ANIMATION

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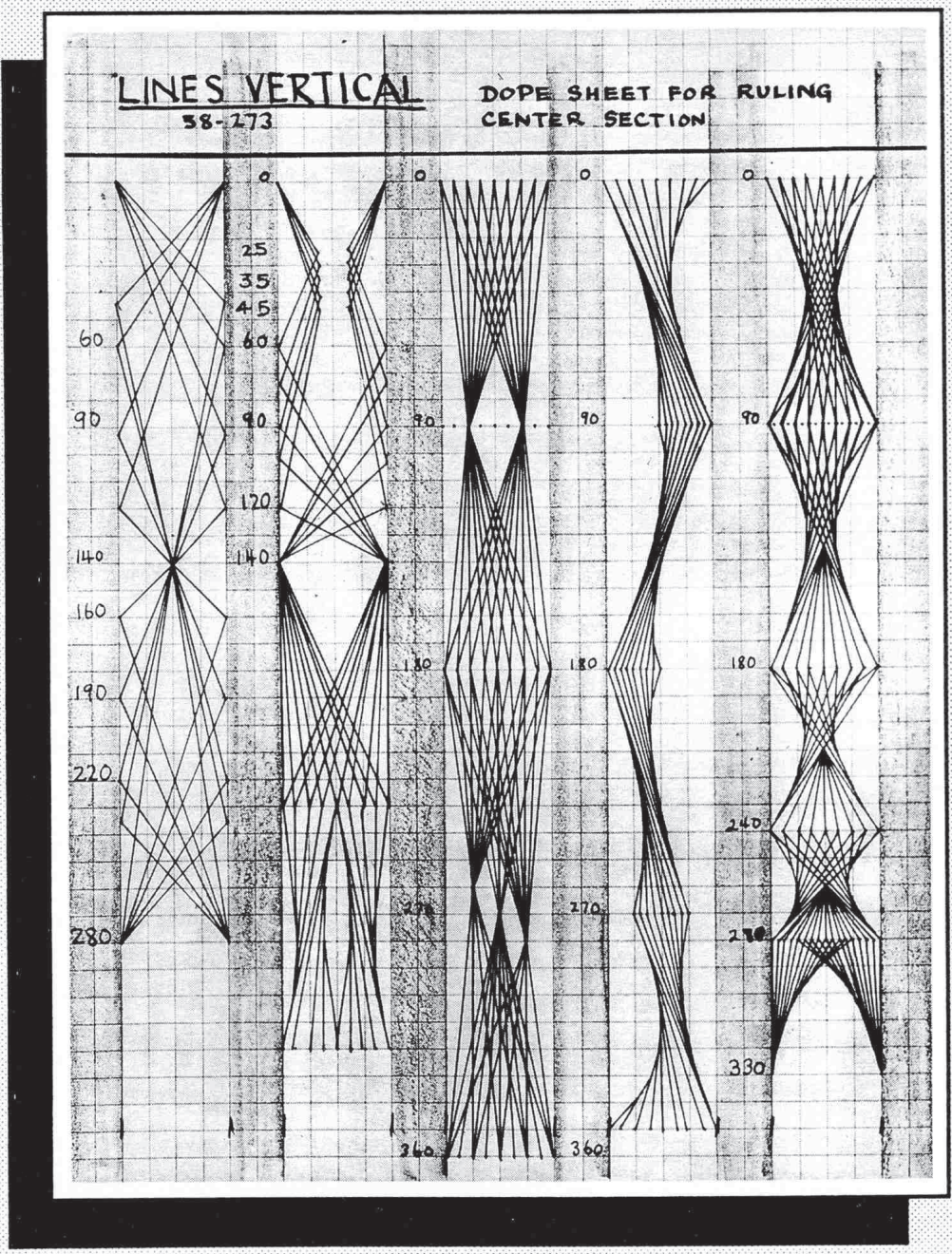

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EXPRESSIVE TECHNOLOGY: THE TOOL AS METAPHOR OF AESTHETIC SENSIBILITY

by Leslie Bishko

The poetic qualities we experience in a work of animation originate from the way in which animators synthesize their creative sensibilities with the technology of the medium. Because animation is a mode of expression that is based on the technology of the cinematic illusion, the various technologies of tools, methods and media are partners in the process. Pencils, paper, storyboards, exposure sheets, clay, sand and computer are some examples of participants and facilitators in the process of forming the components of animation.

Through the works of some experimental animators we experience a clear relationship between the use of various technologies and the formal components of their animated imagery. A spirit of inventiveness merges technique with "personal vision,"[1] involving exploration of the ways in which methods, media and new technologies can manifest qualities of movement, composition, color and sound.

The process of working with computer animation software tools contains elements of "traditional" animation, done by hand, as well as the approach of experimental animation. The nature of animation software is that basic methods for keyframing and inbetweening are logically structured into a generalized technique, taking what has been called the "tedium" out of the frame by frame process. Working on the "global" level, one can explore complex ideas that would be difficult to mastermind without a computer. In some circumstances, the "local"[2] techniques for how movement qualities are formed—the way in which the computer handles the keyframing and inbetweening process—are limited by the global controls.

The animator explores the limitations of the software, uncovering the nature of what the tools can accomplish, and how to infuse one's personal sensibility within that framework. It is a creative process like any other, in which one cultivates a sensibility and craft for working within the medium. On the other hand, some computer artists prefer to form their own *methods* of working. By getting involved on the programming level, these artists model their ideas directly within the logical structures of the software. Thus, the creative activity is focused on the level of making the tool, which, in turn, makes the animation. This approach is known as "algorithmic" or "procedural." The elements of the creative process are abstracted and formed into an actual software tool. Imagine designing a cake-making machine: it measures, sifts, pours and mixes.

Once the method is formed, you can experiment with the ingredients—perhaps revising the method to suit individual recipes.

A majority of computer animated works to date seem to reflect only the method, and not a sensibility towards creatively merging personal vision with technique. The traditions of frame by frame animation, done by hand, have brought forth a richness of expressive movement qualities where the role, skill and sensibility of the animator are apparent. The abstraction and mechanization of the frame by frame process in computer animation casts a shadow over evidence of the animator's involvement. The movement qualities do not express in the same way as hand animation does.

