotidian elements could articulate a far-reaching theory of value, and Rexroth (the teacher with whom I spent the most time reading and from whom I learned the greatest lessons) taught me the simple truth that a poet is "one who creates / Sacramental relationships / That last always." Among those of his poems that are most dear to me is "Time is the Mercy of Eternity." It concludes

There are no fish in the water.
There are few deer or bear in the woods.
Only the bright blue damsel flies
On the reeds in the daytime,
And the nighthawks overhead
In the evening. Suspended
In absolutely transparent
Air and water and time, I
Take on a kind of crystalline
Being. In this translucent
Immense here and now, if ever,
The form of the person should be
Visible, its geometry,
Its crystallography, and
Its astronomy. The good

And evil of my history
Go by. I can see them and
Weigh them. They go first, with all
The other personal facts,
And sensations, and desires.
At last there is nothing left
But knowledge, itself a vast
Crystal encompassing the
Limitless crystal of air
And rock and water. And the
Two crystals are perfectly
Silent. There is nothing to
Say about them. Nothing at all

That visionary geometry, grounded in the transient, remained of enduring importance to me.

Elsewhere Rexroth outlined erotic mysticism that became the core around which the various strands of my work wound themselves—in *The Phoenix and the Tortoise*, Rexroth noted that he found in sacramental marriage a source of values in the midst of the disintegration of traditional culture. The aim of life lived according to this principle, he noted, is to show how, from full love of one other person, the self can develop a reverence for all life. “The process as I see it goes something like this: from abandon to erotic mysticism, from erotic mysticism to the ethicalmysticism of universal responsibility—from the Dual to the Other.

Such love leads to an identification of the self with what Rexroth called “the tragic unity of creative process”—as Rexroth saw it, the creative process is a tragic one because in it creation and destruction are yoked together, as love and death, light and dark, are in reality. But Rexroth insisted the forms arising from the union of opposites do not lead us beyond the world—rather, they are inseparable phases of the whole process of the world. Thus, the poems a poet fashions can serve as lessons in the absolute, ineluctable and insuperable value of contingency.

Love, Rexroth taught, does not lead us out of the world. The place of transcendental calm is located in the intense relation of one to another. So often we want to find our values in a realm beyond that of contingent fact—in his *Tractatus Logico-Philosophicus* (6.4) Wittgenstein asserted that propositions merely express facts about the world, propositions in themselves are entirely devoid of value. The facts are just the facts. Everything else, everything about which we

care, everything that might render the world meaningful, must reside elsewhere. Rexroth's teaching was more profound: the contingent and the ultimate, fact and value, become one when one discovers within himself or herself the illumination of love that allows one to experience everything with an intensity that reveals that it is of ultimate value.

Love is "essentially a relationship," as contingent as all relations are: yet, as the most important value in "the shifting and flowing of contingency," love is illuminated by the transcendent. The division of reality into contraries is the work of reason, and not of love. Reason sunders, love unites, and in yoking apparent contraries together reveals the essential nature of reality, which is love. Just as mortality gives life its value, so contingency and relativity give love its meaning and its pathos:

It seems to me that the fullest realization of the self comes in the acceptance of the limits of contingency. It is harder, but more ennobling, to love a wife as another human being, fugitive as oneself, than it is to carry on imaginary conversations with an imaginary Absolute. The demand to be loved totally, irrevocably, destroys first the love and then the lover. It is a kind of depersonalization—the opposite pole, but exactly like prostitution.

In an interview in Cyrena N. Pondrom published in *Contemporary Literature* (Vol. 10, No. 3)

Rexroth remarked

My point in those lines . . . is that if reality can be apprehended without grasping, the epistemological problem disappears. The beginning of the experience of reality is the same as the end of it. The source or spring of experience is an experience like that of final illumination. That is to say, rather than being built on perception on receiving and sorting sense data, our experience of reality begins and ends in illumination. Jacques Maritain [a neo-Thomist philosopher whose major works were produced between 1920 and 1970] talks again and again about the idea, although this is not really Thomism. It is an idea that goes back to medieval mystical philosophy, to the thought of Richard of Saint Victor. Experience begins with illumination—since this is true, there ceases to be a problem of transcendence of the mundane world. This idea occurs over and over again in my poetry. I think one of the clearest expressions of it is in *The Heart's Garden*: "He who lives without grasping/ Lives always in experience/ Of the immediate as the/ Ultimate. The solution/ Of the problem of knowing/And being is ethical./

Epistemology is moral.”

