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SOFTWARE AS ART: WRITING THE SCORE FOR PAINTING AND DRAWING

by Roman Verostko

Roman Verostko, Professor and Chairman of Liberal Arts at the Minneapolis College of Art and Design, teaches world art history and has been active as a painter for over 25 years. This paper expands on material the author presented at the First International Symposium On Electronic Art (Utrecht, 1988) in a paper titled "Epigenetic Painting: Software As Genotype, the New Art" (Leonardo, Vol 23, No.I, 1990).

1 Overview.

Within the past seven years I have been in the process of developing software to use in my studio for making art. Following several years' development it became clear that the software itself is a form of art somewhat analogous to how a musical score represents a composer's musical ideas. But the analogy stops there. The software grows in an interactive process of trial and error which has a life of its own. Artists who have discussed their software speak of this process as a kind of learning curve which increases as you go along.

And in that process the personal style of the artist also emerges. In its mature forms *software art* already manifests a range of individual styles. Compare the figurative work of Harold Cohen's AARON (Figure 1, 1987) with the conceptual "algorithmic art" of Manfred Mohr (Figure 2, 1987). Both examples were executed with a plotter driven by software created by the artist. In terms of artistic intentions and stylistic character, while they are miles apart, they share one thing in common. Their creators have been drawn to programming their art.

Surely either of these artists is quite capable of making art without the aid of software or computers. Indeed, Harold Cohen has a formidable achievement as a painter independent of his involvement with electronic art. So the ultimate question for those of us involved with programming our art is "Why do it?"

Several years ago I spent long hours adapting a Chinese paint brush to use on a plotter. There were additional complications in writing and integrating a software interface for the paint-brush routine. I felt somewhat foolish loading the brush with ink and installing the brush when the machine asked for it. Initial results were awkward. The machine was unwieldy. It would have been so much easier to simply hand-paint the strokes. "Why bother with such a troublesome and painstaking procedure for something you could do so much better by hand? - and so much more quickly?" or so it seemed then. Several times I almost gave up on the whole idea.

Since then the routine taught me a lot about brush strokes, spontaneity and self-similarity. The routine led me eventually to new perspectives on form possibilities - possibilities I could never have understood without having gone through the process. Some of my assumptions about the nature of allegation structures and "order" were greatly modified. I realized that the visual appearance of human spontaneity as manifest in abstract expressions and Chinese Shufa could be simulated with pseudo-random procedures in my software. More on this later.

Moreover writing software has led to a greater understanding of my working process. However we would probably find this to be the case with any productive procedure an artist might follow.

So why bother with software and computers? Wrong question. Let's ask: "Is there something about the software that provides an 'order of leverage' to your work that would not be available otherwise?" Furthermore, is this "order of leverage" accessible for your artistic needs with the software available in the market-place?

To the first question we come to an easy agreement. Most of us probably recognize that the process made accessible through the personal computer provides a new order of "form" generation. Transformation matrices permit for painless and limitless improvisation of form. This process can unfold visual domains which were either hidden from us before or not easily accessible [1].

The second question cannot be answered absolutely. Only the artist can answer whether she has found software which serves her individual expressive needs. For myself I have been developing a "personal expert system" which evolved from my work as a painter. My current paintings can be seen as a stylistic development from ideas which have occupied me for over 25 years. Let's outline how these ideas led to software art and why it appears that "software art" must, by its nature, be "one-of-a-kind".

1.1 Preliminary Definitions.

Before proceeding further we will define several terms that will apply in this paper.

art concept Here an art concept refers to an artist's ideas about "how make a work of art" during a mature stylistic phase of development. This "how to make a work of art" includes the ideas the artist has about what he is trying to achieve as an artist.

software art Software written or modified by an artist (or collaborators) to carry out an *art concept*. "Software art", as defined here embodies at least some of the form-making ideas of a specific artist, somewhat as a musical score embodies music ideas of a composer.

personal expert system The software art and the hardware capable of processing the unique *art concepts* of a particular artist - in this case, a personal computer, a plotter, and the artist's software.

2 Theory and Practice; The Foundation For Software.

For over twenty years my paintings played with a visual dialectic between *control* and *uncontrol*. The paintings presented visual opposites forming a dialectic between *order* and *chaos*. The first works with this dialectic were executed between 1964 and 1968 on deep grained plywood panels, (Figure 3).

2.1 The Visual Dialectic of Opposites.

These panels were first brushed with a wire brush to raise the grain: then they received about five coats of gesso. In the first stages I carefully delineated several rectangular fields with variable spacing, creating visual tension between the rectangles in the overall field. These rectangles were carefully filled with a heavy synthetic impasto making a slightly raised rectangular relief on the panel. These areas were left to be painted last with carefully controlled hues, saturation, and values.

2.1.1 Uncontrol.

Next, in focused non-cognitive sessions, I would mark the surface with spontaneous gestures, sometimes with brushes - sometimes with crayons or pencils. The gestural marks were imbedded in layers of colored stains that drew out the grain of the wood.

This gestural marking was made without conscious "editing" following a procedure we will call *uncontrol*. The dominant rule was that the marks had to be entirely spontaneous *without any conscious editing*. For several years I had worked through hundreds of such gestural works (Figures 4,5). I was driven by the idea, at that time, that totally irrational human marks could be visual analogies to "feeling states" resident in one's unconscious life. Such marks, some have thought, might reveal something of the inner psychic or spiritual world that was not accessible with representational art.

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1. For the field of biomathematics see Lecture Notes in Biomathematics, Vol. 79: Lindenmayer Systems, Fractions, and Plants, Przemyslaw Prusinkiewicz and James Hanan, (Springer-Verlag 1989) ; The Beauty of Fractals, Heinz-Otto Peitgen and Peter Richter (Springer-Verlag 1986).

During my Paris period (1962-63) I kept notes following each working session. These notes were intended to describe something, however vaguely, of my experience state at the time of the drawing. In order to minimize conscious control (editing) I devised a working method which prevented me from seeing the work until the session was completed. First I used a simple "closed-eyes" procedure; later I improvised visual barriers to hide the drawing until completed.

Through this process, in a kind of spiritual quest, one has to empty the self of *thinking*, be entirely present to the moment, and strive to be *one* with one's world. To be one with the brush, the crayon, the panel, the universe - in a free flowing gesture was indeed the goal. Being most *free* was also being most *joined.* A gesture free of rigid aesthetic conceptions, I thought, might echo cosmic forces. This could be seen in the splash of paint that yields to unseen forces like gravity whose traces are captured in the stroke. The question I asked seven years ago was whether similar strokes could be achieved with software? More on this later.

2.1.2 Control.

In the final stages of the work the rectangular areas were painted according to an entirely opposing set of rules. At that time, I viewed these rules as a form of structural control in extreme opposition to *un-controlled* spontaneous gestures. Each rectangle was painted with a value, saturation and hue calculated to produce a visual push or pull slightly forward or slightly receding from the predominant picture plane (Figure 3). Simultaneously, the placement was intended to maintain both a tension and a balance between all the elements of the painting.

2.1.3 Dynamic Equilibrium.

An important influence was Piet Mondrian's concept of *dynamic equilibrium.* In reference to his own work before World War I, he wrote of how he perceived nature in his quest for unity:[2]

> Impressed by the vastness of nature,
> I was trying to express its expansion,
> rest, and unity. ... To create unity,
> art has to follow not nature's aspect
> but what nature really is. Appearing
> in oppositions, nature is unity...

Mondrian perceived a deeper unity than lay on surface appearances. His search for a deeper force led him to see that life springs from the tension of opposites and that he could make art that reflected this dynamic. For him this dynamic had a profound spiritual meaning which he could manifest in works which obtained what he called "dynamic equilibrium". The ideas he developed for achieving a visual manifestation of this *dynamic equilibrium* could be called his *art concept.* This was the fundamental idea which underlay his mature work.

Mondrian's thoughts about making art, along with those of Malevich and Kandinsky influenced me in seeking and formulating my own *art concept.* Eventually I came to work with the extremes of visual opposites in the same painting field. These elements were shaped by the extremes of *control* and *uncontrol.*

2.2 Meanings and Interpretations.

For me this work came to represent the apparent polarities of human experience - the rational and the irrational, body and spirit, life and death, heaven and earth. Both in the paintings and in human experience we find that radical polarity generally implies its opposite - dark implies light or conversely light implies dark. One cannot know one without having known the other.

The works, as a visual dialectic between *control* and *uncontrol*, flow from an idea about "how to make art". They also represent the spiritual struggle of life itself. One learns that peace and unity lie in achieving a balance between reason and feeling - between all those inner forces that push and pull us in opposing directions. These works seem related to the traditional Chinese wisdom imaged in the yin/yang, woman/man, moon/sun, soft/hard, earth/heaven.

3 Software As Form.

But how, we may ask, do we get from these ideas to software? Well, what is *software*? Software is essentially an *idea* translated into a language that can be *read* by a computer. For my work the *idea* to be

---

2. "Towards the True Vision of Reality", in d.m.a.2. Plastic Art and Pure Plastic Art,p. 15, N.Y., 1951.

Appendix A

Sayings of Omphalos

Omphalos on Parade:

The astute parade
sometimes sticks.

Hold piercingly
while parade rehearses.

Omphalos on Saddle:

The saddle stretches mutiny
impetuously.

Unexpectedly filthy saddle
wagers barrier.

Omphalos on Trial:

The noble trial
intermittently criticizes.

Jiggle darkly
whenever trial dissolves.

Omphalos on Axiom:

Conceal triumphantly
even if axiom stuns.

Omphalos on Jig:

The jig riles comedy
voluptuously.

Seldom paltry jig
melts fable.

(The above quotes were made by Omphalos on October 29, 1989).

Appendix B

Illustrations

Figure 1: Harold Cohen, AARON drawing, 1987.

Figure 2: Manfred Mohr, "P-417/ID, 1988, 22 3/4" by 22 1/2". A "generative work" created by the rational structure of the artist's program which he views as algorithmic art.

Figure 3: *New City Series*, acrylic paint, crayon and gesso on wood, executed by the artist's own hand, 1966-67, 3 ft. by 3 ft. This work shows the artist's interest in the placement of *control* and *uncontrol* in the same visual field.

Figures 4,5: Painting/Drawing, 22" by 30", 1965. Pencil, crayon and wash with India ink. During the early 1960's the author made literally hundreds of such studies exploring human gestures and marking.

Figure 6. *Epigenetic* painting, 1987, artist's software, **Hodos**. Executed with a 14 pen Houston Instrument Plotter and an IBM PC. Chinese brushes adapted to and driven by the plotter. Rag paper, 26 " by 18".

Figure 7. A full scale brush stroke made with *Hodos*. The line configuration at the lower left is a scaled down pen stroke.

Figure 8. *Epigenetic* sketch executed by **Hodos**, 1989. Actual size. The upper left seal imprinted by hand is the artist's Chinese name.

Figure 9. *Epigenetic* painting, 1987, artist's software, **Hodos**. Executed with a 14 pen Houston Instrument Plotter and IBM PC. Rag paper, 16" by 24".

Figure 10. The plotter executing a brush routine. On December 12, 1987, the first software driven paint brush executed a work on this plotter.

Figure 11. *Epigenetic* painting, 1989, artist's software, **Hodos**. Executed with a 14 pen Houston Instruments Plotter and IBM PC. Chinese brushes adapted to and driven by the plotter. Rag paper, 2 ft. by 6 ft.

Figure 5

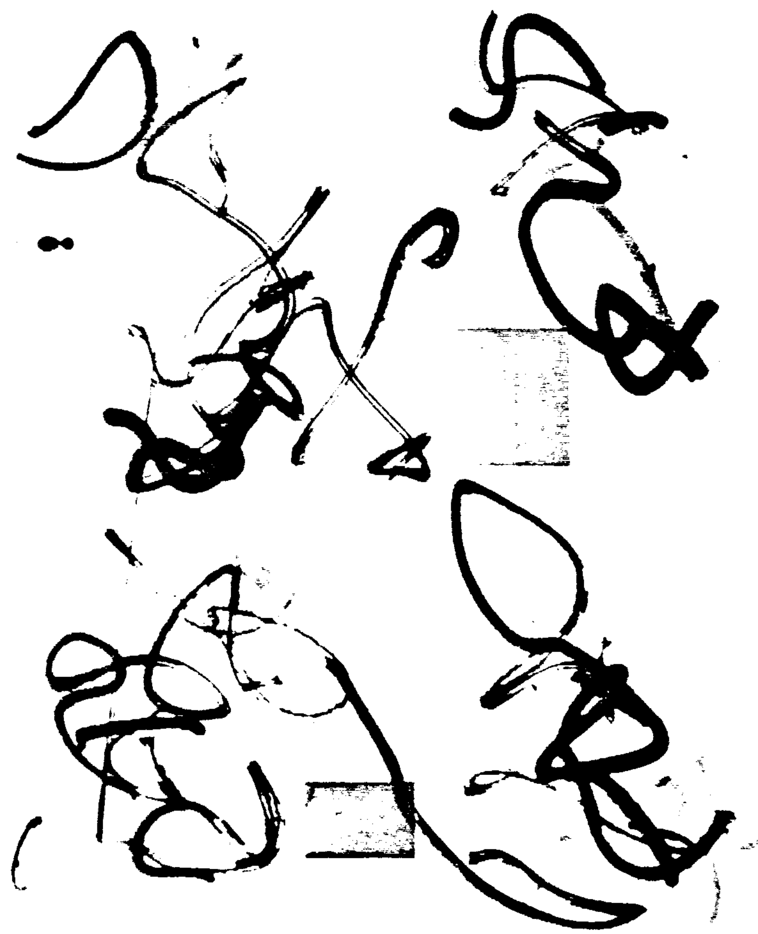
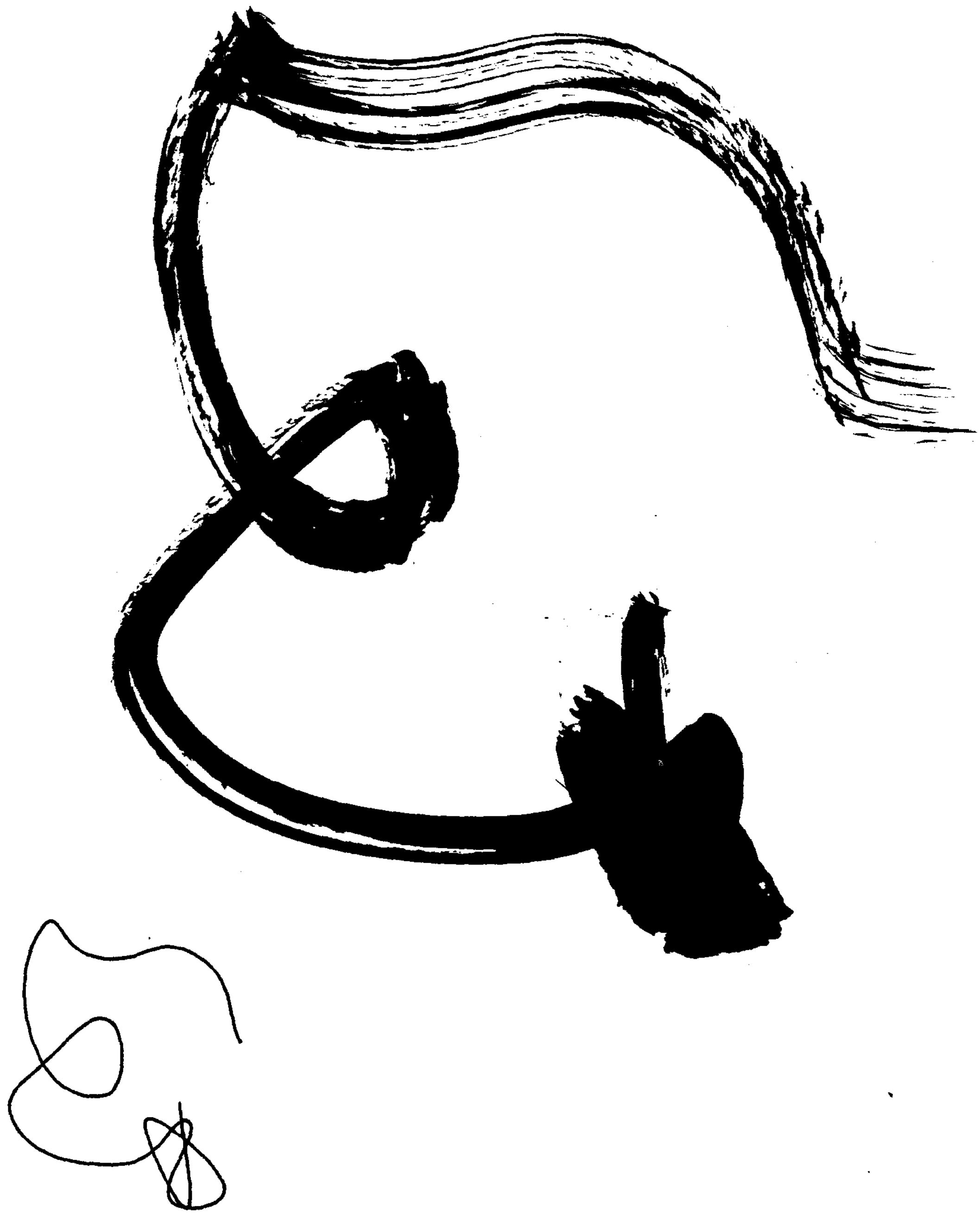