Kit Laybourne asks:

> "But is it animation?"
> That question is invariably raised by many of these new techniques. . . . Animation is more than frame-by-frame filmmaking. For me, at least, the *control* that is brought to the creation of a movie has a lot to do with the designing process by which individual artists approach their work. . . . It has everything to do with the consciousness and precision with which the film is created.[3]

In any animation medium, the animator's designing process realizes expressive content by using the tools to create movement, which can provide both global and local methods of control. Laybourne's comment acknowledges that while new technologies abstract the animation process, they also facilitate abstract creative impulses.

I consider movement to be the fundamental expressive element in animation. Movement forms the kinesthetic sensory experience that engages our feelings. Abstract imagery in animation conveys the complex workings of nature and the mind, using movement to provide a human, bodily connection to its meaning. If movement qualities are affected by abstracting the frame by frame process into mechanical methods, how is the potential for communication affected? When we compare our response to hand animation with computer animation, we generally find that the former contains movement qualities that engage our emotions more readily.

Animation embodies expressive movement qualities in various ways, determined by the nature of the animation methods used, and the attitude the animator has towards those methods. The *way* in which our feelings are engaged is intrinsic to the feelings themselves. We can view our response to animation as variations along a continuum: from gut-level to conceptual. Any work of animation has artistic merit at any point within the

continuum, and many will communicate on several levels simultaneously. To explore these issues, I will focus on how the animation process manifests various qualities of movement, through the ways in which animators attend to methods, media and technologies.

Kinesthetic Experience

Putting the larger contextual issues aside, such as narrative structure, pictorial representation, mise-en-scene and sound, we can simply look at how the movement of animated forms conveys meaning. Because animation presents itself to us in time, as an expression of time, we naturally respond to a work based on how it engages our feelings during the immediacy of the experience. Feelings in animation come to us kinesthetically, as a sensory awareness of movement we perceive with our bodies. Animation uses movement to construct temporal experience. The range of temporal experience in animation goes from seamless fluidity and continuity to total fragmentation. Our responses along this continuum vary, from gut-level, to evocative, to conceptual.

Gut-level Our gut feelings are engaged by the fluid, lyrical qualities we see in animation styles such as Disney. The movement represents a physical reality of form. Objects appear to be solid, occupying a three-dimensional space. They have weight and are affected by gravity. The timing of movements in space, combined with the handling of weight, encompasses a dynamic range from varying degrees of graduated acceleration and deceleration, to slow and leisurely, to sudden and accented. The animation exaggerates qualities in time, so that a particular characteristic is finely tuned to captivate our emotions. We are fully engaged in the continuous flow of dynamic qualities, any disbelief in the animated illusion absolutely suspended.

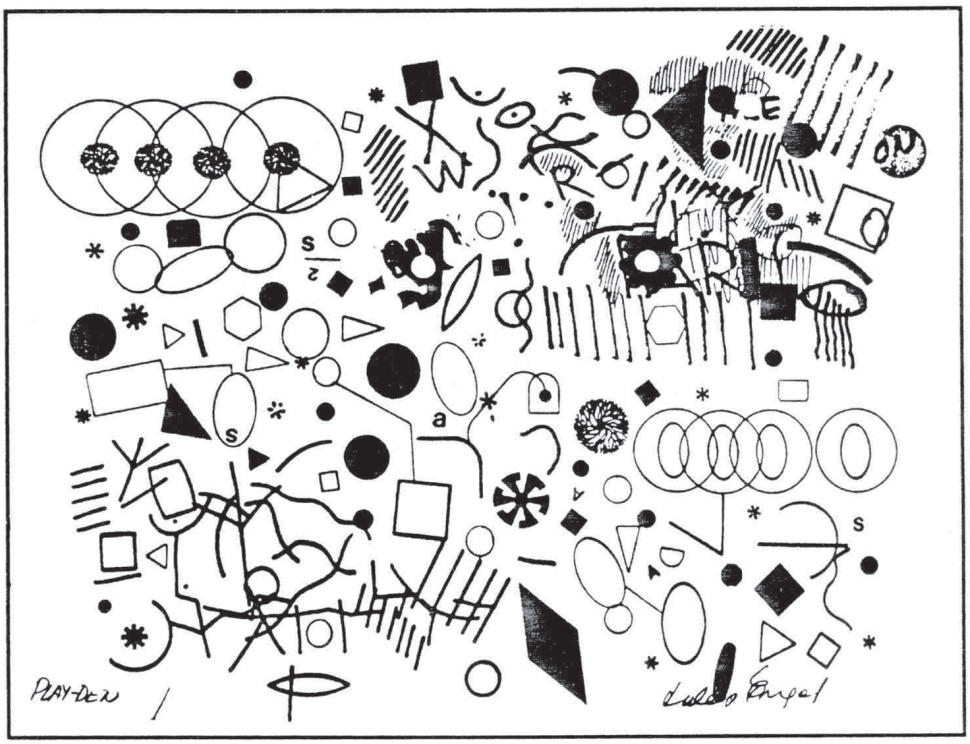
The Disney style treatment of inanimate objects, such as the teapot character in *Beauty and the Beast* (1991) strives to embody a living, conscious soul within a mundane object purely through qualities of movement. The consciousness of this character is represented fully with body gesture. In our human experience, consciousness does not precede our gestures. Gesture is the manifestation of consciousness in the body. As we experience the gestures of Mrs. Pots, we perceive the unity of her consciousness and physical form through our own unified body/mind. The Disney style takes extra steps to insure our engagement by giving the teapot human characteristics—anthropomorphism. The design for Mrs. Pots takes on the form

of a human face—the movements blending dialogue and facial gesture with hopping locomotion that emphasizes her shape and center of gravity. The character is a pure example of the Disney principal of squash and stretch in movement, and how it is used to convey emotions when combined with anthropomorphism. The degree of our involvement is based on the unified, body/mind, kinesthetic experience.

Evocative Even, linear timing is another quality of continuous movement. In this case our kinesthetic response, although it occurs as a physical experience, has the tendency to disengage our emotions. Within the scope of our physical experience as human beings, our movements are a continuous, fluid stream of sensations whose qualities are not at all like the precision of mathematics. We do not start or stop instantly—we prepare, act and recover. Imagine being out for a walk on a sunny day, bouncing along and enjoying the weather, as opposed to walking with each step on the measured cracks in the pavement. The former has feeling, the latter is a mechanical process. On the other hand, consider Michael Jackson's popularization of robot-like dancing—the even, mechanical movements, as performed by humans, creates the illusion of automated body functions—devoid of emotive drive. This kind of movement quality achieves the opposite effect of Disney's anthropomorphic Mrs. Pots.