Rexroth devoted his life and art to identifying a way of living fully, deeply, in the flowing world.

Such idea constituted the basis of a theory of value I developed in the first decade or decade and half of work. But in the mid-1980s, my work reached a crisis point. It became clear to me that I could no longer afford working in such extended forms (particularly in a time when the cost of film stock was increasing rapidly and the “vanguard cinema” was in peril of being co-opted by those who believe that “experimental art” is an excuse for adolescent behaviour). A few years earlier a new technology had become available, the “micro-computer” (as it was called then) and it hadn’t taken me long to build one and to teach myself to program in assembly language (Bill Gates & Co. Had not yet written his BASIC interpreter)—indeed, I produced the piece of fractal music that is the soundtrack for *Sweet Love Remembered* (1980), and so from a when fractal geometry was exclusively a research field).¹

So when I reached that crisis-point in the mid-1980s, it occurred to me that begin working in digital cinema: the cost of producing works that involved computations seemed to offer a very practical advantage—if the ratio of time spent programming a computer to time spent shooting rose beyond a certain threshold then I could keep myself as busy as I like to be without incurring the sort of costs my filmmaking to that point had demanded. That is a very practical reason for embracing this new technology, but I had as well aesthetic reasons for doing so: a strain in my work lead me in that direction. The very first film I made, *Permutations and Combinations* (1974), was generated (as its title suggests) using combinatorial process, and over the next decade, many of the films I made were works based on a limited number of elements that are then subjected to set of transformational processes. (An article by Friedrich Windhausen brought to my attention Hugh Kenner’s article “Art in a Closed Field,” and I was stunned to discover their a more general theory, and provenance, for the work I had been doing.) The new technology seemed to extend the possibility of generating forms using what we would now call algorithmic processes. It also promised to allow me to extend my Pythagorean/Platonic proclivities. From this point on, the central topic of my films and the

generator the forms my works assumed became the issue of how I might reconcile my belief in the ultimate value of floating world that I learned from the poetry of Pound, Zukofsky and (especially) Rexroth with my Platonic/Pythagorean disposition.

Still, to pursue my ever-growing interest in computational art required that I expand my mathematical abilities. I went back to night-school and took numerous applied mathematics and computer science so I could write computer programs for processing images in ways other than off-the-shelf programs allow, for I understood that that off-the-shelf programs embody covert aesthetic assumptions in their processes—covert assumptions I could not embrace. These courses have provided me with a deeper understandings of combinatorics, group theory and representation theory, and these have served as the conceptual foundations for conceptual foundations more complex algorithmically generated forms.

All this said, my engagement with digital cinema raised another, deep worry. Whatever else one might believe about digital of cinema, it seems clear that there a radical breach between the classic, photographically-based cinema and new, digital cinema. Of a photograph, it is always reasonable to ask: “Who created the photograph, the photographer or nature?” The question cannot be answered, but one must acknowledge that an aspect of the beauty of a photograph, is that a photograph, as André Bazin pointed out long ago, strikes us as a phenomenon of nature. Thus, making photographs, or photographically-based films, seemed to me a way of cherishing the gift of what reality—actually of what is more accurately described as *natura naturans* —makes for us. Photography, I concluded, succeeds when the photographer transcends wilfulness and learns to cherish the gifts given him or her. That the will of the human “maker” should have no place in the creation of the image is the most radical implication of photography, its most profound rupture with the traditional image-making. Photography even allows the imagination to be circumvented, and by this, it reveals our being-with-the-world

Digital cinema is another matter entirely—digital cinema gives the subject back its traditional role—or rather, something close to its traditional role. The imagination resumes its traditional function in image-making: digital images once again require that we step back from

the world and enter into the space of subjectivity. And all the usual ontological and epistemological problems that tradition has with images-reassert themselves with digital images: one can ask of a digital image whether what one sees in the image is a real object or a fictitious object. While the photographic image provided ineluctable evidence of the reality of object, there, beyond the will of the arts, the digital image offers no such warrant. The digital image does not require the encounter with an other, beyond the circuit of the maker's self. What is more, I believe digital imaging will eventuate in a process that puts the emphasis on the "made-by-the-self" ("fictitious") image. Though I resist this belief with every digital image I make, I sense, with deep despair, that digital images seem destined to fulfil the age-old belief in the total image, in which the image and the object become identical, and so portend a future in which the products of an enfeebled imagination supplant the real: in a process that Baudrillard's writings expose, images will take precedence over the objects they purport to represent and, finally, block access to those objects. The call to encounter, that fundamental moral demand that love imposes on us, will be avoided altogether.