Figure 6

Figure 7



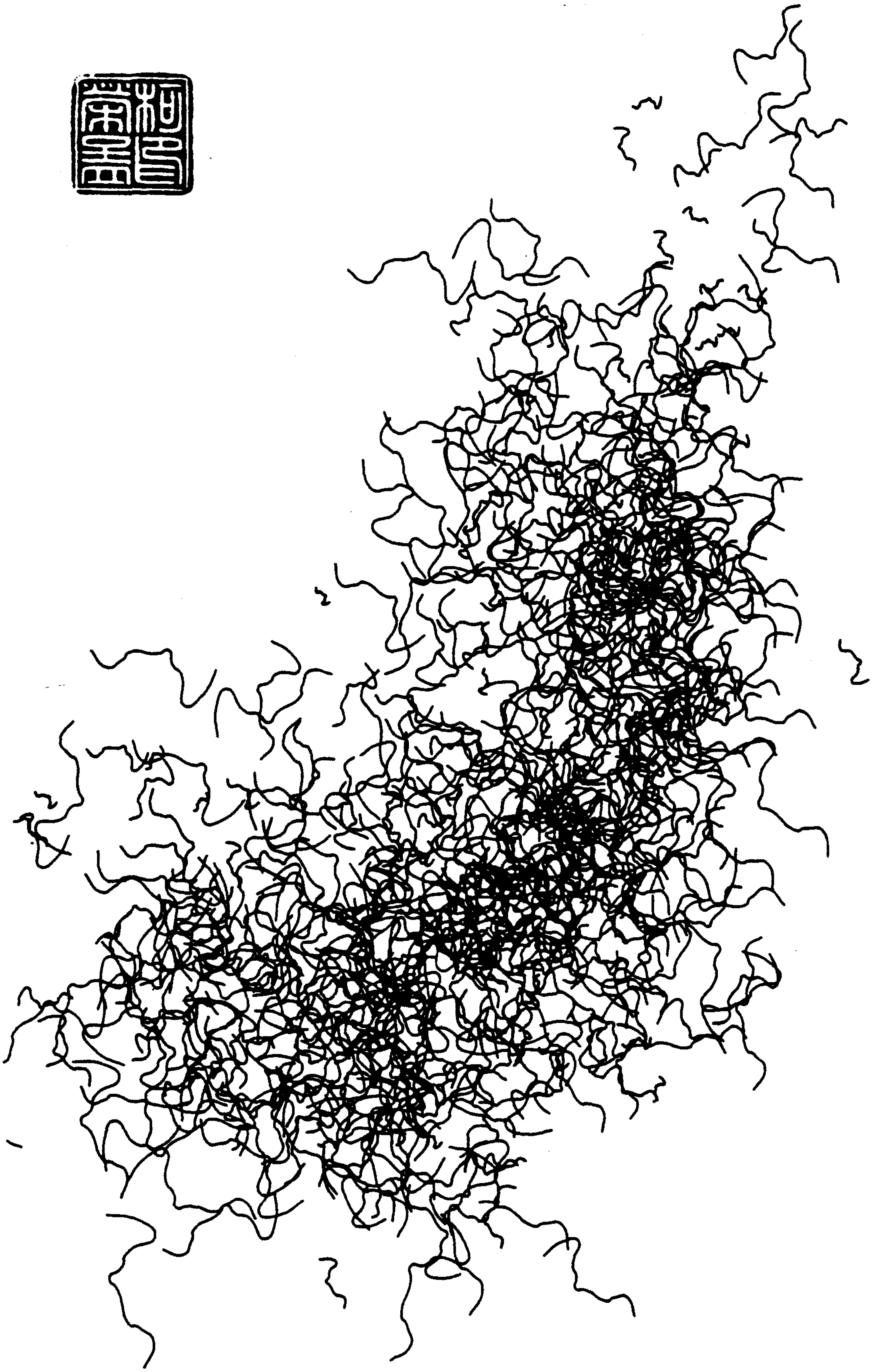


Figure 8

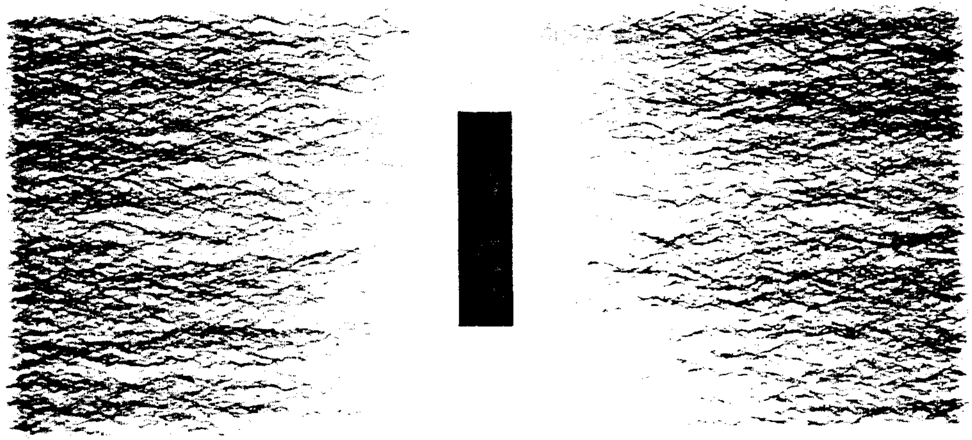


Figure 9

Figure 10

Figure 11

Issues in the Making of a Visual Instrument

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This paper is a pile of chips from a visual instrument workshop. It is a paper of thoughts and feelings that I had while devising the basic algorithm for a family of visual instruments and, then, trying to set my art-making in a trustworthy context with a little help from dancers, musicians and sages. Leftovers that my Amiga did not understand...

Artists must be sociologists, philosophers, technicians--the list is endless. Of course we can not do all these things well, but we *need* to try to orient our art making. My orientation is poetic and lyrical. So this paper is the poetic meditation, the felt journey, behind the technology.

If you wish to skip the journey, my conclusions are listed in the section, *Getting Real,* toward the end of the paper.

Homage in Two Parts

Brooke Boering's dream inspires me. Ceemac is a great visual instrument workshop. I just wish it was available for the Amiga. Ceemac with a blitter; now that's frightening! (At last check, Ceemac could be had through Kinkos Academic Courseware Exchange.)

Myron Kruger is an inspiration as well. What little I know of him comes from a talk he gave last year at The School Of The Visual Arts in New York. I am still thinking about his ideas and work: Amazing person-machine interactive environments-- No doubt, Leonardo is turning green...with envy...somewhere.

A Note on Format

This paper is linear in the most obvious way: It does read from the beginning to the end. The columns, however, are not organized in the conventional left-to-right linear fashion. Instead, they represent chunks of related material which may be read in any order. This strategy has allowed me to give appropriate prominence to what would otherwise be massive footnotes and to give the reader a sense of picking her own path through what has been for me a journey of discovery. (Apology: As my library is still, in storage from a recent move, source references will be mere wisps of memory.)

Introductory Passage in Three Parts

The long distance runner will not make it divided against himself: the lower the tension, the stronger the stride. Yet Heraclitus tells us that the bow thrusts its arrow by back-bending against itself; the harder the pull the more swift the thrust. What of the artist? Is she a runner or a bow?

Tension, madness: the visitation of the Muse driving us out of the frying pan of our minds into the Big Bang, the naval of the world, the egg of the Universe? Creative sexual algebra modulating, again and again, to higher keys as the tension becomes so good we forget to eat or sleep or... Big Bang, indeed! Huzzah, Dionysus! Artists must thrust. Like all creation: The better the piece, the tighter the birth.

The eye of the tempest: here too is the egg of the world. Writing poetry with a pulse of 52; a state, not an act. When Yeats inspected those school children, did he smell fear? Or did he mistake that measured, academic stillness for discipline? Pavlov's dog was not disciplined, Willy. Our ceremonies should not cripple us. *Leopold Pospicil, being a good European, was dismayed that the Kapauku Papuans of East New Guinea never chose restraint as a social sanction. They held corporal and capital punishment kinder. After all,*

Something started with the Greeks. Something that reshaped our control of the world, reshaped the world and, then, reshaped us. It often is called "progress." But whatever we call it, it calls us grist.

What role a discipline will play in "progress" is the central political question in every discipline. If the arts are kept on the receiving end of "progress," then the future will not be a good place in which to live. Artists cary important pieces of the puzzle of the possible shapes of human being and human communities. We must have our say.

"Science and money drive history..." Quickly! Put your ear to the ground. Hear the one, two, three, and four chambered hearts beating our syncopated rhythm of love for the Planet. "Love, *or something kind of like it,* makes the world go round," booms Beethoven!

Museums are the glory and shame of the arts: We must stop dwelling on past successes, and learn to use the most powerful tools available in 1990.

Jesus and Buddha and Marie Laveau are leaving and you are invited! Just give up everything and follow. Talent is like gold. The more talent you have, the easier it is to stay put. (It is easier for a camel to pass through the eye of a needle than for a talented artist to make art history.) Good artists make art; bad artists sometimes make history.

"If it looks like art, then it looks like *someone's* art."

We need to get rid of all these classes of 300 students memorizing lists of bell-ringer labels for cocktail party survival. Oh, for those endless afternoons chatting under the shade trees with illiterates, Socrates and the boys. "Much *learning of facts* does not make wisdom." Or *restraint separates the soul from the body by impeding the soul's will for the body? Figiting is a mortal illness: it means your soul wishes to leave.* (Pospicil, Leopold. *The Kapaupu Pauans of East New Guinea*. Cambridge, Mass.: Harvard University Press.)

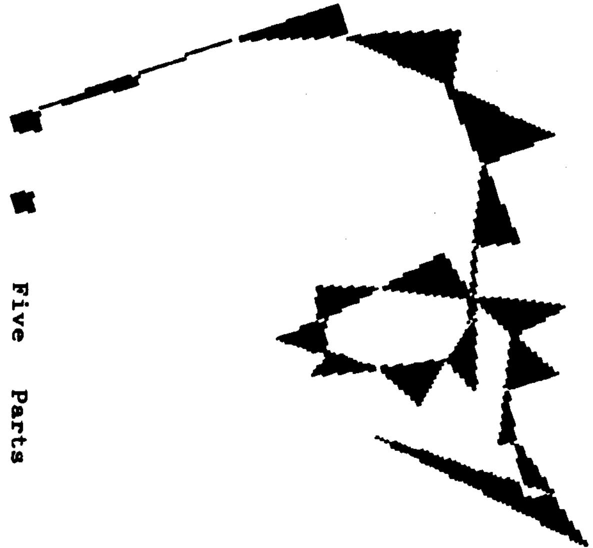
Artists must be long distance runners, clear, just running. The emptier the archer's eye, the truer the arrow's flight.

Huzzah, Apollo! Huzzah, Dionysus! Huzzah! Huzzah!

Perhaps Leonardo will stop spinning in his grave. Perhaps you will be the first to hear a five - chambered heart beat. Serious progress. Perhaps art will become more than a quaint afterthought reinforcing voyeurism and fantasies of easy love and violent self-assertion. Jerry Falwell is right: Art should scare us more than any other source of "progress." It's deepest beauty *must* scare us, one way or another.

imagination... Or creative courage... The best education is to do a variety of things *that seem important at the time* thoroughly and well.

So get serious. Take a chance. The more *authentically* shocking our art is, the more reassured God must be about Her work. *Authentically shocking need not slap, more often it tricks, tickles, deeply reminds and moves.* "Thanks, I needed that!" "You're welcome. I did, too."



On the Possibility of Visual Instruments in Five Parts

I am thinking of visual instruments as contrasted with sonic instruments. The many differences between sight and sound limit what we can learn from sonic instruments about how to make visual instruments. Yet we may learn something. And where else could we begin? So few visual instruments for performance already exist. If we wish to speak of instruments at all, then sonic instruments, mainly musical instruments, are where we must begin. Where else?

Certain characteristics of musical instruments present themselves immediately. For the most part, the interfaces are intuitive. The piano, for example, plays louder if one increases finger velocity. The basic control strategies for drums, trombones, theremins and zithers are fairly obvious from our general experience of getting around on the Planet. In addition, the output of the instrument is different in quality from the input. We put in movement or breath or whatnot and get out sounds. An audio amplifier only becomes an instrument when overdriven. (The Seeds. *Pushing Too Hard*. Hollywood: G&P Creshendo.

I am thinking of visual instruments as contrasted with sonic instruments. The many differences between sight and sound limit what we can learn from sonic instruments about how to make visual instruments. A few visual instruments already exist. It seems right to begin by reminding ourselves of the nature of these instruments. Where else?

First, let us toss out a few silly candidates. Telescopes, microscopes and paint brushes could be argued for if one wished; but they are not *really* visual instruments in the same

1966.) Finally, in this short list of obvious characteristics, we take note of an ongoing, expressive control of the output through modifications of the input. Let's summarize:

1.) Intuitive interface
2.) Output and input have different quality
3.) The player exercises ongoing expressive control

By way of speculation, an intuitive interface would seem to be necessary for an artist to play with *feeling.* The output and input must differ because built instruments must *extend* us. Otherwise, what's the point? Ongoing expressive control is needed for *communication* with an audience.

Again, it is obvious that not all instruments are exemplary in their adherence to our neat little trio of requirements. Violins are only marginally intuitive. Kazoos alter the quality of the input only by adding the silly overtone series. And it takes a better man than me to have anything approaching "ongoing expressive control" of a gong. These are observations, not rules. Nature rules. Human minds discover what they let themselves.

Designers of visual instruments, let yourselves note these three obvious characteristics of sonic instruments. It's not nice to fool with Mother Nature. And...transcending Her is, to use the vernacular, a bitch! The musician is, naturally, a feedback device that depends on subtle affective gates. First, there is an intention/emotion. Then there is an action. Then a comparison of the intention with the sonic result. Finally, both the intention and the action are modified from that comparison, and another action restarts the feedback loop. Again, all this serves communication.

It is important to grasp that a loop has no real beginning and that music does not come from inside. "Your inside is out and your outside is in." I made these observations listening to Albert King playing "Love Me Tender," but even

Interiew with a Composer

Mitchell: Speaking as a composer, how important do you think the experience and intuitive study of vocalizing is in making music and organizing sound?

Composer: "?"

Mitchell: Do you know what I'm asking? Carefully listening to all sorts of different accents; or paying attention to the way people phrase things and how subtle

sense as, say, a cello is a sonic instrument, now are they? We want something *more*.

Well, how about a comic's props? W.C. Fields' cane... Red Skelton's hat... These seem closer to what we want: The comic exercises an ongoing, expressive control over the prop's effect on the audience; much like a jazz musician. But, of course, the comic's messages are more specific and, therefore, less rich.

Puppeteer's might be thought of as visual instrumentalists. Puppets can be richer than props. Unfortunately, they are also more specific in their messages. We are looking for an instrument used to express an *algebra* of feeling and experience , not an arithmetic of plot. (Langer, Suzanne. *Philosophy in a New Key.* Cambridge, Mass.: Harvard University Press, 1942.) Conventionally, puppets are used much as actors in a story.

"So this is absolutely everything one might wish to know about visual instruments. Right?" Wrong again, Moose Breath! Your writer is a trained philosopher and his masterful intellect is on the razor edge of reinventing the wheel.

Let us turn to a dancer's props. Scarf dancing, the Cherokee's hoop dancing; sabers, rifles, baggy pants and all the wonderful folk costumes indispensible to traditional dancing... Here we have our algebra. In this context, the scarf can remain as abstract as music. But, let's face it, scarves are not saxophones. In terms of expressiveness, they are gongs or, better yet, kazoos.

We're getting hot, folks! Yes, kazoos offer an important clue about the wheel's proper shape. What is a kazoo? A voice with lemon-lime icing. And what is the visual equivalent of a singing voice? What is the original, primitive, God-given visual instrument for expressing that old black algebraic magic? All together now! *"The body, Professor Lee."* Ladies and gentleman, I give you--drum roll please, Doc--the wheel!

Yes, *the body* is, indeed, the voice of visual instruments, basic and original. In fact, a dancer's body may be the only visual instrument that has an expressive power comparable to, say, concert pianists may be able to achieve the same thing on occasion. Not even Albert, however, could pull off the trick of playing a digital gong with feeling. All musical instruments for performance are predominantly analogue in their interfaces, none are digital. You've got to feel it: Instruments must be intuitively controllable to play your blues.

Another way to express this thought is that the musical output can not be too much simpler or more complex than the musician's controlling input. Organs with "auto-harmony and percussion" mess up the feed-back. On the other hand, one doesn't have time to program the synth during *performance*. "May the circle be unbroken." Here again, these are observations of how most good instrumentalists work, not rules.

So...how much of this is applicable to visual instruments? One could answer, "That depends on what you want from a visual instrument. What is it to be used for?" To me this is a cheap shot. There

differences in phrasing can change the meaning and listening to babies babble and getting a sense of what the cadence of *that* is... I'm kind of curious about this all of a sudden. I'm kind of curious...about what role all that plays.