Computer animation has been criticized for feeling mechanical. Apart from the hard-edged look and fixed sense of perspective space, many computer animated works do not achieve the movement qualities of animation that engages feeling, due (in part) to the mathematical nature of the process. Yet, in the hand animated works of Paul Glabicki, or the *Lines* films[4] of Norman McLaren and Evelyn Lambart, even, measured qualities of movement are an aesthetic choice. In these films, simple forms and lines traverse the frame, converging harmoniously as they cross each other's paths. Our experience is like the feeling states of music—the visual and moving elements *evoke* qualities of harmony as they interact kinetically within the frame, unlike the way in which the forms in Disney animation appear to *embody* the expressive qualities.

Conceptual Non-linear continuity in animation can challenge us to form a logical ordering of the experience, addressing the process of perception directly. When linear events in time appear to us as fragmented and rearranged, the representation of forms within the image shifts away from physical objects



Artwork for *Play Pen* (1986), by Jules Engel. © Jules Engel

situated in pictorial space. All of the visual/temporal elements that constitute the experience seem to dance within the visual plane of the cinematic image.

With his hand drawn film *Play Pen* (1986), Jules Engel explores tensions between continuity and discontinuity. Bold, graphic lines, shapes and colors form continuous rhythmic phrases, which eventually give way to more and more fragmentation of time and form. The transition is like zooming out, from macroscopic views that present the moving forms as large, having dynamic compositional impact, to a wide angle view in which the screen is filled with tiny shapes and lines. Within the screenful of moving stuff, one's eye is drawn to smoother transitions, such as concentric circles rippling outwards. Discontinuous, single frame transitions between small geometric shapes that change color create tension in the perceptual process, forming a flickering texture that seems to tickle the retina. To resolve this tension, the eye releases its focus, opening up to the flood of stimuli that creates a meditative space.

With this play of perceptual tensions, the kinesthetic experience is embodied in the eyes and head. The perceptual process stimulates a dream-like, disembodied consciousness. We make sense of the experience in a more conceptual way.

The Flow of Kinesthetic Experience in the Animation Process: Feeling between the Frames

Hand animation methods tend to promote movement qualities that carry feeling while a more mechanized approach to animating reflects the qualities of the machine that made them. Animators intuit the physical behavior of forms based on their kinesthetic experience in the world. The familiarity of the kinesthetic experience provides a framework, or reference for movement qualities that communicate feelings to us. The use of hand animation methods, such as drawing or stop motion, is a tradition that allows animators to focus on their sensibility towards weight, time, space and shaping that collectively form kinesthetic qualities of movement.

These are methods that directly promote a sense of *flow* in the animation process. I call this intuitive sense for animating the "feeling between the frames." Each frame of animation indicates an abstraction of a quality of movement, implying or referring to that which happens between the frames. Animators synthesize the elements of their own kinesthetic experience by way of visual composition, anticipating the abstracted form through which their intuition will be experienced as feeling. The animation process *is* a mechanization of human experience, in the sense that the feeling qualities of movement must be analyzed, measured, and somehow re-experienced in the context of the animation media of choice. The intuitive feeling between the frames is the animator's qualitative way of relating to the process, through the use of media and tools.

Animation that engages gut feelings is an engagement of the unified mind/body. Different movement qualities provide the means for expressing varieties of emotions, engaging gut level, evocative and conceptual qualities of unity in the experience. Mind/body unity in the *process* gives way to unity in expression, and can be carried out through the functional nature of the tools.

Experimental Animation and the Use of Tools

Unity in the relationship of animator to animation tools is a merging of sensibility with technology. Animation methods and tools provide an abstraction of body function into mechanical function—metaphoric extensions of the creative process.

Norman McLaren is one example of an animator who has pioneered the spirit of experimental process. In his work we can see a free approach to fiddling with techniques that embraces the origins of animation technology while indicating the digital tools of the future.[5] This attitude towards experimental process in animation extends to all animation media. His aesthetic

sensibility is *to animate*, which is inclusive of virtually any material or technique, be it "drawings, clay, sand, matchsticks, nails, oil paint, etc."[6]

Methods such as scratching on the film literally traverse the frame, manipulating the feeling between the frames across chunks of time with a single gesture. From McLaren's technical notes on *Begone Dull Care* (1949):