In putting themselves forward as "made-by-the-self" images, digital images raise the question of the subject. Issues around the subject are notoriously vexed. But I believe I glimpse a fateful confluence of ideas developing: the precedence of the image (specifically, the "made-by-the-self" image) and a currently fashionable species of contempt for the body that takes the form of the advocacy of cybernetic decorporealizations. One can see the appeal of the idea that the subject is something that can be detached from one body and transplanted. For let's admit that the term "I," as it is ordinarily used in intellectual discourse, is hopelessly troubled—its meaning all but indiscernible, inasmuch as it is surrounded by a thick fog of philosophical, theological and psychological confusions. The new technologies, and the new media they have produced, promise to help render these traditional confusions obsolete, for they propose a new definition of the subject: the "I" is a complex system of electromagnetic and chemical brain processes. This new start on the description of the subject at least promises to clarify what this reality that we refer as "I" really is.

It also proposes the hope that the “I” might be transplanted—already the brains (or parts of brains) of rats can be transplanted from dying bodies to fetuses. In this sense, the immortality of “I,” through the repeated transfer of brain parts, has become a theoretical possibility that the new technology will undoubtedly strive to realize.

Despite all the confusions that have surrounded the traditional concept of the subject and the potential of the new conception to sweep away that fog of confusions, I find ideas that lurk here really pernicious. The emerging conception of the self (or subject) denies the important role of the particular body that each of us has in establishing his or her identity—or, rather, it refuses to accord the idea of personal identity the important role it traditionally had, and in devaluing identity, it devalues the body. All my recent work—and much of the work that I did earlier (though I didn’t realize it at the time)—has been devoted to enhancing the sensation of flesh (and flesh’s belonging to the world). I believe that the art our times calls for is an art of rapture. I think the topic of the body is the most important topic one can devote oneself to in this contemporary climate, where “despisers of the body” are so prevalent. If I were starting out now (or, rather, if I were young enough) I would surely be doing very “in your face” performance pieces that dealt with the body. They would be “in your face” pieces not so as to be transgressive—the idea of transgressive art strikes me as among cultural theory’s most boring ideas—but because body art can so bring to our attention the importance of rapture. I do not mean by “rapture” an intense form of pleasure: it can be unalloyed pleasure, but more commonly, because of its extreme intensity, rapture is felt as unpleasure, or, rather, as pleasure alloyed with unpleasure. By “rapture,” I mean any intense experience that deranges focussed, analytical consciousness—experience so intense that it leaves conventional ways of thinking in ruin (at whatever cost). This sort of experience invariably makes us sense the body’s role of experience: we feel at once acute anxiety (one can even feel some measure of nausea) and acute pleasure as every nerve ending seems to tingle and we feel waves of bliss surge through the body, from head to toe and from toe to head. One experiences this when the energy of the body rises up and imposes itself on us, as occurs in love-making, or when we find ourselves

intensely aroused and intensely embarrassed at the same time—I sometimes experienced it when my assistant photographed me for films we made together (as she did many times), and it was primarily those occasions that taught me the crucial importance of this sort of experience. I am sure that making performance art would allow me to focus much more directly and clearly on that sort of experience, which I believe is so important.

The most important thing that the body teaches us through experience of this sort is that we are “owned”—first by the divine, that fills flesh with desire, and then, through the divine, by all other people. Thus flesh teaches us we owe deep allegiance to one another. It teaches us that the obligation that any other person, just by being human, imposes on me is absolute and unconditional; and yet we have even more profound obligations to those who fall into the circle of our love. I have no choice but to care for others around me, and seek to live a life in which I care profoundly for a number of friends whom I love deeply. They have their roles in divine dispensation, and so they own me. I am not free to choose how I will respond to them, in their need—I belong to them and must act out of my concern for them.