Composer: Well this might be a round about way of answering it, but I have a feeling that in the last 20 years--and I could go back a lot further if I wanted to be really negative--since about 1970 an awful lot of really bad music has been written. One of the reasons for that is that composers are paying an awful lot less attention to what you are talking about. A person's awareness must be informed by attention to *what is there;* even from infancy, there has to be a natural attraction to sound for one to be interested in some day being a composer. Listening to people speak and listening to the world around one in that kind of way excites one. Eventually, it will incite one to try and reproduce those sounds. I can remember myself as a child wailing away. If I heard something I would try and imitate it. Constantly imitating people and things-- . Not really studying sounds, just raw imitation.

But the more people in music got into study--Which *is* extremely important; counterpoint and harmony and all the tracks that they channel phenomena along is important--but people have gotten so they ***actually believe*** *all that academia. If one is not a person who is naturally excited about natural phenomena--especially talking--one is apt to be gullible about what is taught in schools.* I can listen to someone from Nigeria and be fascinated because I do not understand.

Mitchell: Right.

Composer: I might go home and write a piece. I am inoculated by direct experience. All this logical vocal gesturing is going on and I am intuitively taking it in. It becomes a beautiful world all of its own. There is something vocal about my music even though I do not use the voice that much. Most music that I like--even if it is mechanical--has to have the gesturing of a conversation. That's what counterpoint evolved out of. The natural aspect of music, 16th century counterpoint and all that; all that scholastic music came from a natural use of the vocal apparatus. All the harmonies came because people did thing "a" 100 times and then 3 million times, so finally they noticed that it kept happening and decided to call thing "a" something. Now, before they called thing "a" something, it just happened. It happened because people's little rocks got off on it. When they heard people go up for that 6th part, they got a little jiggle; so they said: "That's a lot of fun. I think I'll keep on doing it. This isn't a whole lot different from a baby sitting in a crib who is imitating words when he doesn't know what they mean. But if you say: "Daddy's going to the store," they will say: "Daddy, store!" **They just want to say it. Yeah. So I think it's damned important!**

a piano. It might be argued that it is the only classic phase, mature visual instrument. *And human beings cannot claim credit for it anymore than we can for the voice. Both of these natural instruments have a fitness that does not depend on our understanding but on God, the Tao, natural selection, what have you...*

In case anyone wishes to play skeptic, let me just point out, for example, that we do not have to work to keep the voice in an audible frequency range. We *trust* the voice in so many ways. It is correctly proportioned in human scale, flexibly expressive; it is well structured. From the cradle to the grave, it gets us through. The voice and its phrasing, dynamics, expressive timbrel nuances and so on serve as the basis of all musical structure; or, at least, it is the basis for all structure *that works.* The voice keeps one right. Anyone who wishes to contest this point should go growl at a dog and see what is a prior question: What *can* it be used for? How can the computer technology that makes a plethora visual instruments possible be used to enrich our culture in novel ways? I want to see something really new and exciting. I do not simply want to get what I want in my art-making; I want to want better things. That's why I am an experimental artist.

Mitchell: Uh huh.

Composer: Of course, you also have Stefan Wolpe when he was at Julliard who threw open the window on his composition class in New York and said: "Write *that*." And one always sees those photos of Messiaen crawling through the woods, under some tree, looking hysterically up at a bird. That is almost an act of desperation. There is this call to nature. "When nature calls, you go." It was the woods, but now it's traffic through an open window.

Mitchell: But I think you are right. It is an act of desperation. We are the fundamental source of music's structure. And, of course, we are part of Nature with all that implies; but there is no escape from seeing through our eyes and hearing with human ears, especially with respect to making sense along the path of living as an artist. Like it or not, Kant was right about some things: When we crawl through the woods, we also crawl through our own minds.

happens. The Planet has been at the game of putting emotional algebra into voices for millions of years. Everyone from Beethoven to Little Richard to Kay Gardner (Gardner, Kay. *The Rainbow Path.* Durham, NC: Lady Slipper Records, 1984.) is sucking from the Big Tit. Moma Planet.

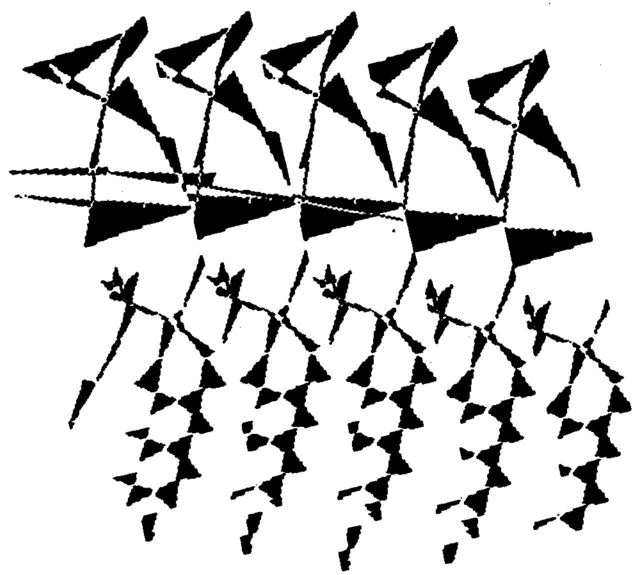
At first it seems there might be quite a bit to learn from musical instruments about the requirements of any sort of instrument to be used in performance. Performance is performance. Right?

I make the working assumption that the body should play the same role for visual instruments, performance and composition that the voice plays for musical instruments, performance and composition.

Let us, then, take a look at dance. What is dancing good for? Why dance?

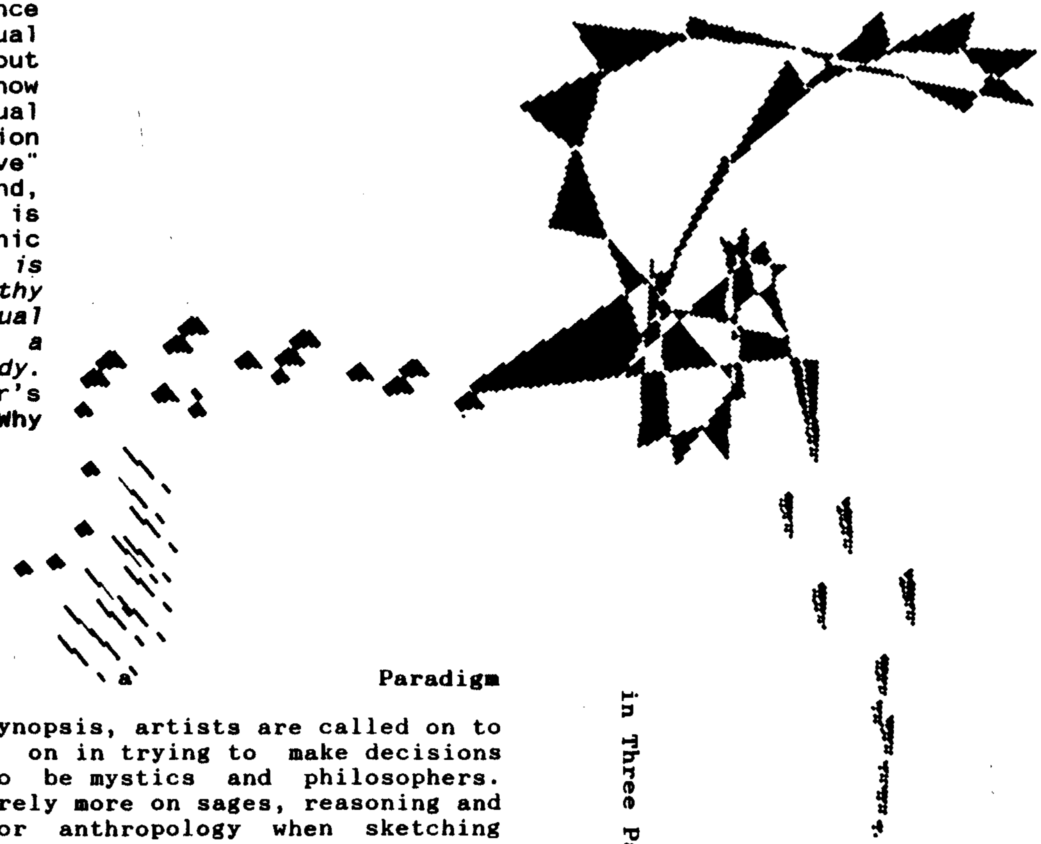
Right. From the point of view of the performer, preferences for visual and sonic instruments should be similar. After all, the only difference is the output, sound vs. image. We could, for instance, attach a keyboard to a monitor (with a black box between). Our performer could sit on the stool and play. The only difference is that she would watch rather than listen to "monitor" her performance. So far so good. But when we introduce an audience the plot thickens. As a matter of fact, it coagulates. There is no way to appreciate the

Wrong. From the point of view of the audience, preferences for visual and sonic art are dissimilar. Imagine, if you *can*, several thousand and persons with a variety of backgrounds sitting silently for hours in rapt attention watching moving abstract visual art... Not bloody likely. People do it for music all the time. This difference could be cultural. My own informal epidemiological survey suggests, however,



that the brain is simply wired differently for sound and image. Best forget purely *visual* symphonies. Or, if you prefer windmills, good luck! As for me, I will now turn to an examination of *the pardigmatic natural visual instrument* to get a better feel for what comes naturally in visual aesthetic expression: What is dance used for? Why dance?

exigencies of this aspect of performance for visual instruments without examining how traditional visual instruments function in "live" performance. And, just as the voice is the mother of sonic instruments, *there is no more trustworthy instrument for visual expression than a dancing human body.* So what is a dancer's body good for? Why dance?



Dance as a Paradigm in Three Parts

A tough question... As I stated in the synopsis, artists are called on to be scientists, theologians, technicians and so on in trying to make decisions about their art. Fortunately, we can also be mystics and philosophers. Following my training and Kandinsky's lead, I rely more on sages, reasoning and intuition than on physiological psychology or anthropology when sketching designs for, say, visual instruments. Confucius, in particular, seems like a good choice since he has a lot to say about art's social purposes. But first, a little intuition...

I feel that dance is like language, music, and sex: It is built into us--just waiting to be triggered and shaped. Check out a group of four-year-olds moving to James Brown. Or sailors pulling together with a sea shanty. Or a perfect discus throw. Or lover's fingers, fingers that have been dancing their feelings for a slick million years now. All this is so close. We can hardly marvel because dance is intimate, closer than we can focus. Dance has so many functions. Where to begin?

Let's focus on what dance does for individuals: Dance feels real good. The better it feels, the better it is for one. So here are hedonic and aerobic motives for dancing. Social dancing can be a good way to win friends and influence folks. Dance can be a *safely abstract* way to check

A Dancer's Epiphany

"All day I'd felt agitated and disconnected. I knew that dancing would help. It had always worked before. So, I decided to attend a party. At first I felt awkward. Then a song with a pulsating beat was played. I started to dance. The movements were unfamiliar yet somehow assured. I'd never felt these particular rhythms. Then, the out threatening psychological, sexual, emotional roles and feelings. *All Americans should bow down toward Africa five times a day. We are all African-European-Americans in our powerful living arts. Hail! Great Aunt Africa!* Dance can lead to religious ecstasy and other altered states. The people of the Kalahari are a striking example. Voodoo rituals, holiness churches, and the Ghost Dance movement are others worth studying. (Ventura, Michael. "Hear That Long Snake Moan." *Whole Earth Review*. Spring 1987, pp. 28-44.) *To dance with people of another culture is the ultimate emic study; to move right is to feel right.* All this leads naturally to what dance can do for groups.

Obviously, health and religion are group as well as individual concerns, but Confucius sees deeper:

> **Music unites, while rituals differentiate. Through union, the people come to be friendly toward one another, and through differentiation, the people come to learn respect for one another. If music predominates, the social structure becomes too amorphous, and if rituals predominate, social life becomes too rigid. *To bring people's inner feeling and external conduct into balance is the work of rituals and music.*** (emphasis added) (Yutang, Lin. Between Tears and Laughter. New York: The John Day Co. 1943. p. 72.)

In European traditions, dance is usually "music"; that is, it is the realm of the muses. It is inspired. But note that in almost every culture, including Europe, dance can function as ritual, as well. Once again, Confucius is right on. Dance powerfully brings "people's internal feeling and external conduct into balance." Quite a visual instrument!

So far I have avoided the distinction between performer and audience (vidience?). No more. Professional dancers speak of dance as being "an entire self-contained universe" of concerns. Musicians speak of "an environment of relationships." Here are two superfantabulous revelations from talking with dancers: Dancer's get the same rewards as any other performing artist. Dance audiences are much like other audiences. Big deal. The difference is that the some of the dancers also get some of the good stuff I have mentioned in the last few paragraphs. And their audience gets to watch and get a contact buzz.

Music and dance are frighteningly similar. Both are "no pain no gain" yokes, yogas, on a number of levels. Very few examples of either are truly free of symbolic

crowd blended as if in mist and I was aware of only one man dancing with me and matching my movements. Our dancing seemed choreographed in its precision and its passion mesmerized the crowd. They spontaneously formed a circle around us.

When the dance ended, I felt serene and deeply connected with my partner and the others in the room."

"Every life is lived in the rhythm of its time. We carry in our bodies the rhythm and movements of every life we have lived. When searching through past lives most people focus of traumatic and violent experiences. By focusing on these wounds, we rob ourselves of the beautiful completion of regular lives which nourish us with pleasant, quiet, passionate and joyous strength. We remember having nothing left to learn in order to love, to work and belong.

A reservoir of strength and wholeness waits in the vast mind of your body. Music from different cultures and eras can be used to activate this healing power and knowledge.

Music and movement, as a dance meditation, engages an energy in your cells that supports your on-going work toward personal transformation."

and psychological associations despite the *neat* intentions and *sloppy* bull of so many dancers and musicians. There is one striking difference, however.

Most dance needs music to move its audience. Most music does not need dance. Worse yet, most music moves us to dance. Most silent dance puts us to sleep. This asymmetry reminds us, once again, of the humility suitable for all visual performers and designers of visual instruments. Our ears seem more receptive to performances of abstracted emotion (music) than our eyes (dance).

None-the-less, I am modestly turned on by making visual instruments and I believe that they can be powerful aesthetic and therapeutic devices. *Dance hints at the possibilities for visual instruments* in the same way that the voice hints at all the other musical instruments. Is anything hinting at a visual equivalent of music theory.........? The question need to hang a while, turning slowly in the wind........ Yes. Ceemac hints. Hint. Hint. Choreographic systems hint. Just lonely hints.........

As an aside, one obvious use for visual instruments is prothetic, as a means of expression for people who have lost their physical mobility. "And the lame shall walk." How much of what dance can do for people socially and emotionally depends on visceral involvement? Kinesthesis?

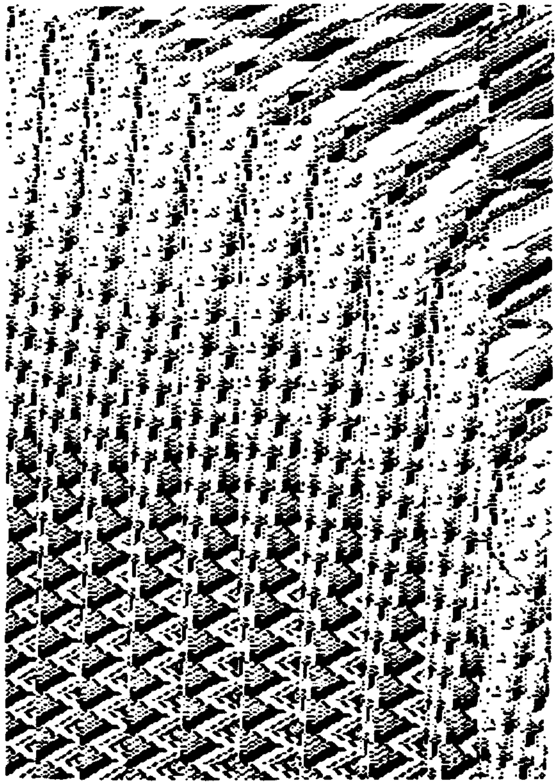
A few weeks back, a noted psychic told me of a dream in which people were dancing and singing in an intimate round room on a mountain side. The walls were like video monitors that smelled slightly of pine. They did not flicker and there was no high pitched whining. Comfortable! Every human movement and sound elicited a creative response from the walls. Fabulous patterns of light and sound that reinforced and clarified the human expressions. (Morningstar, Rose. *A Course in Crystals*. New York: Harper & Rowe, 1989.) Will the day come when much of our life is lived through such extensions? Will it be lived beautifully? Clearly, human wholeness would be at stake in the design of such environments. Deep algrbra. Serious play. *I'm game. How 'bout you?*

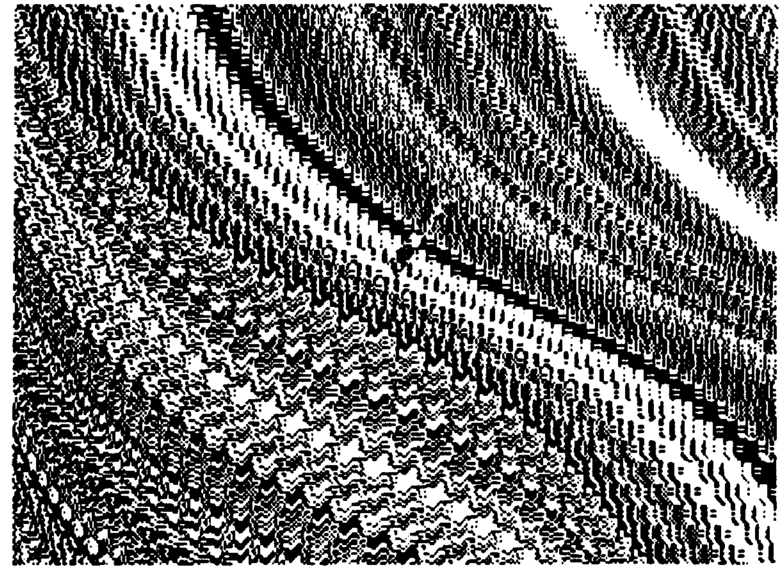
Human frailty impels people to make too much of our uniqueness as a species. Joseph Campbell thinks that the purpose of myth is to harness the distractable mind to the service of the needs of the body. This is quite close to Confucius. It is also close to Cliff Edward's explanation of the therapeutic power of Van Gogh's art: It broadens us by making spiritually present the things to which we should attend no matter physical distance. (Edwards, Cliff. *Van Gogh and God*. Loyola University Press, 1989.) Art and myth reconcile our inner life to the world. This is as much a question of beauty as it is of food or other "practical" exigencies.