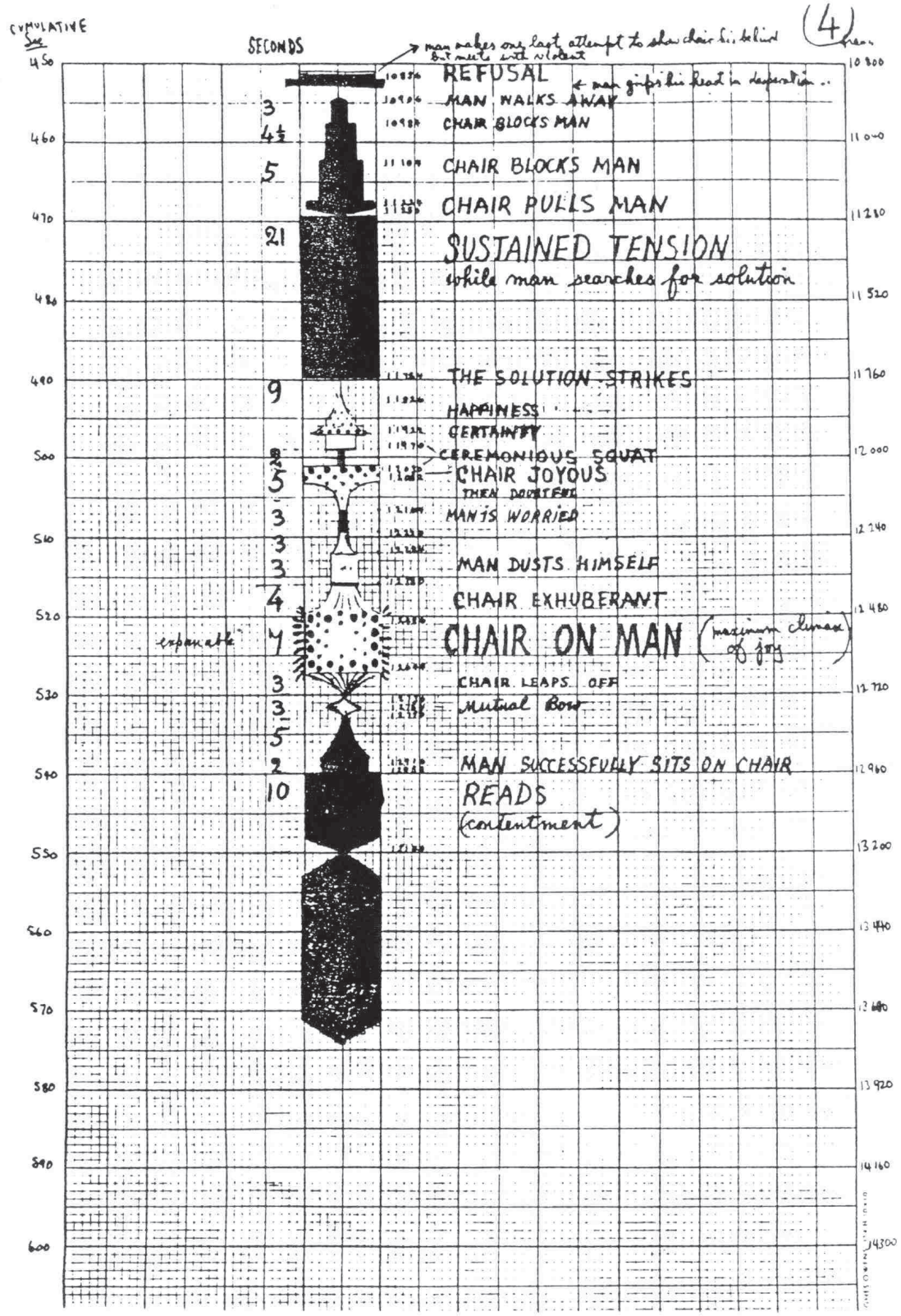
> Generally . . . the frame-line was disregarded. . . . While running in a moviola interlocked with the sound track, [the film] was engraved on by a sharp-pointed knife. . . . Thus, the knife-point was made to slide and move on the surface of the film; my hand pressed, guided and, as it were, made it "dance" to the rhythm of the music.[7]

Instead of animating feeling between the frames one frame at a time, McLaren and Lambart work directly with "real time." The intuitive feeling of the music isn't altered in the translation process from feeling to frames. We experience it within the same temporal frame of reference as McLaren did, as he touched the tip of the knife to the surface of the film. McLaren and Lambart do not disregard the feeling between the frames. Their sensibility merges feeling with form through inventive use of technology. A knife and a moviola provide an abstract, "global" level to the design process that addresses dynamic movement qualities—feeling between the frames—a metaphoric extension of inner feeling into its outward, animated expression.

McLaren gives us another way of looking at his process, through dope sheets which visually diagram the composition "in metrical lengths of textured patterns corresponding to the paragraphs and sentences of the music."[8] The dope sheets give us a "bird's eye view" of compositional structure, revealing changing patterns and textures as unified graphic/temporal ideas. McLaren used the dope sheets in various ways; for example, as a planning tool for the *Lines* films, and as a visual device to convey the dynamic qualities of *A Chairy Tale* (1957) for musician Ravi Shankar's use as a compositional aid. These dope sheets can be viewed as tools for thinking through the animation process. They are global level abstractions of the feeling between the frames that will ultimately qualify the viewer's experience.

Computer Animation

The abstraction of the process of feeling between the frames points towards the abstract methods of computing. Stan VanDerBeek said it's like "driving by looking in a mirror instead of at the road."[10] The fascination with computers, and their forte, tends to be in the ways in which they are able to



Visual outline for *A Chairy Tale* (1957). From *The Creative Process*, courtesy of Donald McWilliams. © The National Film Board of Canada

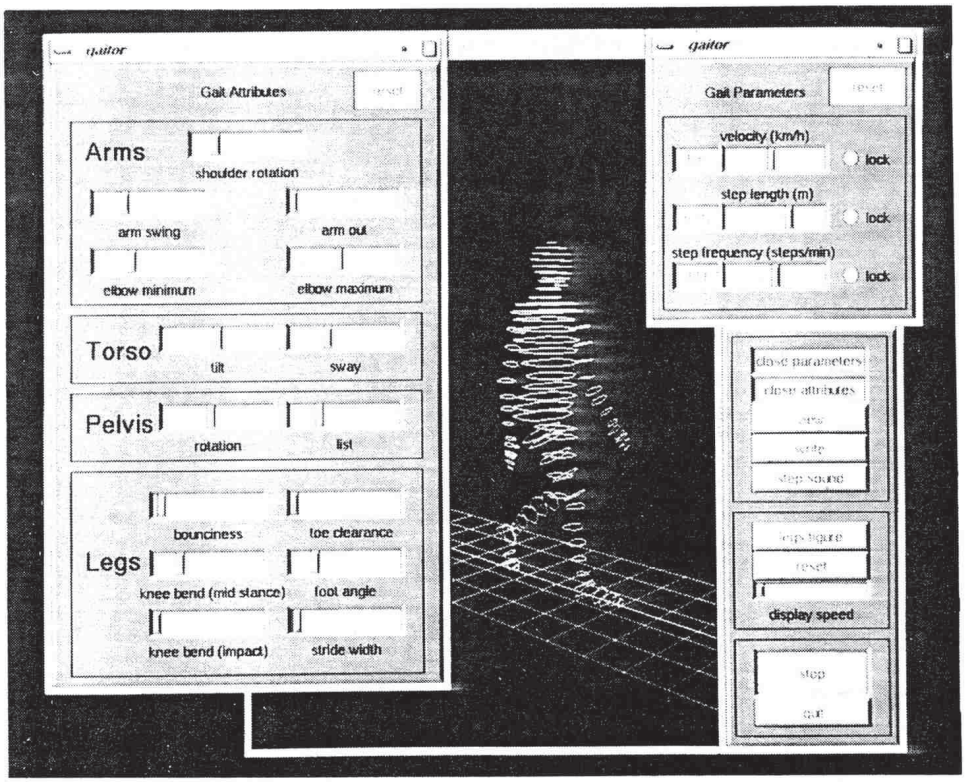
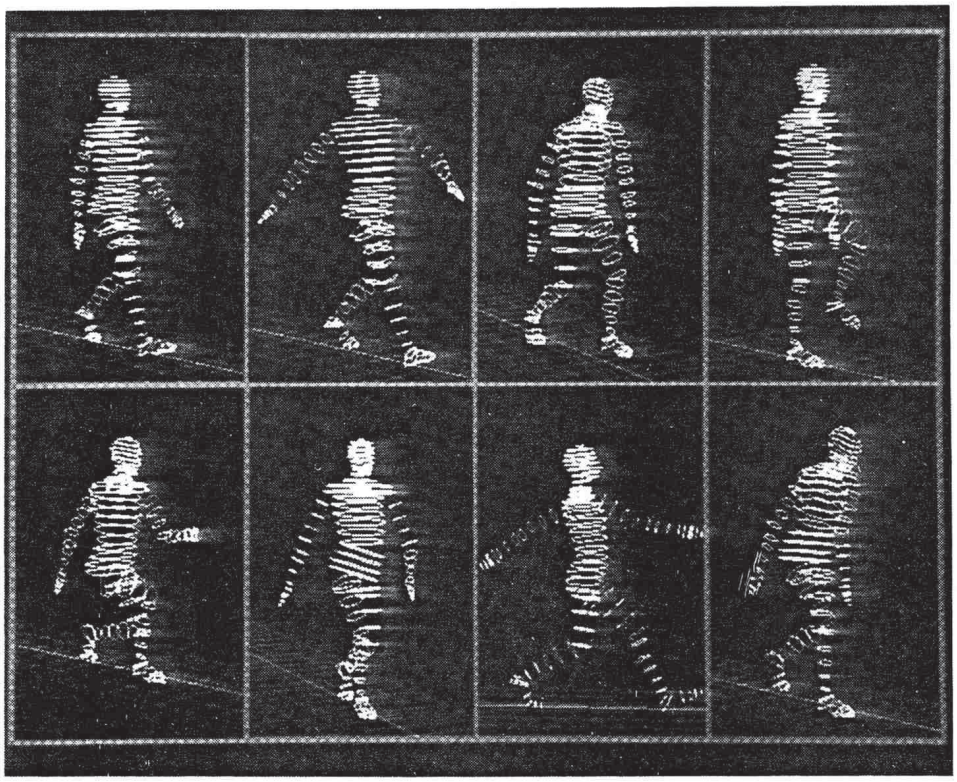