Art should reveal areas of experience that we cannot reveal except by making art—forms of relating that we cannot reveal in any other way. By doing this, art gives us a more profound sense of what human be-ing is—it acknowledges that we think in ways other than the analytic/instrumental/propositional forms that have dominated us (in the West) at least from the time of the Enlightenment (and possibly earlier). Artists who have adopted the computer as their instrument of choice have often adopted as their model of human intelligence a view of the nature of thought that was prevalent in the early years of artificial intelligence—thinking, they all too often believe, can be modelled by a set of elementary (semantically defined) symbols and string-rewriting protocols (rules for transforming a string composed of elementary symbols into another string. I am often astonished to see artists resorting to this idea that understanding can be modelled by using structures derived from linguistics—from theories of semantics and syntactics. (Let these people try to model the ever-deepening understanding that develops out of an ever-deepening love for a significant other!) Propositional thinking of that is “deranged” by

the intense feelings surge through the body as it responds to the field of energy that lies “beyond us.” I believe it is important to tell one another that we possess the capacity for rapture, too—and for all those sorts of experience that are close to rapture (such as mad love, the delirium strong, repetitive rhythms can induce, trance, transport and prayer). To do this, art has to acknowledge the less seemly contents of our thoughts.

The fundamental responsibility artists have is to make contact that enrapturing field of energy that lies around us and to enter into that energy. When one does this, it takes control. Then one’s responsibility is to obey its commands; in this, there is no “freedom of imagination.” One takes orders—an image flashes into your mind and you have to make it, no matter how wrong-headed or embarrassing or unaesthetic or humiliating it might be, so long as one does no real harm to another. One cannot be allow considerations of audience/reception to intrude upon this; such concerns make one less willing to go to the extremes to which one might be commanded to go—one might get to thinking “What will people think?!?” When one becomes disobedient, one breaks with the source of the energy that impels one’s work. (This is why the Muses were frequently thought to be very jealous.)

In my insistence on the importance of body art in this era of the body’s digital devaluation, I am concerned to reject want to bring into disrepute assertions like those of Arthur Kroker, the Canadian media theorist, that cyberspace and virtual reality will lead us into a better future—a future that will undo all the devastations of the centuries since the Enlightenment have wreaked on us, a future that will be a heaven-on-earth. In one such hysterical comment Kroker proposes, “So begins our violent descent into the electronic cage of virtual reality. Down we go into the floating world of liquid media where the body is daily downloaded into the floating world of the net, where data is the real, and where high technology can fulfil its destiny of an out-of-body experience.” William Gibson, the author of *Neuromancer*, opines that soon we be shuffled off into “bodiless exultation.” And Microsoft asks “*Where do you want to go today?*” as our bodies remain fixed, in front of the screen of our monitor.

According to one prevalent conception of the metaphysics of digital reality, the

convergence of the media (of text, image, moving image, and sound, all “interactively” available) promises to unite non-corporeal information and non-corporeal individuals in the same electronic medium, in which everything and everybody are co-extensive. This total co-extensivity is the basis for the “total awareness” my new media students keep telling me is dawning. This idea of the non-corporeal self implicit here, of the self that is identical with information, is a modern, debased version of the soteriological dream of transcendence through the emptying out of the self. But the real appeal of these ideas, after all is said and done, is that it covertly the idea that the new non-corporeal world can come under our complete control, because we know how we made it and how to reproduce it. In the end, we would act as a new Creator—this is the dream that fuels those who proclaim that the new media offer unlimited creative freedom, that we might usurp the place of the Divine. We are unshackled from all moral limitations of our world as it is, and nothing outside of us limits our capacity to impose on the world.