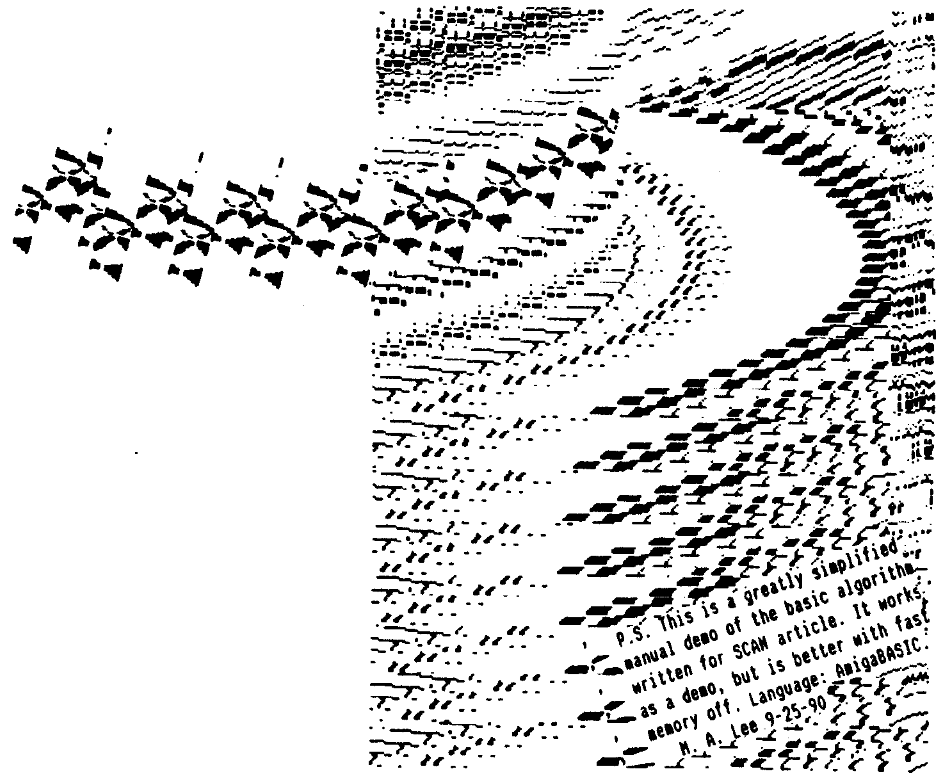
Human arrogance would like to see music and dance as extra-natural, *as ours. They are not. We need to be clear that a wolf packs' group howl is more like music than unlike it.* When Paul Winter plays his saxophone with a wolf, Winter is not more conscious than the wolf. Winter is not speaking algebra to the wolf's "instinctive" arithmetic. If anything, wolves are more abstract than people with respect to song. Both individuals are trying to bring the inner and the outer together into social harmony through emotional algebra. The encounter cannot be literally translated with out loosing its power because, for both, it is not a literal encounter. For both it is a matter of feeling. It is serious play. It is muse-ic. (Winter, Paul. *Common Ground*. Beverly Hills, CA.: A&M Records, 1978.)

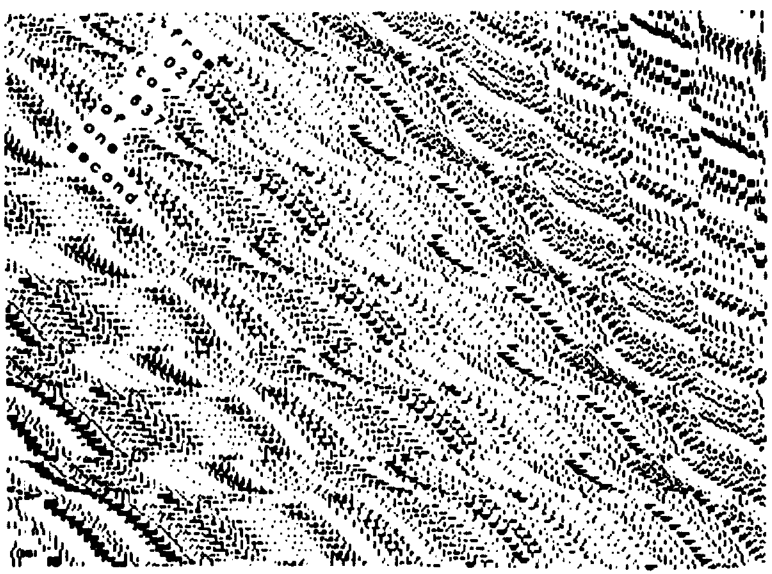
```
' Thanks to Walter Bowie for
' sparking the visual concept
' for this program.

' All programming and algorithms
' are original except as noted
' in the code below.  This was
' written in the last 3 days, so
' many improvements are posible.
' Check it out!
'    Mitchell A. Lee  4-17-89
```

All of the graphic marks in this paper are stills from gestures made by playing the visual instrument, SimplEel. See adjacent pages for a listing of program code. Production time for graphic marks:









Getting Real in Two Parts

So I have spent the last six months talking with dancers, musicians and mystics; reading Confucius; learning from Mother Nature about being whole; and I have not been programming or making art. But I have been imagining and thinking about what art is worth making. This same sort of imagining was buzzing through my brain two years ago when I was working out the basic algorithm for a family of visual instrument. I am slowly getting clearer on all this.

Here are some firm ideas about what visual instruments should be like to work:

1.) Visual instruments' output should ***seem free,*** not trapped in a box. If it is on a video monitor, then the monitor should not contain, but reveal, it. Like a window. It must be in our world, not its own or we become passive watchers.

2.) Visual instruments should be ***flexible,*** capable of a wide variety of expressive movements and shapes; but always within characteristic instrumental limits. This is necessary for aesthetic expressiveness. Think of a simple penny whistle. It can subtly express the full range of human emotions. Happy vs. optimistic, for example. A thousand personalities can emerge from a hollow tube with a few holes in it.

3.) Visual instruments should provide the player with ***ongoing control*** over the output. The player should be able to "say something." Modulate the message.

4.) Visual instruments should be ***intuitively controllable*** like musical instruments.

5.) Visual instruments' ***output should differ in quality from their input*** like musical instruments; movement to color or pitch to shape, et cetera. They should extend us.

6.) Visual instruments' ***should make intuitive sense*** to the performer and the audience. The nature of its movement should feel free and natural, like dance or like an appendage, an organism, water, clouds, *something. It should not move as it is easy to program it to move: trapped in a box, bouncing off the walls.* Movement quality has a meaning to Earth Planet creatures. There is no escaping how we will see things anymore than how we will hear things. For example, things that get larger seem to be coming closer.

7.) Visual instruments should produce ***no distracting irritations:*** no positive ions, high pitched whines, weird radiation, gasses, bad smells. If cellos smelled like urine...

Oh, did I mention that these are not general criteria for visual instrumental virtue. They are the actual criteria that I applied to developing the algorithm for a visual instrument. I've shown you mine; now you show me yours.

```
SCREEN 1,320,200,1,1
WINDOW 3, " SimplEel " ,,0,1


REM variables
   'passed around
   ProgName$      : "SimplEel"
   'misc.
   hres%          : WINDOW(2)-1
   hres.d2%       : hres%\2
   vres%          : WINDOW(3)-1
   vres.d2%       : vres%\2
   topclr%        : WINDOW(6)
   z%             : 0
   w%             : 1
   squash%        : 90 : 'Fun one!
   'centering
   holdhGetStart% : hres.d2%
   holdhGetEnd%   : hres.d2%
   holdvGetStart% : vres.d2%
   holdvGetEnd%   : vres.d2%
   'blitter
   row%           : (hres%\16)+2
   CALL GetDepth    (depth%)
   header%        : 3
   blocksize%     : row%*vres%*depth%+header%+1
   DIM block1%      (blocksize%)
ManualWaltgorithm:

  Choices:
    mouStatus% : MOUSE(0)
    IF mouStatus% : w% THEN
      GOSUB ClrScrn
    END IF

  REM Adjust Scope With Squash
    hSquash% : (hres%\squash%)
      hGetStart% : ((hres%-MOUSE(1)-hres.d2%)\hSquash%)
      hGetEnd%   : hGetStart%+hres%
    vSquash% : (vres%\squash%)
      vGetStart% : ((vres%-MOUSE(2)-vres.d2%)\vSquash%)
      vGetEnd%   : vGetStart%+vres%
```

```
REM Do the Eel
   AREA (hres.d2%,vres.d2%)
   AREA ((hGetStart%+hGetEnd%)\2,(vGetStart%+vGetEnd%)\2)
   AREA ((holdhGetStart%+holdhGetEnd%)\2,(holdvGetStart%+holdvGetEnd%)\2)
   AREAFILL 1

REM Get It
   GET (hGetStart%,vGetStart%)-(hGetEnd%,vGetEnd%),block1%

REM Put It
   hPutLength% = (hGetEnd%-hGetStart%)
   hPutEnd%    = hres%-hPutLength%
   vPutLength% = (vGetEnd%-vGetStart%)
   vPutEnd%    = vres%-vPutLength%
   FOR vPuts% = z% TO vPutEnd% STEP vPutLength%
      FOR hPuts% = z% TO hPutEnd% STEP hPutLength%
         PUT (hPuts%,vPuts%),block1%,PSET
      NEXT hPuts%
   NEXT vPuts%

REM Store Previous Position
   holdhGetStart% = hGetStart%
   holdhGetEnd%   = hGetEnd%
   holdvGetStart% = vGetStart%
   holdvGetEnd%   = vGetEnd%

GOTO ManualWallgorithm

END

SUB GetDepth (depth%) STATIC
   REM This is just a utility.
   REM It is not interesting.
   n%      = 2
   depth%  = 1
   nClrs%  = WINDOW(6) + 1
   WHILE n% < nClrs%
      n% = n% * 2
      depth% = depth% + 1
   WEND
END SUB

ClrScrn:
   REM This is just a utility.
   REM It is not interseting.
      '-- determine most common color --
   FOR looop% = z% TO 33
      reg%    = POINT(INT(RND*hres%+w%),INT(RND*vres%+w%))
      IF reg% = topclr%-w% THEN switch% = switch%+w%
      IF reg% = topclr% THEN switch% = switch%-w%
   NEXT
   IF switch% >  z% THEN COLOR topclr%-w%,topclr%
   IF switch% <= z% THEN COLOR topclr%,topclr%-w%
   switch%     = z%
   reg%        = z%
      '-- fill screen with most common color --
   AREA (z%,z%)
   AREA (hres%,z%)
   AREA (hres%,vres%)
   AREA (z%,vres%)
   AREAFILL 0
      '-- fill the buffers --
   GET (z%,z%)-(hres%,vres%),block1%
   PUT (z%-hres.d2%,z%-ves.d2),block1%,PSET
   PUT (hres.d2%,vres.d2%),block1%,PSET
   PUT (z%-hres.d2%,vres.d2%),block1%,PSET
   PUT (hres.d2%,z%-vres.d2%),block1%,PSET
RETURN
```

Affectionate Technology[1]

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Abstract
There are four main areas I will touch on in this paper: In PART 1, I will give brief introduction to my current work as a high-tech artist as well as explain what motivated me to get involved in this area. In PART 2, I will introduce the thesis that the way our culture views technology[1] is in many, ways very biased, and that this bias strongly affects the use made of technology, and in particular, inhibits its integration with the arts & humanities. In PART 3, I will discuss some of the reasons why I think it's important that we attempt such an integration. In PART 4, I will share some perspectives- on why I think the development of high-tech artworks is uniquely suited to facilitate this integration.

In closing, I will try to insure that this paper has a happy ending.

PART 1
My Own Work

I am currently in the process of designing and engineering 3-dimensional computer controlled[2] kinetic sculptures which have enough flexibility in their motions, and/or physical appearance, that one can reasonably think of composing for them.[3] Thus, one could think of them as visual analogs for musical instruments. Alternatively, one could think of them as non-human dance troupes that can be choreographed. (One of the images I enjoy thinking about is that of a stage filled with all different flavors of visual instruments; thus one could have a visual symphony - perhaps performed by the deaf.)

I got into this whole area for a couple of reasons: First, most of the high-tech art I had seen tended to be either technically sophisticated but artistically naive, or artistically sophisticated but technically naive. Since it seemed obvious to me that a better balance between these two extremes would naturally lead to wonderful "living sculptures", I was excited by the opportunities I saw in this area.

Second, I was miserable at always having to <u>choose</u> between entering environments which were technically sophisticated, innovative and alive, but emotionally and relationally naive, or entering environments which were emotionally and relationally sophisticated, innovative and alive, but technically naive - it seemed impossible to find work which was deeply rewarding in both these areas simultaneously. Designing and building "living sculptures" has given me one of the few opportunities I have ever had in my life where my understanding of physics, electronics, and computer systems, and my understanding of human emotional dynamics each contributed equally to the success of the final "product".

It has been meaningful and touching to see that artworks which incorporate many of the pieces of life I value, appeal so broadly to other people of all ages and all professions - ranging from professors of

NOTE: This paper was presented at the 1990 *Direction and Implications of Advanced Computing* (DIAC-90) conference held in Cambridge Massachusetts and organized by the *Computer Professionals* for *Social Responsibility* (CPSR). The DIAC Proceedings will be published by Ablex. An earlier and less extensive version of this paper was presented at the 1990 *College Art Association* National Conference in NYC.

computer science, to street kids who dance, to art therapists. Exhibiting my work has also provided an occasion for computer scientists, street dancers, and artists to talk with one another - an occurrence which in itself I think highly valuable. The whole project has been very exciting, and has reinforced my feeling that the world could use more bridges between art and engineering.

Part 2 The Affectionate Side Of Technology

In this part of the paper I will try to highlight certain biases I see present in the way technology is currently viewed, biases which greatly inhibit technology's integration with the arts and humanities. Essentially, the point I wish to make is that technology can be a medium of emotional expression just like painting, dance, theater, or writing can be; that technology need not be used only for making tools, and for extending our intellectual capabilities, but can equally well be used for extending our empathy and compassion, increasing our emotional understanding of ourselves, and generally adding a richness and physical beauty to our lives. In other words, I wish to claim that technology is a true art form.

I further wish to show that the extent to which our current technology is cold and emotionally sterile is attributable more to our cultural biases than to anything intrinsic to the technology itself.

To begin, I would like to discuss some technological devices that are available now, that are almost exclusively being used for emotionally sterile purposes, but that with a slight change in orientation could be central elements in an emotionally and visually rich artwork.

*

First, let us consider robots: Frequently in robot design, high speed repeatable motions, accurate to within (say) 1/1000 of an inch, are considered highly desirable and part of the aesthetic which defines success. This is reasonable because these robots are used to assemble objects where exact positioning and speed of assembly is critical. What the robots are not frequently engineered for is grace of motion - no one funds *grace*.

We have the necessary skills, right now, to build extremely graceful robots; all we would have to do is change the perspective. The problem is that very few people engineering robots have grace of motion as the governing aesthetic (particularly since there tends to be a tradeoff between achieving repeatability and achieving grace). Thus, we have lots of robots around that can repeat their motions accurately, but are clunky and not graceful to watch.

I would like to highlight how, in a certain sense, the aesthetic governing robot design is "inhuman". Consider the sentence "I fell in love with her/his grace." It is a plausible sentence which sounds reasonable to the ear; on the other hand, the sentence "I fell in love with her/his repeatability" is ludicrous - no one cares.

The point I'm trying to make here is that the aesthetic which defines a "good" robot is not a human, emotional, relational aesthetic and if we merely changed our aesthetic, we could be surrounded with "robot art" whose grace was stunning.