Figure 4. Gaitor interface—procedural walking of human figures. Courtesy

model abstract thought. Computer software is formed of weblike layers of interconnected conditions and circumstances—a thinking metaphor. The nature of the web: the things it is made of, the way it is constructed, forms the way of working. Animation by computer amounts to *thinking* about the feeling between the frames, as opposed to the way it is actually *felt* in the frame by frame process.

The characteristics of some numerical methods used for inbetweening can result in limited and predictable movement. The flowing process of the feeling between the frames is dissipated through the layers of abstraction inherent in the nature of computer software. Although computers remove the directness of the artist's hand, the metaphoric extensions of the animator's way of thinking are becoming quite sophisticated through new developments in hardware and software design. Tools specifically for character (figure) animation have emerged, providing global level controls for organizing hierarchical levels of body structure and function, as well as better tools for keyframing and inbetweening that allow refinement of movement on the local level. The rotating joints of the figure can be constrained, so that the elbows and kneecaps behave according to the limitations of human anatomy. Recently, the use of real time motion capture has become quite popular.



of Armin Bruderlin, Simon Fraser University. © Armin Bruderlin

Instant playback of motion offers animators immediate feedback, during which the timing of movement can be intuited and refined. The computer is gradually proving itself to be a versatile animation tool, as software developers continue to focus on emulating the way of hand animation.

Other software efforts emulate the results of hand animation while focusing on less tedium in the process. "Gaitor," written by Armin Bruderlin at Simon Fraser University, is an example of software that takes a global approach to figure animation, or what is called the "director level."[11] While a generic walking figure is displayed, the user can change the parameters of the walk and see it instantly updated on the screen. Options such as stride length, bending of knees, pelvic tilt and swinging of arms make it possible to adjust the characteristics of the walk without the use of key-framing. The attitude behind these kinds of tools does not seek to decrease the role of the animator while the machines make the frame-by-frame process less precious, but rather to elevate the animator to broader methods for treating the content of movement.

My own attempt at animating from the director level perspective provides an interesting case in point. Using software that simulates the physical properties of rubbery materials,[12] I animated a brick that takes gravity-defying, twirling leaps into

the air like Baryshnikov. The elongated ends of the brick were specified as "goopy," while the center was made rigid. Gravity and mass parameters determine how much the goopy parts are stretched as the brick accelerates up and down through space. The resulting brick appears to be made of a soft, floppy substance the consistency of loose Jell-o.