The great Canadian philosopher George Grant critiqued this very position in such stunning books as *Technology and Empire* and *Technology and Justice*. Grant showed that the belief that the Good is not inherent in the order of nature underpins that belief, essential to the regime of technique in which we exist and through which we conceive the world, that humans are free to remake the world. Grant pointed out the notion of technique is central to modern civilization—so much so that the progress of techniques has now become the horizon for those who seek to understand the Good. Moderns have lost the ability to understand the standards of goodness by which particular techniques may be judged. The conviction that human knowledge has the purpose of mastering human and non-human nature is central to moderns’ ideas about the nature of human being. The idea that new media theorists expound, that human being possesses no inherent nature has the purpose of justifying the proposition that humans can be made and remade at will—that nothing in the nature of human being limits society’s/ideology’s/the artist’s freedom to refashion them. And that conception, in its turn, belongs to a discourse on value and freedom that is associated with the will to technique—indeed it is part and parcel of the modern belief that nature, since it is objectively devoid of

value, can be remade at will. Ideas of a totalization of truth and of total awareness (acquired through the complete co-extensivity of the decorporealized mind and the decorporealized text) that cyberspace promises will surely eventuate in tyranny.

It is time to put away this myth of decorporealization and of the totalization of knowledge that will bring history to end. The notion that digital reality will be heaven on earth arises from the Gnostic belief in the possibility of immanentizing of the *eschaton*, a belief that (as Eric Voegelin showed in *The New Science of Politics*) goes hand in hand with the idea that the future can be foreseen and planned. The prevalent metaphysics of digital reality is simply the “dream world” of Gnostic lore, where the structure of reality is disregarded, facts ignored, and the openness of history (of history with purpose or ends) replaced by a revolutionary step into the New Age. To dispense with this myth, may I suggest that we return to where all true understanding starts—with the real body, not the amalgam of metal and flesh that is the cyborg nor the data body of Kroker’s Gnostic dream, but the real body of flesh.

Attunement to the rhythm of what unfolds beyond us – a rhythm that is flexible and ever changing, has the strength to release us from the tyranny of an abstract, rationalized temporality that is a key foundation of modernity’s regime. Rhythm is number—number that addresses flesh and belongs to flesh. In rhythm, the dream of the unification of abstract pattern and the concrete real, of form and flesh, might become actual. Rhythm is a form of harmony, the result of proportionate relation between simple elements. Rhythm connects us to the cosmos (itself a harmony). It is also the most corporeal of all of arts’ resources.

In striving to make these vague (and rather grand) hopes concrete, I have been influenced by the writing of Joseph Schillinger. It is in the effort to develop complex rhythms of the sort that Schillinger laid out—or even to go beyond them—that the digital computer became such a great resource for me. The digital computer allowed me to create interactions between simply numerical cycles with a degree of intricacy hitherto impossible, because the calculations of a complexity we could not dream of hitherto.

.Contemporary virtual existence has rendered space wholly abstract. The etiology of that

form of space can be readily charted, beginning with the geometric optics of the Renaissance. The development of geometric optics and camera obscura led to the rationalization of vision around an axis consisting of the fiction of a single, fixed vantage point outside the depicted scene, at a place established by the vertex of a pyramid, whose base is the surface of the painting and the slope of whose sides is arbitrary. Thus, the body was removed from the scene of vision. But in the nineteenth century representation took on a different character: the space of a drawing, especially those drawings whose primary purpose is to provide information about reality, came to be understood as a Cartesian plane, and the relations between elements in the drawing were to be determined not through appearance, as projective geometry had attempted to do, but rather through measurements, which were then transposed orthogonally to the drawing surface. If the body had been excluded in the system of Renaissance perspective, the subject was excluded in the representational regime that developed in the nineteenth century. When the subject is given no place, the drawing surface itself becomes utopian. That utopic space is the predecessor of the utopia of cyber-nonreality. Paul Virilio points out that cyberspace constitutes a new space without the usual space-time coordinates; as a result, cyberspace engenders a disorienting and disembodied form of experience in which communication and interaction takes place instantaneously in a new global time, overcoming boundaries of time and space. Cyberspace is a disembodied space without fixed coordinates, a space in which one loses connection with one's body, with nature, and with one's community. It is a dematerialized and abstract realm in which cybernauts can become lost in space and divorced from their bodies and social world.

To counter the abstraction of space and time, we insist on working methods that, in their intensity, leave the trace of the body all over them. And the most important of these methods is rhythm: because rhythm is experienced corporeally, rhythm undoes the effects of the rationalization of space into a wholly abstract form. It returns us to ourselves, in our loving relations to others.