*

Second, let us consider computers: There exist chess programs now that can beat all but the best human players; there also exist what are called Expert Systems that assist in diagnosing certain diseases. These things are important; chess programs are intellectually rich and diagnostic Expert Systems may save your life. However, neither of these structures is emotionally rich. Why, for example, have we chosen to write programs. which evidence a "human-like" skill at playing chess, but not programs which evidence a "human-like" desire to play chess in the first place? Why are we not surrounded by programs which are lousy at playing chess, but which (seem to) care about playing a great deal, and express extreme distress if they don't get a chance to play?[4]

Computers are rarely programmed to behave in a playful fashion, or in fact in any fashion which would cause you to enjoy their company and emotionally bond with them. Again, emotional issues such as these are not generally the primary goal of the programmers. Why, I wonder, do we not have operating systems whose primary design goal is to convey to the user the collective sense of humor of the software engineers who implemented it, with issues like speed of response, device independence etc. being secondary?

On a humorous, but nevertheless significant note: A friend of mine created a computer "character"[5] which you could converse with in written English. One of the things he found that was crucial to making it seem human was that it not listen to you very carefully. It had its own agenda and invariably it would bring the conversation back around to, say, its sick grandmother living in Arkansas. No matter what you talked about, eventually the grandmother that lived in Arkansas came up. It' is rare that computer scientists have not-listening as a design goal - but it is a human characteristic.

***

To give a contrast to the typical state of affairs - when my sculpture *Dancing Trees* was reviewed in the Boston Globe Magazine, the reviewer, Mopsy Strange Kennedy, wrote:

The iron clumps, with amazing anthropomorphic aplomb, begin to shiver, to plump up narcissistically, to swoon toward one another, to receive the computerized wind like gracefully moving wheat.

Now, the reason I'm bringing this in, is that this is not a typical review of a new high-tech development. It is not typical simply because few high-tech objects were designed to "plump narcissistically". Mine *was* designed to plump narcissistically. I don't mean that literally, but rather, I mean that it was designed to "plump narcissistically" as well as "plump aggressively" as well as "swish petulantly" etc. That is, it was designed to be emotionally evocative. That was its design goal; when a particular implementation failed at that, I threw it out and tried something else.

Now, if our technological society chose "plumping narcissistically" as its *general* design goal, then we would have all kinds of high-tech devices plumping away - your toaster might burn the toast, but damn if it didn't plump! Similarly, your word processor might not do such a great a job at checking the spelling, but it would sure as hell convey the image of plumping. It's all a matter of priority.

If we, as *a culture,* chose[6] , we could be surrounded by relationally rich and visually fascinating high-tech artworks, spanning a wide range of visual appearance and *personality.*

We have the technology, right now, to implement a device which would be sensitive (and potentially responsive) to one's mood. The very same pattern recognition technology that is *currently* used to identify characters on a printed page could be modified to detect sadness, joy, or anger in the human face; the same acoustic recognition technology that the military uses to identify submarines and aircraft by the sounds of their engine could be used to detect these selfsame emotional states from tonal qualities of the human voice.

One fact that tends to impede progress in this area is that the computer science and artificial intelligence community tends to focus on extending the head, the intellect down, as opposed to extending the heart, or loins up.[7] It's a question of where you start. Eventually we may get *emotionally* interesting objects by making them smarter and smarter and smarter and smarter, but it's a damn long path, and we already have the ability to make things that are truly emotionally rich right now; we don't have to wait until it happens by what I think is a quite roundabout path.

I would like, for contrast to the intellect extending paradigm, to bring in dogs. I grew up with Golden Retrievers. Now, Golden Retrievers can't play chess very well, nor are they very good at diagnosing diseases. However, they are playful, responsive to your moods, beautiful to watch, and I consider them works of art and important additions to *our* world.

In addition, dogs know (at least the Golden Retrievers I grew up with knew) when a joke has been told. The way that they know a joke has been told is not by analyzing the words for meaning (as some members of the Artificial Intelligence community focus on) - they know because they pick up the laughter and the body language and the exuberance of the people in the room who have heard the joke.

We have all the technology to do that very same thing as I just mentioned that a Golden Retriever does. Thus, at *least,* we could have a high- tech art object that knew when a joke was told, and that alone would be an interesting thing to play around with!

***

There is one more perspective I would like to introduce before concluding this section. I begin by recalling to you my friend's conversational program *Racter*, and noting that its strikingly life-like quality was a direct consequence of its *having its* own *agenda*. This brings me to a very important' point, and that is, that our technology has almost exclusively been used for tool building.

The consequences of this cannot be stressed enough, for tools are by their very nature passive. They are designed to do nothing but what they are directed to do by the user. That is, they are designed to be extensions of our autonomy. (You do not want a hammer that refuses to hit the nail because it doesn't want to; you want a hammer that just hits the nail.) It is not surprising, therefore, that it is of no interest to "get to know" a tool -there is nothing there to get to know; no sense of autonomy, no hopes, dreams, fears etc.

I think this period of history provides us with a. unique opportunity, through the advent of computers, to create devices with enough flexibility (including the potential for self modification and learning), that the label "tool" is at best incomplete. I must say I sincerely hope that computers do not continue to be used so predominantly for implementing intellectual tools, for if they continue to be so used, they will remain, in certain profound ways, emotionally lifeless, cold and sterile, which I think will be very sad.[8] It's time we free computers[9] to act as central elements in creations who, like us, are both beautiful and playful - I think people are one of the highest art forms around, and really neat.[10]

***

To conclude, in this section I have tried to introduce an image of a world in which the high-tech objects in our environment are visually striking, radiate emotional accessibility, and contribute to a general feeling of warmth. I also hope to have made clear that the changes I envision do not require advances in technology so much as an alteration in people's orientation - in other words, what I am presenting might be *emotional* and *social* fiction, but is not *science* fiction.

PART 3
Why All This Is Important

The first image that comes to my mind when I think of why all this is important is that of a human face expressing enchantment, calm, and satisfaction. In other words, the real reason why all this is important is because of the effect it has on people.

I have shown my work around the world, and have had the privilege to watch people's faces as they experience my piece and others. The expressions people have watching *Dancing Trees* sometimes remind me of that parents have watching their child walk for the first time; it is a combination of joy, satisfaction, and mild incredulity. More interactive pieces (created by other high-tech artists) tend to engender expressions that initially consist of caution and exploration, and then rapidly extend to include wonder and joy.

Bringing audiences great joy is reason enough, I think, to pursue this area.[11] However, there are other reasons to support this work aside from audience enjoyment - reasons directly related to the concerns of computer professionals, and in particular, computer professionals worried about the directions computing and other technologies are heading.

***

Recall if you will PART I of this paper wherein I described my despair at finding environments (and tasks) which were simultaneously technically and emotionally rewarding. Unfortunately, having spoken to many many people, I have found myself far from alone in this despair. Generally, the people who care deeply about both technical research and emotional exploration are either unhappy or have managed to split their lives into two relatively distinct parts: one that satisfies their emotional and relational needs, and another that satisfies their intellectual and analytical needs.

There are many people who understandably find this type of split lifestyle both unpleasant and rather difficult to arrange in practice.[12] Therefore, engaging in activities which naturally form bridges between the different worlds is likely to positively impact the lives of these people. Creating high-tech art is one particularly effective activity in this regard (more on this in PART 4), and thus it is not only the audience that benefits from high-tech art, but also the computer programmers and engineers who spend their lives developing it.

***

Let us focus next on some more subtle consequences of the above mentioned split, particularly as it impacts the very content itself of high-tech research. In order to do this, I feel the need to reiterate how really pronounced is this split. It is so extreme that it is a frequent occurrence for people to think I am slightly crazy (or at least a romantic dreamer) for even trying to combine, in one activity, technological research and emotional exploration![13] Our society, for some reason, views these activities as mutually exclusive. Unfortunately, because of this (in my opinion completely unfounded) point of view, people who highly value and enjoy emotional exploration tend to avoid working in areas such as computer science.

The consequences of this cannot be over-stressed. To begin with, the situation is dangerously self-perpetuating. What I mean by this is that the more emotionally sterile and intellectually focused high-tech development environments become, the more the devices engineered (programmed) therein will be intellectually sophisticated and emotionally simplistic. The proliferation of such devices throughout our society will then contribute to the already rampant belief that technology is suitable only for addressing the "physical", "practical", and "computational" needs of people, and is virtually useless for addressing their emotional needs. This will then lead to high-tech development environments attracting only those people who rate the practical/physical significantly above the emotional/relational etc.

The negative consequences of this self-reinforcing and unhealthy rift between technical research/sensitivity and emotional exploration/sensitivity are already clearly visible in areas both concrete and abstract. To give a concrete example: In contrast to the astronomical amount of money and research put into developing high-tech medical equipment engineered to keep people *physically* healthy - artificial hearts, dialysis machines etc., virtually no one has built sophisticated high-tech devices to address the feelings of fear, isolation, and simple boredom that frequently accompany a hospital stay.[14]

*

On a more subtle note: I occasionally encounter people who react negatively or with reservation to the idea of developing creations with extremely life-like qualities and onto which human beings would undoubtedly project. This reaction seems to imply that these people feel such creations are not already prevalent (and highly valued) in our culture. I find this quite interesting:

Let us consider novels for a moment: Perhaps the highest praise one can give a novel is to say that the characters "seemed real" and "came alive". The whole purpose of a novel is to take one into a fictitious world, in comparison to which the real world recedes into the background. Yet few people actively debate whether it is ethical or prudent to have novels loose in our culture. Puppet shows and stage dramas are similarly engineered to create, by simulating human behavior, an "illusion" onto which people strongly project emotionally, and yet such art forms are all tacitly accepted as healthy and important.

Because of the omnipresent association of the technological with the cerebral and artistic with the emotional, debates over whether it is desirable or prudent to create objects which simulate life-like behavior are not even being held in the right arena. We *already are* creating objects and structures which simulate life-like behavior. The significant thing to notice is that technocrats tend to create objects/structures which simulate people's cerebral and computational aspects[15] and artists tend to create objects/structures which simulate people's emotional and relational aspects — and that is the primary thesis of this paper.

***

Now, all that we have been talking about might not be so important if we were discussing, say, building sand castles.[16] First off, there is only a small fraction of our population regularly involved in building sand castles, and so if the. working conditions are not ideal - well that might not be so terrible. However, in the case of creating technological devices/computer programs, a significant fraction of our culture is involved in their design and implementation (and an even larger fraction is directly impacted by their use).

Second, creating sand castles does not give the builder access to the kind of power that can, on the one side, greatly enrich our lives or, on the other side, wipe life off the face of this planet. So, if it turns out that the environments in which sand castles are built are a bit particular, and this particularity results in the creation of a rather narrow genre of sand castles - well, so what. However, in the case of creating high-tech devices/systems, the builders do get access to just such power.

***

To conclude this section: In my opinion, unless we start building objects which embody a more even balance between emotional/relational sophistication and intellectual/computational sophistication[17], we will head further and further down the road toward the creation of amoral juggernauts.[18]

PART 4
Why Developing Hi-Tech Art Might Help

I believe the. high-tech art development process itself to be very healthy, for it engages, in a necessarily integrated way, the emotional sensitivity and technical expertise of the human designer.

In addition, I project that the presence of high-tech artworks in our society will help counteract the current tendency of people, who choose to devote their life to emotional exploration and developing relationships, to avoid entering research areas such as computer science. This would be good.

***

I would like to articulate and explain further these two perspectives, both of which come in part out of my own personal experience. Let me begin by describing my own high-tech art development process:

When I work either on designing physical systems or on choreographing (programming) these systems to enact dances and dramas, I hold in my mind a human face. I then imagine what expressions I would like to elicit on that face, and what emotions would need to be evoked to prompt such expressions. I then fantasize various high-tech art mediums whose visual appearance and personality might elicit such an emotion. Then, while holding the image of this as yet unbuilt high-tech art medium clearly in front of me, I carefully examine my own emotional response to this fantasy creation as it runs through dramas in my mind. If I like what I *feel*, and the art medium seems sufficiently rich and flexible, I then start *intellectually* examining concrete implementation issues, such as the state of artificial intelligence, the availability of large sensor arrays, the construction time, the cooling requirements, the overall cost etc. If after all this, things appear practical, I then build a small test model - a process which invariable involves solving many concrete technical problems. I then examine my emotional response to this concrete embodiment, hoping for the best...[19]

One significant and rather unusual feature of this high-tech design cycle is that human emotional response is *never* put into the background - it is intimately coupled to the design process; all the hundreds of thought/feeling experiments act to integrate the analytic and the emotional.[20] I contrast this explicitly to many computer programming projects where, while there usually is an intimate bond formed between the computer programmer and the computer, the governing aesthetic is often determined more by the relationship between the programmer's intellect, the computer hardware, and design goal of (say) speed, than by the human feelings of play, sensuality, and compassion.

***

I would like to focus next on the effect that seeing such high-tech artworks has on the general public:

One feature, and in my opinion a very wonderful one, of good high-tech art, is that the feeling (if not always all the thought) that went into it is as immediately comprehensible to a child as to an adult, and as meaningful to an art therapist as to a computer scientist. Thus, one's work naturally acts as a common bond between diverse groups, for it is something to which they can both immediately relate. Furthermore, since a high-tech art development project benefits equally from the skills of computer programmer and those of a psychotherapist, it is one of those rare and wonderful situations where two such different types of people are each given the opportunity to feel competent and be active contributors towards a jointly valued goal.

Another feature of this type of art is that it portrays technology being used in an emotionally rich and accessible manner. Thus, young people and others) who are *particularly* focused on emotional issues and relationships, will not be given such a stark message that a career in technology mandates putting into the background their central concerns.[21] I would hope, therefore, that exhibiting high-tech art would induce more emotional and relationally focused people to enter careers in engineering.

***

One more reason to support high-tech art: A common path taken by engineers who feel alienated by their experience in engineering environments, is to step back and become policy makers, science advisors/writers etc. I think this is a good solution for some to adopt; but we also need such people to remain involved in the day-to-day technical tasks as well, in order that they change the very essence of what constitutes hard engineering. Developing high-tech art presents many real problem' in hard engineering, yet is an activity which might nevertheless appeal to such people. This would be good.

And finally, on a related note, if we can succeed in changing the values surrounding high-tech development "from the bottom up - from the inside out", as the integration I have been suggesting would lead to, then we may reduce the need to pass formal legislation restricting technology's use. This would be good, for it woul.d alleviate the resentment people invariably feel whenever laws restrict their possible range of actions (as well as help avoid all kinds of lengthy legal battles).

The Happy Ending

I would like to end this paper with some hopeful notes: First, developing high-tech art presents, in my opinion, one of the relatively few engineering opportunities where the resultant devices can compete in sparkle and flash with devices developed by the military. This is good.

Second, because relatively little time and money has been devoted toward the serious development of high-tech art, one can make significant contributions in this area if one can remove from one's perspective certain profound biases.

Third, we are right at the forefront of an exciting revolution in micro-engineering. This revolution will make possible and economical the creation of sculptures with hundreds of thousands of (computer controlled) moving elements.[22] Thus, we will (soon?) be able to have full computer control of the texture, color, light reflectivity properties, and overall shape of three dimensional sculptures.

And finally, for the process of evaluating our high—tech art creations, I am pleased to note that each and every one of us is integrally equipped with the finest and most sophisticated testing and quality control feedback system in the world - that of our own emotional responses.

> There is so much to talk about and to build - let us begin...[23]

Footnotes

1 While I frequently speak about technology in general, I feel that computers are unique in their ability to support rich and potentially self modifying structures, and without them much of what I envision would be impossible.

2 Or, when they are being played in real-time by someone, "computer facilitated".

3 One of these sculptures is composed of iron powder in a computer controlled magnetic field; it is this "living landscape", (sometimes called *Dancing Trees*), that is referred to in the Globe Magazine excerpt quoted later in this paper.

4 I suggest, if you think this a wild example, to consider the purpose and the tasks involved in creating fictitious but richly evocative characters in novels, theater, or dance...

5 "Racter", created by Tom Etter.

6 We can not do this on an individual basis because it is too expensive and too difficult.

7. Of course economics (via the consumer market and the military etc.) strongly affects the direction technology takes as well.

8. One explanation, I believe, for the current state of affairs is that the scientific tradition has given high-tech development environments a legacy in which navigation via emotional reaction is *explicitly* relegated to second place behind navigation via formal analysis. Adhering to this navigational directive is, in my opinion, gaining our culture incredible advancements in science & technology while simultaneously crippling our ability to decide what aspects of this very same science & technology are meaningful to us.

9. We have to come up with some name other than, "computer" - it is too narrow a label. Perhaps "extender" or "facilitator"?

10. On a slight aside: I think there is reason to believe that in the future we will adopt a somewhat parental role toward our (high-tech) artworks, and it is of interest to note in this regard that Daniel Hillis, the designer of one of the more powerful computers in the world today (THE CONNECTION MACHINE), has as a design goal to make a computer that is "proud of him".

11. We are discussing an art medium that is rich almost beyond dream, for it will permit joining, in a single creation, the relational sophistication of a novel, the emotional richness of a symphony, the physical beauty of a sculpture, and the immediacy, playfulness, and audience responsiveness of a street performer.