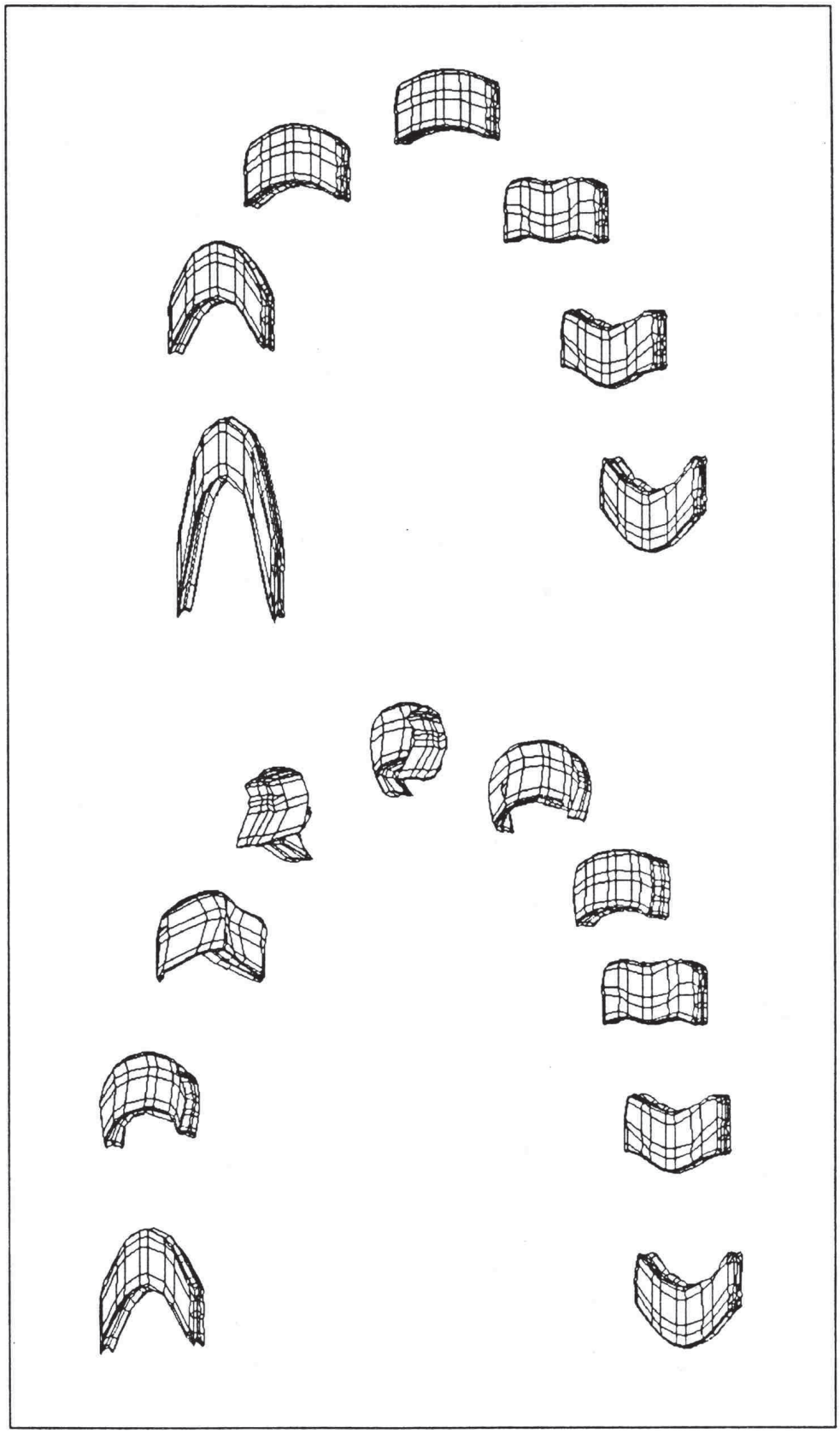
I had experimented with using this software to animate other objects, but was never happy with the results. It always made various forms of Jell-o. The brick experiment was an attempt to allow the behavior of the software to lead me, as opposed to my animator's propensity towards total control of movement. The software does behave, and the animator becomes willing to accommodate in order to use it.

People become magically hypnotized by computer animation's ability to represent visually the symbolic processes of mathematics and linguistics. Computer animation made with newly developed methods is usually presented as a demonstration of technique. Dwelling in the method instead of expression, the work is packed with sensational imagery, reflecting the power of computing in accomplishing its dazzling effects. Some animation software users become immersed in the "push-button" aspect of the tools, confusing technological infatuation with creativity.[13] In the spirit of Warhol, we can open a can, pour out the contents and call it our own creation. Unless we add our own seasoning to the soup, it is the same for all those consumers who would open the can.

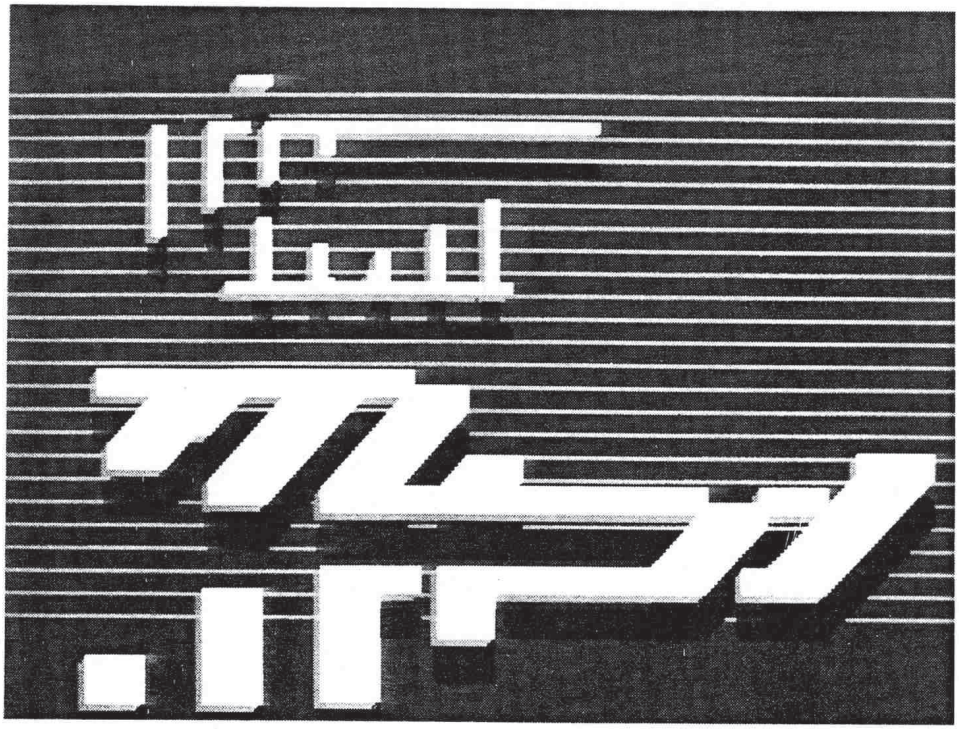
It all depends on the animator's attitude towards the tools. Hand animation can be just as infatuated with technique—as we occasionally see in epic narrative works that display painful amounts of visual detail, yet essential elements such as movement or story line are neglected. Think of animation's early beginnings: "toys" such as the zoetrope, phenakistoscope and praxinoscope were technical parlor amusements. The process was the attraction. As new technologies foster new modes of artmaking practice, the aesthetic is the last thing to evolve.

Algorithmic Computer Animation

My brick experiment bordered on a more abstract, procedural, or algorithmic way of working. The process involved making decisions about the brick's physical structure, and how the form would change (behave) under different conditions of velocity, given the constraints of the software. This method constituted thinking about the movement qualities as abstracted ideas, separate from the frame by frame process. If I had been truly interested in pursuing procedural methods, the next step would have been to customize my own brick



"Brick Sequence" (1991). © Leslie Bishko



From *Calculated Movements* (1985). © Larry Cuba

behavior software. Making the software would involve imagining all the various manifestations of brick consciousness, and how it responds to simulated environmental factors. The task at hand would be to invent my own methods for animating, attending to the *way* the animation is made, rather than the animation itself.