Suggested Questions

***Crack, Brutal Grief, Eros & Wonder* and *The Young Prince*, was created using digital technology. How did you become interested in using digital technology in your filmmaking.**

B: My interest in computers started early, and grew out of my fascination with the fact that beautiful patterns are often mathematically elegant. There is an entire field of design that explores the beauty of mathematical patterns, and I was fascinated by it; from the time I was boy, I read about the Fibonacci series, and the golden mean, and logarithmic spirals – various topics of that sort. There is another sizable field of investigation, this one rather flaky (to be sure), known as spiritual geometry, which uses the mathematics of harmony and both an image of and a means for tuning the soul. I spent a lot of reading in that disreputable field of well. You might be surprised how many artists of the last 100 years have.

Your use of digital technology in *Eros and Wonder* is quite different, however. There you used computer technology to process digital images. I believe that you write the computer programs you use to make your films. Could you tell us about these programs?

B: When I decided to use digital processes in my art making, I started by studying the requisite fields of mathematics and computer science; I went back to night-school and took classes for engineers. Working with the knowledge I was able to garner, I developed a computer application that would allow me to collaborate with the machine to produce “visual compositions”—that would allow me to use many of the same principles that I have employed in my filmmaking today, but would help eliminate subjective whim.

I developed a rudimentary application that stored a set of images into a database along with a set of image descriptors (“meta-data”) and a set of image processing algorithms. The application’s function was to decide what image-processing methods to apply to the images in the database, and to apply them. At first the method for selecting the processing methods to be applied to the images was pretty simple: Images were partitioned in groups based on the similarities indicated by their descriptors, as were the image processing methods (my decision on which methods most closely resembled other methods was completely informal and subjective); the image processing methods to be applied to a reference image were chosen at random – the operator got to approve the selection, and if he or she approved it, then the methods most similar to the randomly chosen method were applied to the images in the database that most resembled the reference image.

I used this application in a film I finished almost three years ago now, *Crack, Brutal Grief*. This way of using image processing methods in film/video production interested me enough (and, I thought, the results were good enough) that I wanted to work further on this application.

It was obvious what refinement I should introduce first: using image descriptors as I did was awkward and introduced an unnecessary subjective element that conflicted with the ideal of

avoiding authorial imposition. I quickly realised the application would need to use of methods to “compute” the similarity between the two images algorithmically.

Can you elaborate on the ideal of avoiding authorial imposition?

B: John Cage protested against the idea that an artwork is the product of an artist’s feelings, believing instead that the creative process should imitate nature in its manner of operation. Cage was among the first composer to make the use of chance operations central to his compositional processes -- and he developed a variety of aleatory techniques that allow chance and indeterminacy to play key roles in shaping musical result. Cage insisted that aleatory operations mimicked natural processes and that by imitating the operation of natural processes, the composer bypass his or her limiting ego and allow a larger system or set of systems to shape the work. This principle has been very important to me. The richness of Cage’s writing helped make the use of aleatory techniques common among composers. The rigour of writings by Iannis Xenakis and James Tenney -- composers who, like Cage, took an interest in stochastic methods – and the power of their works re-enforced this influence.

Over the past few years, I have worked on projects that explored the possibility of extending these composers’ ideas to the visual domain. The initial framework for this exploration was drawn from composer James Tenney who made extensive use of measures of similarity in the analysis of music structures in his book *Meta+Hodos*. I was intrigued by the possibility of developing analogous compositional procedures for working with sets of images and, in particular, by the possibility of using measures of similarity to constrain random processes.

How does your computer programme calculate image similarity?

B: The process takes place in a number of steps:

- 1) Load the “key image” or “query image” (the image for which we want to find similar images).
- 2) Utilizing methods of feature extraction, measure a number of features of the key image. This stage creates a “signature” for the image.
- 3) For every image in the database, load and generate a signature.
- 4) Calculate the Euclidean distance between the signature for the key image and the signatures for each of the database images. Sort and store these values -- what results is a list that shows the proximity (based on its signature) of each of the database images to the query image.

The features I used for creating an image signatures were the intensity of the image, its dominant colours, the mean and standard deviation of image’s RGB values, the frequency of change in RGB values, the number of defined areas (“pixel groups”) enclosed within a well-defined boundary, the compactness of the principal (i.e. largest) pixel group, the major and minor axis of the principal pixel group, its circularity and its perimeter.