12. The problem has some similarity to that of finding a mate: Getting involved simultaneously with two people, one emotionally warm but intellectually uninteresting, and the other intellectually challenging but emotionally cold is a solution neither satisfactory nor straightforward to navigate...

13. It is interesting to notice that people I speak with generally fall into one of two rather distinct groups: The "artists" who readily accept the importance of emotional expression, but who don't believe technology is well suited for this; and the "technocrats" who readily grant that the technology could implement the creations I envision, but don't really see the point...

14. Solutions to this isolation problem could range from beautiful and relationally focused high-tech artworks to sophisticated Virtual Reality/ Tele-Presence systems. (Such systems could permit the sick individual, while *physically* still in their hospital room, to nevertheless be in intimate daily contact with their family and friends and, in many respects, make them feel as if they were actually at home.)

15. Technological environments have already produced untold numbers of objects with extraordinarily human-like behavior: If a creature which points out spelling errors in your text or plays chess is not "human-like" in its behavior, I sure don't know what is!

16. I sincerely hope I do not offend any sand castle builders in the audience!

17. Which would seem only to make common sense; this is, after all, what we would want in a friend or mate...

18. I refer here both to potential high-tech devices/systems and to the culture and environment surrounding their development.

19. I sometimes get stuck and find the need to back up, think carefully, and talk to my friends, in order to form more general models of how people emotionally respond to entities (both animate and inanimate) in their environment. I find that process to be extremely interesting on an intellectual as well as on an emotional level.

20. It is encouraging to note that developing and showing my art has been as effective at enhancing my human relationships as it has at increasing my understanding of (say) real-time process control.

21. Unfortunately, our educational institutions (along with the rest of the world) frequently do give the message, if only implicitly, that a career in engineering does require a lessening of focus on these emotional dynamics. Imagine how much poorer our world would be if writing courses restricted their discussion to the shear-strength of book bindings...

22. They have already made electric motors so small that something like 60,000 of them fit on a 1 square inch piece of material, and research in this area is proceeding forward at a furious pace.

23. There are three books I would like to suggest whose subjects, when combined together, can lead to a vision of a whole new world. These books are:

The Engines of Creation by K. Eric Drexler (Anchor Press/Doubleday): which is a comprehensive summary on the potential for what I was referring to as "micro-engineering".

Vehicles by Valentino Braitenberg (The MIT Press): He is a neuroanatomist who has conceptualized a variety of simple mechanical "vehicles" which exhibit strikingly life-like behavior.

Reflections on Gender and Science by Evelyn Fox Keller (Yale University Press): which discusses possible gender biases inherent in the manner in which we view and practice science ('and thus, engineering). This book also contrasts, explicitly, cultural stereotypes of artists "vs" engineers. (It might be appropriate to note here that I consider myself a *Feminist Engineer*, and my business card lists my title as such.)

I am including this brief work to further define the term Feminist Engineering.

Appendix

A brief introduction to Feminist Engineering[a]

To begin, I think it makes sense to define feminism: The feminist movement includes, it seems to me, an attempt to shed light on some very deep seated biases in our culture - specifically, those biases associated with and correlated to gender. It is also a movement which, at times, gives serious thought to the *consequences* of such biases. The resulting insight and clarity of vision is then used to highlight and to change inequalities and general lopsidedness in the relationship between the individual and all elements in the individual's environment.[b]

It is not too uncommon to hear discussions considering the effects of such biases on the individual's internal experience of themselves and of the surrounding world. What is uncommon, is to hear discussions considering the effects of such biases on the actual designs and implementations of the (generally man-made) technological devices which surround us.

And finally, what is even more uncommon, is to encounter individuals who have chosen to devote a significant fraction of their lifetime to engineering new high-tech creations of a flavor consistent with and resulting from the unique perspective feminism brings to bear. It is this that for me defines the activities of a Feminist Engineer.

I have up to this point been extremely abstract. The attached paper, entitled Affectionate Technology includes many discussions, along with concrete technical examples, of the above perspective.

The women's movement has written extensively about the difficulty women have had being promoted into upper level executive positions. One of the reasons cited for this difficulty was that women (as compared to men) tended to be quite personal and emotionally expressive, and to *value* being personal and emotionally expressive, in their dealings with individuals in their organization and in others. This was frequently considered inappropriate behavior by the in-place upper level executives doing the prosoting.[c]

The generally recognized consequence of this is that persons (male and female) who are very personal in their interactions and who put a high priority on emotionally expressiveness are less likely to be promoted.

However, it follows just as immediately from the above that upper level executives must devalue emotional expressiveness in the work place - and what is <u>not</u> generally recognized is that this implies that the chance of these selfsame executives choosing to initiate a long term, expensive, and labor intensive high-tech research and development project, whose primary purpose is to develop tools to facilitate intimacy and devices to *emotionally* enrich the lives of the user, is virtually zero... again, it is this type of R&D project that would interest a feminist engineer.

I leave you with a (rhetorical) question: How many engineering classes have you taken (or even heard of) where the professor begins the lecture with a sentence like "Today we are going to discuss technologies well suited for conveying sadness?"

Footnotes

a. Others may have their own definition - what you read here is an introduction to mine. (I will note at the outset that I consider myself a feminist engineer.) and no, the phrase doesn' t refer to engineering feminists!

b. Elements in this environment typically discussed include: the spouse, the employer, the legal system, the educational system, etc.

c. This response tends to be particularly acute in engineering environments, where emotional reaction is explicitly relegated to second place behind technical analysis.

A Guide to 3-D Surface Acquisition

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Abstract

Vision systems that sense in three dimensions are described. A simple application of the venerable light pen interface is used to quantize video signals. Stereoscopic and triangulation range finding are discussed in active and passive modes of illumination. A novel method of diffraction range finding is introduced.

Introduction

While three-dimensional modeling programs have become ubiquitous in computer graphics, 3-D vision systems remain esoteric peripherals. This imbalance between processing power and user interfaces has caused a bottleneck between the real world and the computer, limiting artists to a vocabulary of mathematical and hand-formed 3-D images. When camera recording is needed, the input is invariably two-dimensional.

Back when the breakthrough from black and white to color was investigated for photography and video, an assumption was made that three different monochrome images could be used to approximate real-world color. Similarly, the breakthrough to 3-D can be achieved by adding another channel of information to the well-known 2-D data stream. This second channel is the offset of a second view angle. The technology is often referred to as triangulation range finding.

Although the principle of triangulation is well known, range finding cameras are practically nonexistent. In a world flooded with video cameras, one must wonder why there aren't just a few range finding camera options available to the computer artist. One reason has to do with the difference in function between conventional cameras and range finders. The former is designed to optimize the recording of brightness while the latter primarily records *position.*

Until a new generation of range finding cameras is developed, we home brew, fly-by-the-seat-of-our-pants, shoestring operators will have to make due with the children of Necessity. Here we explore the options of modifying existing video and optical peripherals to give our micros 3-D vision.

Position Tracking

In 1982, Phil Edelstein and I published a SCAN paper on Pantomation, a system for position tracking [1]. A demonstration was presented to ACM SIGGRAPH the same year [2]. The computer architecture for our system was identical to the light pen, but we reversed the source/sensor dimensions.
A light pen uses a photocell which is triggered by the light from a scanned light source, typically a CRT. The photocell is a one dimensional pick-up, and a CRT is a two-dimensional light source.

In Pantomation the light source was a "tag" treated as a one dimensional object, and the sensor was a TV camera, that is, a 2-D scanner. The 1-D light source in Pantomation was any illuminated object which could be video keyed. We used color-encoded objects that were chroma keyed and self-illuminated objects (such as flashlights) that could be luminance keyed. The key source was used in the same manner as the photo-cell trigger is used in any light pen interface. The pulse would latch x-y registers and initiate the transfer of those numerical values to the computer.

The first Pantomation system was built around a PDP 8L, hardly your garden-variety micro. The following year, I introduced an Apple II-based Pantomation system at SCAN [3]. This system improved performance by latching the x values for both entry and exit from a keyed target. The software written by Gustavo Fernandez, Jr. calculated the centroid of the tracked object. This improvement accounted for the fact that in the real world, our "1-D" light source actually had 2-D properties.

Light pen registers have been included as standard features in some micros. The Amiga has "beam position" registers which serve the function of light-pen registers. The original IBM PC's came with graphics cards that had a Motorola CRT controller chip designed to support the light pen. In early IBM color video cards, the light pen toggle input was extended to the video output jack, and Microsoft wrote Basic routines to support it.

However, light pens are no longer popular; they have been nibbled away by mice. Moreover, Pantomation requires video hardware, an expense beyond the scope of low-end computer sales. For most of the past decade, the computer world has been content to march along on a 2-D maze for mice. No one is marketing a low cost 3-D mouse, which I call the flying mouse, *Die Fleidermaus* or the bat. So when playing with 3-D packages, the user must figure out a way to translate 2-D drawings into 3-D images.

3-D Pantomation

Just as 3-D computer graphics are a straight forward extension of the mathematics of 2-D, so Pantomation can be easily converted into a 3-D peripheral. Using alternate field switching, two cameras are used to view a tracked object at different view angles. The offset between the views is a function of the third dimension. If the process is quick enough, the resulting data will seem to be arriving in "real time," although there is a delay on the order of 1/30th of a second.

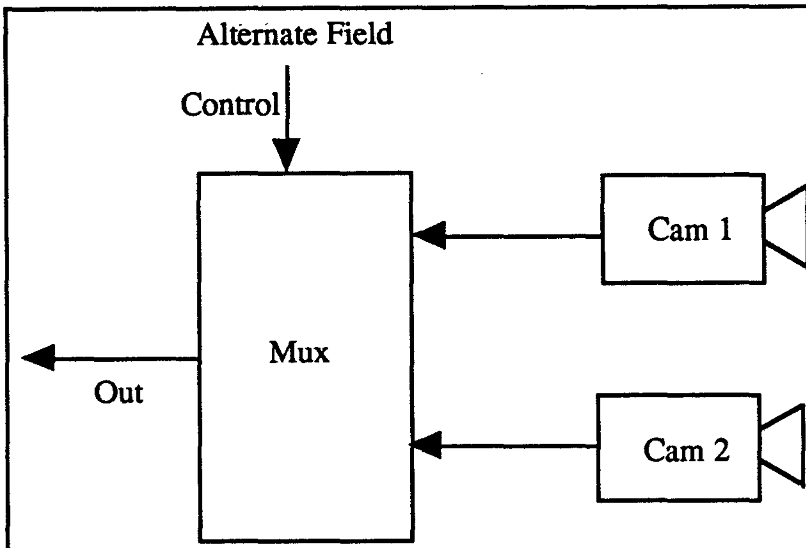

Figure 1. Stereo Camera Switch.
An electronic multiplexer (mux) selects from two cameras on alternate fields of a video frame.

Three-dimensional Pantomation can be achieved by adding a front-end switcher to the light pen interface that selects alternative camera views on sequential video fields (Figure 1). Such electronic switching has become a technical simplicity, since FET transistor switches are a common IC. Doug Lyon of RPI Image Processing Lab and I have built several using the 4066 chip, but today there are many competing products to choose from.

The software supporting 3-D Pantomation must derive depth information by comparing offsets between two views of the same object. If two cameras are placed side by side to achieve stereopsis, we can calculate the range of an object if we know the distance between the cameras, the focal lengths of the camera lenses, and the horizontal offset between the two camera views.

In the simplest case, both cameras stare straight forward and have the same focal length lens (Figure 2). The distance from the baseline between the cameras to an object, z, can be calculated with the equation:

$$z = \frac{bF}{x_1 - x_2}$$

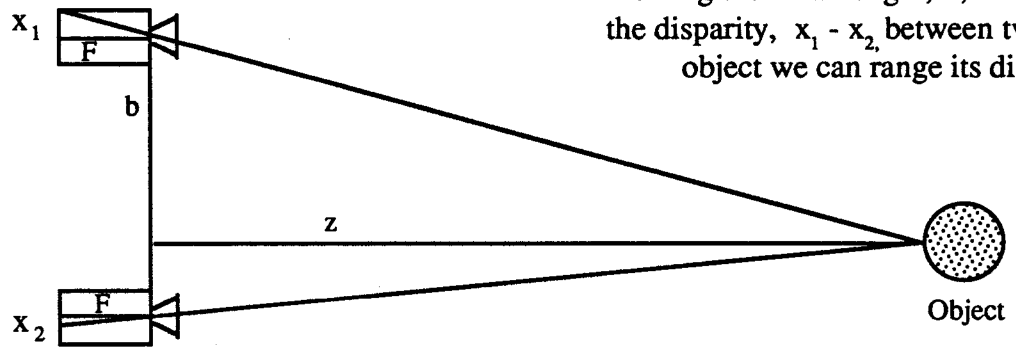

Figure 2. Stereoscopy.
Knowing the focal length, F, of our cameras and the disparity, $x_1 - x_2$, between two views of an object we can range its distance, z.

Where b is the baseline
F is the lens focal length
x_1 and x_2 are horizontal view offsets

This equation reveals important relationships in stereo range finding. Increases in the baseline between cameras or increases in the focal length of the camera lenses will increase the accuracy of the setup. As the offsets approach zero disparity, the range approaches infinity. Moreover, at smaller values of offset, accuracy declines in geometric proportion; in stereo range finding, accuracy is inversely proportional to distance.

Surface Illumination

Pantomation assumes that tracked objects can be discriminated in the field of view by some "tag." Typically, the object has a distinct color that can be chroma keyed, or the target has a high luminance relative to the rest of the scene, such as a hand-held flashlight. Such tags work well for tracking a few points, but acquisition of entire 3-D surfaces presents additional difficulties.

Surfaces can be illuminated "actively" to facilitate the discrimination of position. Such lighting is called structured illumination. If a single source of illumination is created, its angle of incidence on a subject provides triangulation information, much as the second camera does in stereoscopy. The light source replaces the second camera. As illustrated in Figure 3, we know the angle at which the active illumination is projected as well as the displacement of the camera's image of that light. Equation (1) can now be rewritten as:

$$z = b(F/x - \tan a)$$

Where a is the angle of projection
x is horizontal view offset

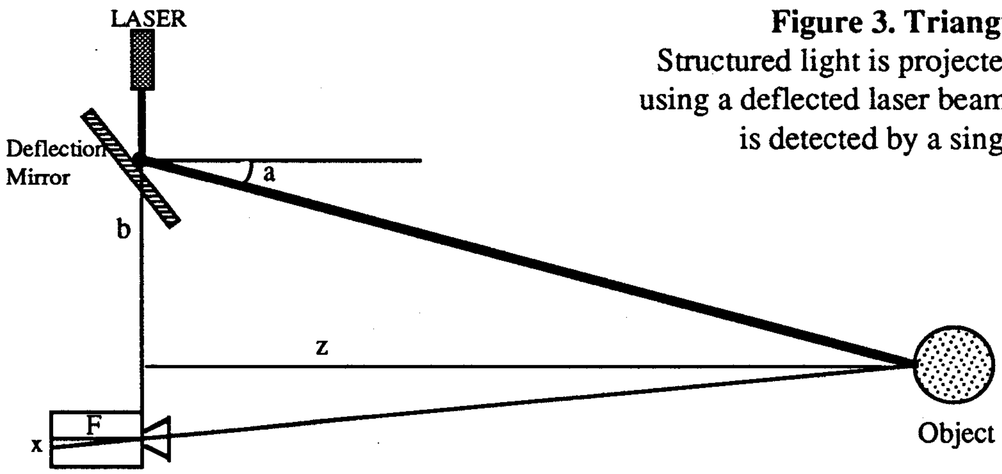

Figure 3. Triangulation.
Structured light is projected onto the object using a deflected laser beam. The disparity, x, is detected by a single camera.

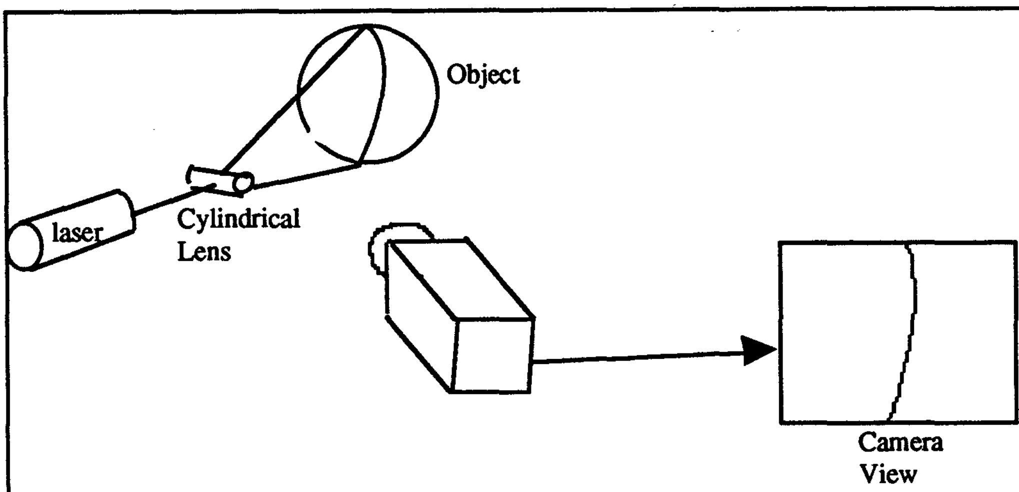

Figure 4. Profile. A sheet of light is project on the object and viewed off axis by a camera.