The sensibility of the algorithmic computer animator is different from those who would emulate the qualities of hand animation. The algorithm, or the "way of working" becomes the central focus of the creative process. The animator fiddles with numbers, abstract structures and conditions, runs the program and sees what happens. We see something completely new and unexpected. This resembles the experimental approach of McLaren and others. What does this abstracted way of working imply when compared to the expressive nature of frame by frame methods? Does the work engage our gut feelings? How does the work embody its expressive content? Is something articulated through the layers of abstracted processes that we can experience as a poetic quality?

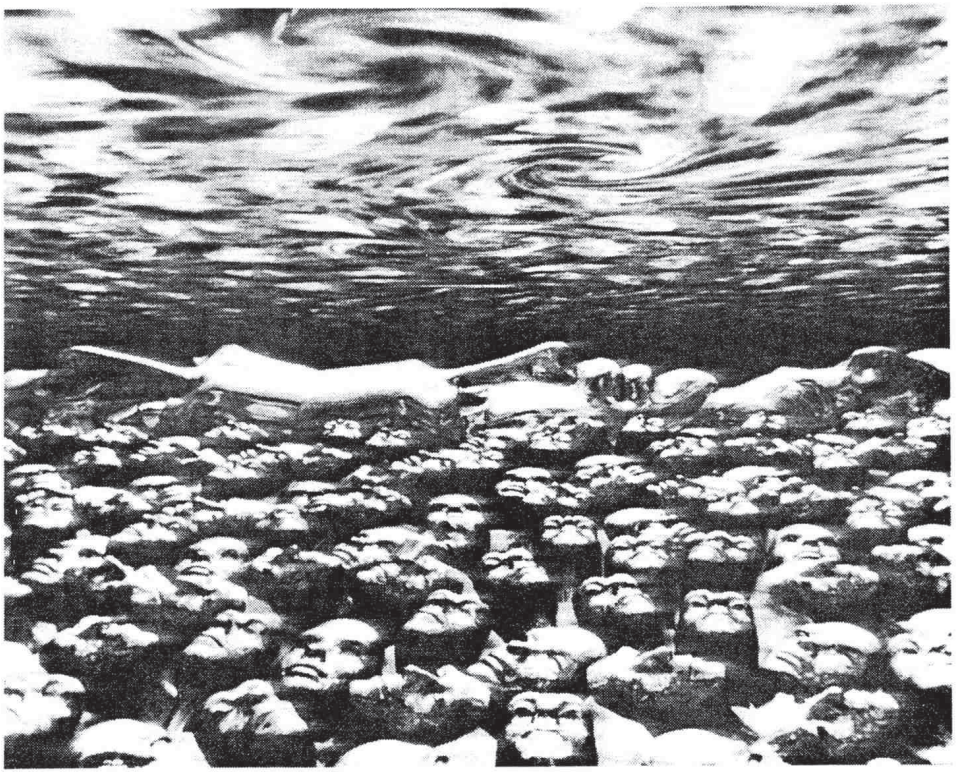
Larry Cuba's *Calculated Movements* (1985) explores the qualitative possibilities of theme and variation, using mathematical structures to evoke the experiential feeling-states

of nature and music. White, geometric bars move through the frame in crisscrossing patterns, against a grey background. The bars vary in thickness and number, their movements occurring at varying intervals over time. As the traveling bars intersect, various groupings, patterns, textures and shapes emerge. Two themes are explored, one delicate and meditative, the other ominous and slightly jarring.

Cuba explores composition through "the basic structural ideas that come from algebra, or from the nature of the [computer] drawing process, or from the hierarchical structure of the items in the scene and how they will dance—the choreographic movements from a mathematical point of view."[14] His creative choices in *Calculated Movements* are based on the varying dimensions of the bars, their direction of movement, and their spatial/temporal relationships. For an earlier abstract work, *3/78* (1978), Cuba developed the software tools first, without previsualization of the results. *Calculated Movements* involved merging the visuals with the evolution of the software, using visual feedback to further the direction of the tools. While mathematics as a "domain of thought" is elemental as a shaping factor of his work, visual and musical sensibility drive the aesthetic decision making.[15] This way of working is significant to the evocative qualities of Cuba's art, separating it from process-oriented work that is founded in technique, as opposed to creativity.

Karl Sims's genetic evolution algorithms are modeled after Darwin's "survival of the fittest" theories. He designs genetic characteristics that produce populations of entities called "phenotypes." Sims selects which phenotypes will survive and reproduce, and the cycle continues. When mutation occurs, new genetic traits are introduced, expanding the range of possibilities. The visual results of these processes are abstract forms, textures and patterns. The repeating cycle of selection, reproduction and mutation animates change over time. Sims also uses "genetic cross dissolves," in which genetic traits are animated by dissolving between two variations.

Sims's attitude brings this seemingly esoteric process down to earth. He emphasizes that the aesthetic decision is still based on human input—he evaluates the results of the algorithm and makes choices according to his personal preference.[16] His *Liquid Selves* (1992) uses these methods to explore personal imagery: rippling water dissolves into mask-like expressionless faces. Forms are in constant flux—surfaces covered in stretching faces flow into curving layers, mirrored human figures spiral and merge into branch-like patterns. A low, heavy cloud of



From *Liquid Selves* (1992). © Karl Sims

shifting faces hangs above a landscape strewn with empty stone masks—like shells washed up on the beach, their former souls drifting in the sky above. An image of Da Vinci's human figure illustrating proportion erodes into swirling particles the color of orange flames.

With this piece, digital methods are the means for making a statement about digital experience. Computers make "virtual spaces" possible, places where the mind can travel without the body.[17] Algorithmic processes are used to represent these ideas in the piece: the body evolves, dissolves and dissipates in a cloud of particles. Perhaps the body-less state describes the process of algorithmic thinking—abstract speculation fuels the process. This piece does not present itself as a purely algorithmic work. While the overall feeling is one of floating, disembodied contemplation, the algorithmic processes are blended with the cinematic use of temporal events, pictorial space and symbolic imagery to create this quality.