The challenge was—and remains—to select image features and a distance function such that the resultant distance really is a measure of image similarity: ideally the distance between the images, gauged on this metric would correspond to our subjective assessments of image similarity. Measuring the distance between two images which we judge to be alike would result in a relatively low aggregate value, while measuring the distance between two images which we

judge to be quite different would result in a larger aggregate value.

How do you use these measures of similarity to help you decide what effects you will apply to images?

B: First, I wanted my program to emulate the filmmaking methods to which I have become accustomed. To this end, I formulated some loose rules that would capture some of my experience in deciding what image processing algorithms might be appropriate to images that possess a given set of features. (Examples of such rules are: if there are a large number of pixel groups in the image and there are many changes in colour between adjacent pixels, then sharpening the image is not highly recommended; if the image is of very low contrast, then reducing the intensity of the image is seldom valuable; if the average size of pixel groups is large, then applying algorithms that enhance the texture of the image is a less valuable choice.) I created a program that employed a constrained random process—the constraints were based on these rules as well as on the image’s signature—to decide which image processing algorithm or algorithms would be applied to images.

The program looks at images and assesses their features, and based on what it discovers, decides which processing procedures most likely suit the image, and what procedures will be less likely (and how much less likely). Different features of an image are assigned different weights, and those features that are assigned greater weight are given a greater role in deciding which image processing methods are desirable or undesirable (and how much less desirable or undesirable). The application then chooses, by chance operations, a set of processing methods to apply to the database images.

Where would you like to take your work with this computer programme? How do you want to improve it?

B: I want to introduce better means for modelling a film- or video-maker’s working methods, for capturing a filmmaker’s (or videomaker’s) understanding of what characteristics of the image make certain image-processing appropriate and other’s inappropriate. The way I modelled one’s estimation of the appropriateness of a particular method to a given image was far, far too simple. What I did was simply to imbed in the program a “seat-of-the-pants” “guess-timate” of how undesirable a certain feature made a particular algorithm. For example, having a certain property might make using given image-processing methods either “slightly undesirable,” or “moderately undesirable,” or “very undesirable” (each represented by a different weight), and more precise measures of a filmmaker’s sense of the appropriateness of a method need be introduced.

I also incorporated a kludgy sort of “fail-safe” provision into the application. After applying the constraints I have described, the program selected one or more image processing methods to apply to the image, processed the image and displayed the result. The user was then asked to confirm that what he or she sees is satisfactory -- thus, instead of modelling the film- or video-maker’s knowledge, I simply called upon it (and used it interactively). If the result was deemed satisfactory, the program applied a similar treatment to a set of similar images and saved the

result to film.

All this needs to be drastically reworked. My “fail-safe” method of allowing the operator to interact with the program conflicts with my goal of refusing immediate authorial imposition. Further, I need to develop means to capture the “fuzzy logic” involved in these decisions. This could be done by building a learning component into the program that would enable the program to correlate the features an image possesses with the image-processing methods a particular film- or video-maker finds appropriate. Further, to make the program more flexible and better able to accommodate different ways of working, the user should be given the choice as to which sets of features, from a broader array of features than I now employ, would be relevant to determining which image-processing methods might be applied to the image.

Introducing fuzzy and neural learning into this application would have this benefit as well: the assumption that there can be standardised metric that corresponds to all users judgements of image similarity is a doubtful one -- just as it is doubtful that all film or video editors take into account the same set of features when they are creating “plastic” cuts (edits based, essentially, on the similarity of images), or even that an individual editor takes the same features into account on all occasions. Creating a system that would adapt to individual users (and, perhaps, even to individual circumstance) by being “re-trained” could allow for these variations.

Despite its current limitations, however, I believe the programme is a novel way of using image processing in film and video production. I also believe that the Cagean compositional ideas on which this application is based are rich and this makes me eager to continue to develop the project.

¹ I made Sweet Love Remembered long after Mandelbrot had published his article “How Long Is the Coast of Britain? Statistical Self-Similarity and Fractional Dimension,” which would become so well-known after the mid-1980s, but before Mandelbrot brought out his enormously influential *The Fractal Geometry of Nature* in 1982.