As with stereoscopy, this equation shows that increases in baseline length will increase ranging accuracy over distance. Also, like stereoscopy, this method of range finding has an accuracy inversely proportional to distance.

Structured illumination works well with Pantomation, because the source illumination provides a tag for each illuminated point of an otherwise passive surface. Moreover, Pantomation can be operated in a "flash" mode to speed up the acquisition process.

If a vertical line is projected onto a surface, as illustrated in Figure 4, each point in the line can be ranged in one video frame. In flash mode, the light pen register portion of Pantomation transfers every tag occurrence to memory. This will be a list of horizontal offsets proportional to the range of the vertical stripe of illuminated points. The maximum rate of acquisition is 63 microseconds per point, that is, the duration of one video line. In one video frame, 480 points can be obtained along the projected line of light. Hence, the acquisition rate is about 1500 points per second.

Delivery of structured illumination to a target surface requires a projection subsystem. Laser projection is one method. In such systems the angle "a" given in Equation (2) can be correlated to a control voltage governing deflection mirrors. This control voltage can be generated by the same computer that is storing the range data. One advantage to this method is that horizontal and vertical coordinates are determined by the projector, and only the range data need be acquired by the sensor system.

If the light source is a laser, it will have a precise color frequency, and the sensor can be band-pass filtered to select only this frequency. Points illuminated by the laser can be visible to the camera regardless of ambient lighting, if the proper color filter is used on the camera.

Where there is no ambient light to interfere with the structured light source, a color encoding scheme can be used. In Rainbow Range Finding [4], the target is lit by a full spectrum wedge from red to blue. Such lighting can be created by passing a white light source through a prism or diffraction grating. If the pickup is a color camera, vertical bands of individual hues can be discriminated by chroma key techniques. These vertical bands are then analyzed by Pantomation in the manner just described for laser stripes.

Problems

Stereoscopic and triangulation systems do have limitations. For some difficulties there are trade-off measures, for others there is no practical compensation.

Since accuracy is inversely proportional to distance and directly proportional to baseline distance, the spacing between the offset views must be increased as range increases to maintain accuracy. This can lead to an awkward layout where the two cameras or the the light source and camera are so distant from each other that it is difficult to move or calibrate them.

Our examples have presumed static camera views. Here is a limitation that no cameraperson has had to endure since the *camera obscura* was the size of a house. As described, the range finding camera would be difficult to reposition, since it would involve synchronization and recalibration.

A change in focal length of the viewing lenses in stereoscopy can be accommodated with a recalculation of the look-up tables used to determine range. However, when long focal lengths are chosen to increase accuracy, there is a corresponding loss of view angle. This limits the volume that can be digitized.

Finally, every triangulation system suffers from occlusions or blind areas. As illustrated in Figure 5, there are potential occlusions in the near field, the far field, and within the field of view itself. If extreme wide angle lenses are used, the near and far field occlusions can be avoided but at the cost of resolution. There is no solution to all cases of occlusion within the field of view, since there can always be obstructions that block one of the two views that make up the triangulation system. However, redundancy of views through multiple cameras can help ameliorate this problem.

Diffraction Range Finding

To address some of the limitations of classical triangulation range finding, I have introduced a new method of range finding based on the use of diffraction gratings [5,6,7,8,9,10]. Diffraction gratings are surfaces covered with regularly ruled lines at a periodicity approaching the frequency of radiant energy incident on the grating.

A diffraction range finder is illustrated in Figure 6. It consists of a single camera and transmission diffraction grating. The diffraction images delivered to the camera will consist of the zero-order image, which is the real image, and a multiplicity of symmetrical higher-order virtual images. These higher-order images are designated as integers, n, and appear at integral steps across the face of the grating in positions that are proportional to range.

The classical diffraction equation is:

$$\sin r + \sin i = \frac{n}{w}p$$

Where r is the perceived angle of diffraction
i is the corresponding incident angle
n is the diffraction order
w is the wave length of light
p is the pitch of the grating

This equation can be rewritten as:

$$z = \frac{xd\sqrt{1 - \left(\frac{nw}{p} - \frac{x}{\sqrt{x^2 + F^2}}\right)^2}}{F\left(\frac{nw}{p} - \frac{x}{\sqrt{x^2 + F^2}}\right)}$$

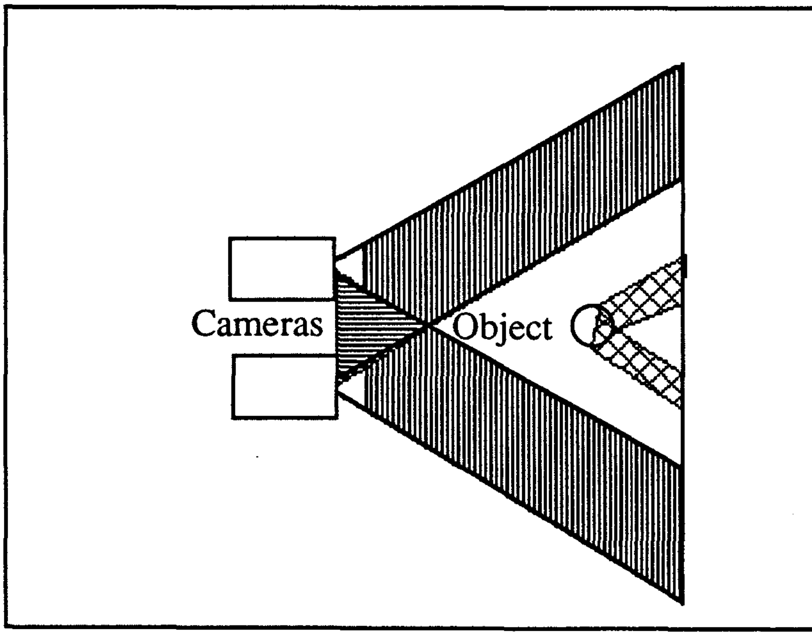

Figure 5. Occlusions.

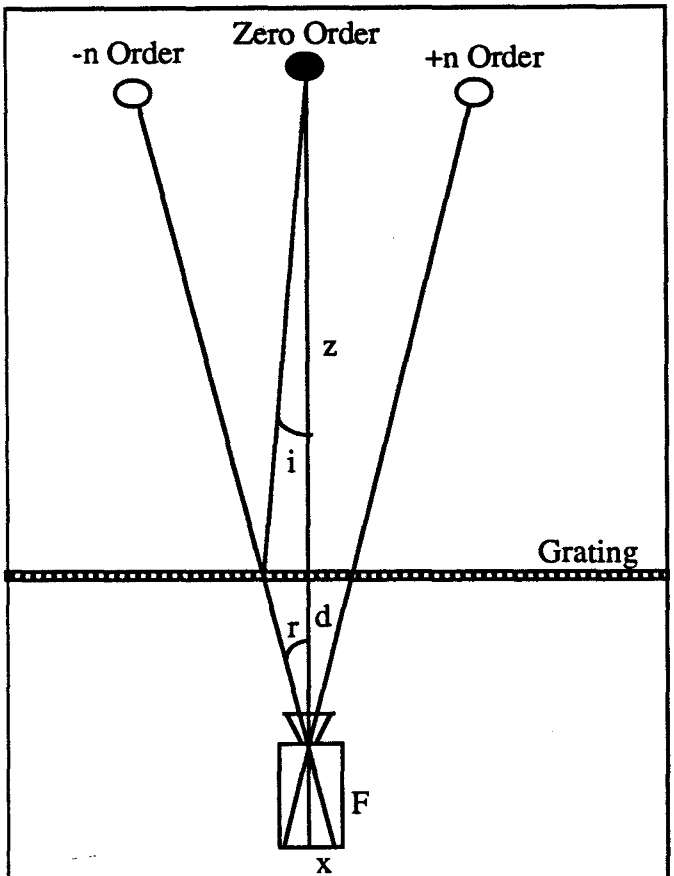

Figure 6. Diffraction Range Finder.

Multiple images of an object appear when viewed through a grating. Their displacement, x,

Where z is the range
x is the horizontal view offset
F is the camera lens focal length
d is the distance from camera to grating

Equation (4) describes the relationship between range and the parameters that can be measured by an optical system running under Pantomation. Admittedly, this is a complicated calculation, but x is the only independent variable. The equation can be used to create a lookup table for real time operations.

The addition of the terms n for diffraction order, p for grating pitch, and w for the wavelength of light opens possibilities for range finder design not encountered in classical triangulation systems.

Diffraction orders are symmetrical in nature. If there is a virtual image on the right, there will be an equally displaced view on the left. This redundancy allows alternative measurements. If one view is occluded by an obstruction, the symmetrical view often is not. A single grating can produce many higher order views, depending on the nature of the grating grooves. Grooves in the form of sine waves produce a single higher order, but parabolic grooves produce a series of odd numbered higher orders. Hence, a single grating can function like many "virtual" cameras, overcoming most occlusions and providing increased accuracy at greater range through the magnifications inherent in the higher order views.

If grating grooves are in a two-dimensional pattern, such as a cross hatch, the virtual images appear in two dimensions, that is, horizontally and vertically. With a sinusoidal groove cross hatch grating capable of only one higher order, eight views are obtained. Circular gratings, as exampled by the grooves of a compact disc, produce an infinite number of views around a perspective center.

As the pitch of a grating approaches the frequency of the light incident on the grating, the angle of diffraction increases. Sensitive range finders with long stand-off distances to their targets can be fabricated with gratings that are carefully matched to a precise illumination frequency, as can be easily achieved with lasers. Such high accuracy gratings can be built with wide angle lens cameras, allowing simultaneous wide field of view and high accuracy.

The color frequency response of gratings has long been used in spectroscopy or to effect decorations. It so happens that the bands of colored light seen through a grating are a proportional measure of distance. A method for creating holograms using ordinary color film has been proposed by one researcher in diffraction phenomena [11]. This method, dubbed holophotography, takes advantage of the fact that the color bands in a higher order diffraction image are the functional equivalent to stereo views. This can be appreciated by viewing a diffraction image through red/blue anaglyph glasses.

A rainbow of variable width appears around each point in a higher order diffraction image. This could provide cues for distance measurement and pattern recognition in sophisticated computer programs. I have not written such programs but predict a pot of gold at the end of this rainbow.

A final benefit of diffraction range finding is that it tracks from infinity to point-of-contact. As we have shown, most triangulation systems have blind areas, and these can only be eliminated by making significant tradeoffs. Since diffraction range finders are essentially monocular, they can be made to dynamically track their structured light systems [12]. Such designs overcome the static view angle limitation endemic to simple triangulation systems.

The Future

Regardless of what range finder is adopted by the artist, the ability to capture 3-D surfaces will change art forever. The analogy to the Renaissance never had greater meaning then when comparing computer art to previous art forms that had limited command of the depth dimension. The formalization of perspective drawing had an impact centuries ago that 3-D imaging will have today. The default standard will become 3-D, and flat art will be regarded as a special effect. Breakthroughs, both literal and figurative, are on the horizon.

To achieve efficient 3-D surface acquisition, new cameras must be developed. The design changes needed to go from the conventional grey scale transducer to an efficient position sensitive device are not very profound. Even with lateral-effect photodiodes, a technology known for over fifty years, special cameras can be constructed with position detection in mind. CCD foundries which now routinely make specialized grey scale sensors could knock out position sensors with extant technology. Depth detection technologies need scrutiny. I have grown tired of hearing people ask, "What have *they* done now," as if there was another race of creatures upon whom we are dependent for our advances in the arts. With our labor as well as our collaboration we can hope to see the technology of 3-D emerge before the end of this decade.

Acknowledgement

Thanks to Doug Lyon of the RPI Image Processing Lab who has assisted me in many ways ranging (no pun intended) from the development of Pantomation to the transmission of this article to SCAN 90.

Endnotes

1. Tom DeWitt and Phil Edelstein, "Pantomation — A System for Position Tracking," *Proceedings of the Second Symposium on Small Computers in the Arts*, 1982, IEEE Computer Society, No. 455, pp 61-70
2. Tom DeWitt, "Pantomation Demonstration," videotape, 10 minutes, 1982, *SIGGRAPH Film and Video Review*, No. 2, Section 9
3. Tom DeWitt, "A Pantomation Interface for the Apple II," *Proceedings of the Third Symposium on Small Computers in the Arts*, 1983, IEEE Computer Society, No.499, pp. 25-29
4. Johji Tajima and Masato Iwakawa, "3-D Data Acquisition by Rainbow Range Finder," 1990, *Proceedings of the Tenth International Conference on Pattern Recognition*, IEEE Computer Society, CH2892, pp. 309-313
5. "Range Finding by Diffraction," U.S. Patent No. 4,678,324, July 7, 1987
6. Tom DeWitt, "Novel methods for the acquisition and display of three-dimensional surfaces," *Optical and Digital Pattern Recognition*, 1987, SPIE, Vol. 754, pp. 55-63
7. Tom DeWitt, "Range Finding with Diffraction Gratings," *Advanced Imaging*, 1988, No. 12, July/August, p. A50 ff.
8. Tom DeWitt, "Diffraction Range Finding for Machine Vision," *Proceedings of Robotics 12/ Vision 88*, 1988, SME, Vol 1, Section 5, pp. 139-150
9. Tom DeWitt, "Rangefinding by the Diffraction Method," *Lasers and Optronics*, 1989, Vol. 8, No. 7, April, pp. 118-124
10. Tom DeWitt, "3D Image Acquisition by Diffraction Profilometry," *Paper Summaries of SPSE's 42nd Annual Conference*, May '89, pp. 51-54
11. Jose J. Lunazzi, "Three-dimensional photography by holography," and "Holography with a diffraction grating," 1990, *Optical Engineering*, Vol. 29, No. 1, pp. 9-18

Note: Issues of this edition of *Optical Engineering* were distributed with a pair of anaglyph glasses to facilitate viewing "holophotographs" that were printed on the cover and in the articles.

12. Tom DeWitt, "Diffraction Range Finder Demonstration", videotape, 1987, 3 minutes, available from the author.

Painting Perceptions

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Abstract
The computer is a multidisciplinary tool engaging all the senses. Creating with color, light, and motion is a rich visual experience enhanced by the vibrations of sound. These vibrations, both light and sound, are absorbed by the viewer and influence his experience. This makes the computer a profoundly powerful tool with which to create experiences - paint perceptions. These perceptions could create unity among people as well as giving them a new appreciation of their diversity or they could seek to divide us further. The purpose of this paper is to underscore the impact of this visual technology and the responsibilities facing the multimedia artist. It develops a philosophy based on a historical perspective that includes Decartes, quantum physics, religion and psychological wholeness.

A Global Perspective

We live in a turbulent time of change and question. Our progress as a culture has been a rational, intellectual affair. This one sided evolution has caused an imbalance. This imbalance is reflected in the mass media; high inflation and unemployment, the energy crisis, a crisis in health care, pollution and other environmental disasters, a rising rate of violence and crime, and so on. These are all facets of the same problem as Fritjof Capra writes in his book The Turning Point, this is essentially a crisis in perception.[1] It arises from the fact that we are trying to apply the concepts of an outdated world view - (the mechanistic world view based on Cartesian, Newtonian science) to a reality that can no longer be understood in terms of these concepts. Classical physics and its reductionist, deterministic view that a whole may be broken down into independent parts and studied and understood separately, no longer can apply.

Today we live in a global interconnected world, in which biological, psychological, social and environmental phenomena are all interdependent. If we do not recognize this then we are living in an unhealthy and dangerous state of denial. We need a more ecological perspective which the Cartesian world view does not offer, a new vision of reality - fundamental changes in our thoughts, perceptions, and values.[2] A shift from the mechanistic to the holistic conception of reality, a shift that can bring about world peace, cooperation and improved conditions to all mankind.

Self awareness can no longer be considered an esoteric luxury for a few educated individuals. It has become a social necessity. We are only beginning to understand the possibilities inherent in mastering the mind, but the challenges of our time call for accelerated learning. Humanity is gaining access to vast reservoirs of undeveloped potential, but unless egoic excesses are curbed by discriminating wisdom we run the risk of destroying ourselves. Perhaps the dilemma is a choice between ego transcendence and biological planetary death. The fact that collective suicide has become a real possibility vividly reflects the struggle between life and death... which is reenacted by the soul on any path. No one is exempt from participation in this human dilemma.[3]

Through modern physics, the study of the unseen world reinforces all of life's interconnectedness. With the advent of systems theory (a holistic interdependence and relatedness of all phenomena) comes a framework, an integrated whole, whose properties cannot be reduced to those of its parts. These concepts can provide the scientific background to the changes in attitude and values that our society so urgently needs. Because our culture is dominated by rational, sensate, logical, linear thought it is much easier to convince our social institutions that the fundamental changes are necessary if we can give our argument a scientific basis. We must modify or even abandon some of our concepts when we expand the realm of our experience, like when you were a kid - giving up your favorite clothes when you grew out of them. It takes time to break the new ones in, to feel comfortable with the room for growth they provide.