These are examples of algorithmic approaches to the animation process that involve human input as part of the feedback loop. Meaning is embodied within the software tool, which is a metaphoric prototype of aesthetic sensibility. The artist's involvement in using the tool completes the aesthetic process. Meaning is embodied within the invisible, global

structures formed by the animator's interaction with the tools, shaping the frame by frame visual changes we experience as the animated illusion.

In Conclusion

It is easy for those who love the process and qualities of hand animation methods to be skeptical and critical of computer tools. I include myself in this description, and my criticism motivated me to explore the issues in this text. It is easy to be skeptical of computer methods, because their abstract nature puts them beyond comprehension in many cases. Even when we do understand how the computer works, the ability to control its infinite functions in a creative way is still in question. Some would say that creativity is possible, just as early photography and cinema had to defend the artistry of mechanized representation.

The exploration of new animation technologies has been an ongoing part of animation history. In this sense, the experimental use of digital tools has evolved from the aesthetic of earlier experimental animators. The sensibility towards using computer tools seems to be divided into two broad categories: emulating the approach of hand animation, which influences a kinesthetic way of communicating, or using procedural methods, in which conceptual issues are explored through intuitive choice and aesthetic decision making.

My own aesthetic concerns are with the emotional content expressed kinesthetically through qualities of movement. Because I have struggled to accept algorithmic work, I have chosen examples of experimental methods that do away with the frame by frame process that I hold near and dear. I see that these methods promote a different sensibility than my own—one that explores visual possibilities, reflects the logical ordering of its methods and presents itself as an experiential mind-state. The kinesthetic sensibility can reflect these qualities, but communicates more on the level of the body. Both approaches involve the abstraction of body/mind into tools and methods, organizing the process of animating in a way that symbolizes the animator's aesthetic sensibilities.

Animation has often been judged solely upon its ability to engage the senses at a gut-level of response. Audiences for animation have been conditioned to "get it" without having to think it over. Abstract, conceptual work expresses through a complex of interwoven layers that can hit us kinesthetically as well as mentally. However, many people find such works of art have no tangible frame of reference within their experience. The alienation they feel from the work, and from the artist who

made it, perpetuates a cycle that further alienates the artist from society.

I believe that an approach in which the animator merges with the tools, in some physical or mental way, can express a synthesis of kinesthetic and conceptual meaning. I feel that it is desirable to do so, in order to express oneself fully as an animator, which in turn creates a satisfying and meaningful experience for others.[18]

[1] For more on this, see Jules Engel, "Experimental Animation Art in Motion," *ASIFA-Canada* 21:3 (Dec. 1993): 26-27.

[2] Global and local are terms often used in computing. In animation, local, or low-level, refers to a level of description that requires a lot of detail. For example, the location of an object can be determined for every frame of animation and expressed as XYZ coordinates. To describe the movement of the object by expressing an XYZ value for every frame would be local description. A more global, or high-level frame of reference would be to describe the location of the object only at the keyframes, providing simple instructions for how the object proceeds from one location to the next. Lets say we are animating a walk cycle. First we keyframe the positions for one cycle of each leg. Then we specify that twenty steps are to be taken. Then we create a swerving path on the ground, and set the figure to walk along it. Next, add twenty figures, spread them about, and have them perform the same movements, each one beginning at a randomly chosen point in time. These are progressive levels of description, going from local to global.

[3] Kit Laybourne, *The Animation Book* (New York: Crown, 1979), 146.

[4] The *Lines* films are *Lines-Vertical* (1960), *Lines-Horizontal* (1962), and *Mosaic* (1965). These three films are related because they were created by situating the same original footage in various ways. McLaren explains: "By engraving straight lines on black leader with a knife, we had made the film *Lines-Vertical.* By optically turning this image 90 degrees, we had made the film *Lines-Horizontal.* By running a clear-on-black copy of both vertical and horizontal in contact with each other, in an optical printer, we got the basis for the film *Mosaic*, namely a new negative, the print from which had a black background with clear dots wherever the lines intersected." Norman McLaren, "Technical Notes on Visuals of *Mosaic* (1965)," unpublished notes available from the National Film Board of Canada.

[5] McLaren made one computer animated experiment, but became disinterested in further pursuits with the computer as he felt it had nothing to offer that he could not accomplish by hand. Donald McWilliams, phone conversation with the author, 14 March 1994.

[6] Donald McWilliams, ed., *Norman McLaren On the Creative Process* (Montreal: National Film Board of Canada, 1991), 105.

[7] McWilliams, *Norman McLaren*, 83.

[8] McWilliams, *Norman McLaren*, 83.

[9] McWilliams, *Norman McLaren*, 75.

[10] Robert Russet and Cecile Starr, *Experimental Animation: Origins of a New Art* (New York: De Capo, 1988), 198-9.

[11] Armin Bruderlin and Tom Calvert, "Interactive Animation of Personalized Human Locomotion," Graphics Interface `93 program.

[12] The software used was "Funbag," which was written by Henry Preston at ACCAD, The Ohio State University, 1991.

[13] As more and more art schools integrate computer graphics into their animation degree programs, it is important for teachers to cultivate a creative

attitude. Expressive content can be associated with the animated results of push-button tools. Programming courses provide technical empowerment, promoting the attitude that the limitations of the software are not necessarily limitations to creativity.

[14] Gene Youngblood, "Calculated Movements—An Interview with Larry Cuba," *Video and the Arts* 11 (Winter 1986), 38.

[15] Youngblood, 37.

[16] Karl Sims, "Artificial Evolution for Computer Graphics," *Computer Graphics* (Siggraph '91 proceedings) 25:4 (July 1991), 319-28.

[17] Karl Sims, "Siggraph 1992 Electronic Theater Program Notes."

[18] Other sources consulted during the writing of this essay include: Maxine Sheets-Johnstone, *The Phenomenology of Dance* (London: Dance Books, Ltd, 1979); Wassily Kandinsky, *Concerning the Spiritual in Art* (New York: Dover, 1988); Susanne Langer, Feeling and Form (New York: Charles Scribner's Sons, 1953); Carol-Lynne Moore and Kaoru Yamamoto, *Beyond Words: Movement Observation and Analysis* (New York: Gordon and Breach Science Publishers, 1988); Malcolm Ross, *The Aesthetic Impulse* (Oxford: Pergamon, 1984).

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