These new concepts in science, mainly quantum theory and relativity theory, break new ground and social changes will soon follow. The sixties and seventies brought many changes in this new vision but the first stirrings of it can be found in religion. Buddhism and early Chinese thought addressed the paradoxes of the human condition. The I Ching, the idea of continuous cyclical fluctuation between two archetypal poles, yin and yang, the underlying fundamental rhythm of the universe. It is perhaps difficult for us Westerners to understand that these opposites do not belong to different categories but are extreme poles of a single whole: organic unity. Nothing is only yin or yang; all natural phenomena are manifestations of a continuous oscillation between the two poles, all transitions taking place gradually and in unbroken progression. Therefore the natural order is one of dynamic balance between the two poles.[4] In the Chinese view then there seems to be two kinds of activity - activity in harmony with nature and activity against the natural flow.[5]

The two kinds of activity are closely related to two kinds of knowledge or modes of consciousness recognized as characteristic properties of the human mind throughout time, the intuitive and the rational.[6] The first is related to the mystic or spiritual and the second to science. These two complementary modes of functioning must be balanced to insure the progress of an ever advancing civilization.

For too long now the left hemisphere of our brain, the rational, fragmented, linear, analytic side has dominated our culture. Evidence of this defective world order is all around us. Intuitive knowledge, a right hemisphere function, a direct nonintellectual experience of reality arising in an expanded state of awareness, tends to be holistic and nonlinear.[7]

Current brain research has found that when both the right and left sides of the brain work back and forth on a particular concern synergy is created. Synergy is the act of two things working together to increase each other's effectiveness. The progression of flow between opposite poles, parts of the same whole, each is needed to maintain a dynamic balance, a natural order.

In the mid 1800's the first stirrings of this new paradigm were given a social structure. This world embracing vision made itself apparent in the Baha'i Revelation in Persia. The'Baha'i Faith is the youngest of the world's independent religions. Its founder Baha'u'llah (1817-1892 is regarded as the most recent in the line of Messengers of God that stretches back beyond recorded time and that includes Abraham, Moses, Buddha, Zoroaster, Christ and Mohammad. The central theme of Baha'u'llah's message is that humanity is one single race and that the day has come for its unification in one global society.[8]

> "O Children of Men!
> Know ye not why We created you all from the same dust? That no one should exalt himself over the other. Ponder at all times in your hearts how ye were created. Since We have created you all from one same substance it is incumbent on you to be even as one soul, to walk with the same feet, eat with the same mouth and dwell in the same land, that from your inmost being, by your deeds and actions, the signs of oneness and the essence of detachment may be manifest. Such is my counsel to you, O Concourse of Light! Heed ye this counsel that ye may obtain the fruit of holiness from the tree of wondrous glory".[9]

Baha'u'llah wrote that all the peoples of the world must unite in the realization that they all belong to One Creator and to one household. He taught that there is one God whose successive revelations of His will to humanity have been the chief civilizing force in history. The agents of this process have been the Divine Messengers known to mankind as the founders of separate religious systems. Their common purpose has been to bring the human race to spiritual and moral maturity. Humanity is coming of age. It is this that makes it possible to unify the human family and build a peaceful, global society. Unity is a necessary prerequisite. The following principles of the Baha'i Faith are vital to the achievement of this goal:

* establishment of universal peace upheld by a world federal system.
* abandonment of all forms of prejudice.
* assurance to women of equal opportunity with men.
* elimination of extreme poverty and wealth.
* recognition that true religion is in harmony with reason and the pursuit of scientific knowledge.
* the realization of universal education.
* the responsibility of each person to independently search for truth.
* recognition of the unity and relativity of religious truth.

When we as a race, the human race, finally realize how defective the present world order is we will be own as never before to structures which promote a new vision of reality, a new world order. Eventually by the realization of our own mortality we are impelled to search for transcendence in religion, in art, and in our relationship to the world. We are attracted to what connects us to the whole and to the future.

Structures for world peace upheld by a federalist world government will seek to eliminate prejudice and promote equality of each human being, just as each cell of the body is cared for. Each human being is like a piece in the grand puzzle of humanity. If you back up far enough you can see the whole of humanity.[10] Men and women must be recognized as two wings of a bird in harmonious interdependence of equalness. People will need to learn new modes for communicating - an auxiliary language for all people which allows for interaction and communication yet recognizing the importance of promoting unity while maintaining diversity of each culture. Mankind must accept that there is an essential harmony between science and religion (rational left and intuitive right), that these two modes of thinking must come into balance to achieve wholeness and health of our world. We must recognize that each child has the right to have their basic human needs met, but more than that, they has a right to an education and how important that is to the society as a whole.

In the past we have sought answers to our dilemmas through methods of the old world order. They have failed to provide adequate solutions. Each of us in every field has-a responsibility to help keep the balance, to bring about a new awareness and help the world heal itself. We are at a turning point.

> What ever you do may seem insignificant,
> but it is very important that you do it.[11]
> -Mahatma Gandhi

The Artist as a Communicator

Communication of this new world view, this new world order, is of primary importance. Of all the tools presently available to us, the computer holds the most potential to connect us in one common body of humanity. It can provide an integrated mechanism for global communication. People have already begun from a grass roots level to communicate through networks or 'on-line communities' like Meta network which connects people in the United States. It provides members with continual reports on the latest developments in leadership and management theory, and knowledgeable assessments of breakthroughs in computer communication technology.

Computers make available for the first time structures that can contain and encourage the development of divergent nonlinear thinking. They liberate human energy from some menial tasks. Scientists can now communicate with their colleagues in any part of the world. We can even send a satellite into space and receive data about the corners of our solar system with the aid of computers. Children with learning disabilities or physical disabilities can now participate in a world of learning previously closed to them.

Fax machines, teleconferencing and telepresence shrink the world. Children can visit their local museums in the United States and take part in live telepresence of a robot sub on the bottom of the Mediterranean Sea exploring an ancient shipwreck. Computers with interactive exploring programs are becoming as common in museums as the computer in the grocery store that helps you locate light bulbs, or rings up your order through the bar code, or the automatic teller machine machines that give you access, world wide, to your funds. Computers are bringing our world closer to us in a sense, and we are perhaps beginning to see that we are not really so different from each other on a deeper level.

As science and technology progress they must be balanced by a spiritual consciousness, by an awareness of the dance of eternal connectedness. If we don't achieve this then the outlook for our children will be bleak. Presently the world is unbalanced, the balance of science and religion must be given attention. In thought the rational (scientific) and intuitive (spiritual) are poles of the same whole. Balance is needed for healthy progress as a planet.

Wholeness must be communicated. The role of artists in this age could have dynamic implications. They have the chance to communicate this wholeness, to paint perceptions. Even the act of perceiving alludes to wholeness. Can there be object without viewer? The two create a unit; one cannot be understood without the other.

The Computer as a Tool

The computer can reflect the process of our mind instantaneously before us, a stark look at our own organization. Sherry Turkle, a Harvard psychologist, looks closely at the mind and spirit and how we relate to computers. She makes a distinction between tools and machines." Tools are extensions of their users; machines impose their own rhythm, their rules, on the people who work with them, to the point where it is no longer clear who or what is being used.We work to the rhythms of machines - physical machines or the bureaucratic machinery of corporate structure, "the system". We work at rhythms that we do not experience as our own." [12]

For the artist this is an important realization. We must keep in mind that these computers are tools for us to use and not machines that run us. Questions often arise with those just beginning in the field such as: Do the choices I make come from me solely? And how much influence do they have on the creative process? How much does the computer's part in the synergistic process influence the final outcome?

There is a primary concern over the question of consciousness. When lost in the creative process am I conscious of what I am doing? What do "I" want to accomplish? What vision do "I" want to create? What choices am "I" making? What is "my" philosophy? What if the "I" gets lost? Or am "I" acting as a hollow reed through which the divine creative energy flows?

Some search for a link between who they are and what they have made, between who they are and what they might create, between who they are and what, through intimacy with their own creations they might become. [13] Some are constantly trying to heal the split, to bridge the gap between the "I and Thou", the divine creative energy.

Images speak to man's intuitive side and can radically shape one's perception of the world. Artists can take the opportunity to use the computer, an interdisciplinary studio, capable of images, sound and movement, networking and interactive media to begin in the creation of this new vision we all intuitively know must come about.

The computer is viewed by some as cold, linear and rational, which runs counter to the intuitive nature of the artist. Yet artists who use science and technology, i.e. the computer, feel a sense of complementarity. They are giving birth to a new mode of artistic expression, computer art; one that the art world itself does not yet want to deal with in more than a token avant- garde sense. A computer after all is a box of wires and lights. Work is only given form from human machine interaction. Philosophical questions once again arise. What is art?

The art world presently is having a difficult time accepting computer art as a valid art form. It is definitely well out of the comfort zone for Vivian Raynor, art critic of the New York Times, Bob Reilly of the San Franscisco Museum of Modern Art, and

Harry Rand of the National Museum of Art. All were participants in a panel discussion entitled, "Computer Art The Oxymoron?" at the 1989 Siggraph Convention. Phillip Pearlstein who was also a member of the panel spoke more favorably about it as he showed slides of his experimentation of painting with paint systems.

Just as photography struggled to be recognized as an art form, computer art must go through its own struggle. Forms and avenues of human expression will continue to change just as mankind progresses spiritually and technologically. Direct biological image interfaces (yet undeveloped) might someday even transmit images directly into the viewers' mind.[14] The expression "art" therefore will always be in transition. As a culture we are expanding our limits of thought. Art is thought that finds form. As our thoughts transform so will our art. Kandinsky talks about art that imitates the art of the past and likens it to a stillborn child. We need to ask, what makes us so afraid to move ahead ?

We must expand our consciousness and get a broader picture of how we as people interact with these machines and with each other. We live in a culture that psychologists refer to as narcissistic. We are very much absorbed with ourselves and our immediate family.

> "We are at a state where we are insecure in our understanding of ourselves, and this insecurity breeds a new preoccupation of who we are. We search for ways to see ourselves and our world. The computer is a mirror, a tool that allows us to witness ourselves and interconnect to the world. Beyond its nature as an analytical engine it has a second nature a reflective philosophical provocateur." [15]

In our culture we are coming to interact with the computer in ways that allow us to become intimate with its second nature. As this happens, the connections and relationships between people through machines offers us the long awaited tools to connect the planet; the possibilities of intercultural, interpersonal exchanges. Idea banks, connections with ourselves and connections with others working throughout the world on scientific, cultural, or any area will become possible. Education networks, learning centers, communication systems, and interactive television, can bring to us a depth of knowledge and interactions with others who share our interests and concerns around the world.

Our culture, for the first time in history, has been given a chance to realize its wholeness. We are terrified of being alone, yet afraid of intimacy. We experience widespread feelings of emptiness, of disconnection, of the unreality of self. The computer, a companion without emotional demands, offers a compromise. You can be a loner but never alone. You can interact but never feel vulnerable to another person.[16] We must not allow ourselves to escape, we must take the initiative and the opportunity to connect with each other. The computer can be a connector within our comfort zone. There is a sense of merging with a universal system that appeals to one's sense of wholeness and order. All our ideas about self and ego may be challenged and reformed. The computer as a communication tool could make it possible for humanity to realize its unity.

Perhaps we will begin to catch glimpses of ourselves from a new perspective. No longer will we be the center of the universe but a particle of dust in the vastness of space and time, a single cell in the body of humanity. We are capable of promoting unity and oneness to the whole system of life on the planet, or we can be ambivalent.

> "Every decision chooses the future. You are free to choose the qualities that you want to express in the world, just as you are free to choose beliefs and attitudes that you accept into your mind. If you do not choose consciously the choice is made unconsciously, or it is made for you by someone else. You can reclaim your capacity for choice at any time." [17]

Unity Among Disciplines

Artists are communicators of visions as are scientists, both generating products of their minds. Einstein's Theory of Relativity is no less a work of art than Picasso's Guernica. These visions create new patterns around which human life itself is organized.

Art in this sense is not so different from science. In physics for example there are two kinds of scientists, research and theoretical scientists. One analyzes and the other synthesizes. One takes apart and one puts together. A research scientist dissembles, categorizes and catalogs. A theoretical scientist conducts no experiments. He sees a chaotic variety in scattered parts and puts them together to form a single whole. He creates a theory and tests it through mathematics. They are works of art in and of themselves, pure human creative spirit at work. "The minds of great scientists have been governed by the artist's synthesizing vision."[18]

Mathematicians, especially in the field of generative mathematics are finding they can create aesthetically pleasing images through algebraic equations. Ken and Bonni Evans of Manotick, Ontario, produce images made by manipulating equations founded on a similar principle as fractals, yet unlike fractal in that these images have a greater variety of self replicating spiral tentacles. A single mathematical formula is iterated - the output of the first equation is then reentered as the input to form a new variable for the original equation. Fractals themselves producing interesting images. Yet there is a reluctance to call these aesthetically pleasing images art. It depends on the viewer's perspective. Perhaps art is a window which allows us to see what otherwise we would not see?

In the purest sense of the word, what is art and what isn't is not an issue I have spent time debating. Its my belief that the process of creating for us as human beings is the process of reflecting the creative spirit from a source greater than ourselves. It flows into many media, connecting the fields of philosophy, religion, the sciences, mathematics, art, literature, etc., to each other in the dance of eternal connectedness.Those who cannot recognize the interconnectedness of all things will want to separate, categorize and protect his view of the world. Those who can recognize have no need to - there is a quiet awareness of something greater.

"Works of art and works of science teach us to see. They are the wings that lift us above the chaos of the here and now to a higher standpoint. Whatever is worthwhile in life depends on what they enable us to see, which we would not see otherwise. So all art invests our experience of actuality with meaning that it would not otherwise have. It creates meaning. This meaning over the whole range of art and actuality shapes our individual and collective lives, determines our behavior, provides design for the ever developing civilization by which mind has lifted life above the level of the beasts to such levels of awareness as we associate with divinity."[19]

Just as artists had to rethink their role in the world with the advent of photography, so too, now they must rethink their role as image makers. If aesthetically pleasing images can be generated by scientific visualization of data or mathematical formulas, machines, artificial intelligence etc. then the artist will be left to focus more on the purpose of his work. Work without purpose may be aesthetically pleasing but is it art? Maybe what is left for the artist is complete ego transcendence - to be a mirror with which to reflect the spirit which animates all.

Artists today have opportunities never realized up until this time in history. Not only do the have they chance to lead mankind into a new vision of interconnectedness but they have the tools to do it.

Notes

1. Fritjof Capra, The Turning Point: Science, Society and the Rising Culture, Simon and Schuster, N.Y. 1982 p. 1 5
2. Ibid.,p. 16
3. Francis Vaughan, The Inward Arc, New Science Library, Boston, MA 1986 p.151
4. Fritjof Capra, The Turning Point. Science, Society and the Rising Culture, Simon and Schuster, N.Y. 1982 p. 35
5. Ibid., p. 37
6. Ibid., p. 38
7. Ibid., p. 38
8. Baha'i International Community, Office of Public Information, N.Y. 1989 p.I
9. Baha'u'llah, The Hidden Words of Baha'u'llah, Baha'i Publishing Trust, Wilmette, Illinois, p. 20
10. Wayne Dyer, Transformations, Nightingale Conant, Chicago, 1987, selection from tape 4.
11. Mahatma Gandhi, words attributed to Gandhi in a film on his life, 1983.
12. Sherry Turkle, The Second Self, Computers and the Human Simon and Schuster, New York, 1984, p. 307
13. Ibid., p.12
14. David A. Ross, The Art of David Em, H.N. Abrams, N.Y., 1988, p.10
15. Sherry Turkle, The Second Self, Computers and the Human, p.306
16. Sherry Turkle, The Second Self, Computers and the Human, p.170
17. Sherry Turkle, The Second Self, Computers and the Human, p.154
18. Louis Halle, Out of Chaos, Houghton Muffin, N.Y. 1977, p.583
19. Ibid., p. 619

Bibliography

Brand, Stewart. The Media Lab - Inventing the future at MIT, New York: Viking, 1987

Baha'u'llah, The Hidden Words, Wilmette, Illinois: Baha'i Publishing Trust, 1932.

Capra, Fritjof. The Tao of Physics, Toronto: Bantam Books, 1976.

Capra, Fritjof. The Turning Point, New York: Simon and Schuster, 1982.

Descartes. Discourse on Method and Meditation, New York: Bobbs Merrill Co. Inc.,1960

Ross, David A. The Art of David Em, New York: H.N. Abrams, 1988.

The Use of Cinema in Computer Graphics/Animation Education

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Abstract
The thesis of this paper is that it is useful to teach concepts of cinema in a computer graphics/animation course. While the computer offers new methods of animating and creating images, the mode of expression belongs to cinema. Fundamental concepts of cinema can be incorporated into a course that explores the nature of animated expression and the developing of craftsmanship in traditional and computer animation methods.

Introduction

"Introduction to the Computer in the Visual Arts" is an undergraduate level, five credit hour course taught in the Department of Art Education at the Ohio State University. The course explores the practical and aesthetic implications of image making through the use of interactive graphics software on Amiga computers. The content of the course is based on the use of Deluxe Paint III, Digiview and Pixmate. This choice of software offers a broad area of exploration ;n painting, image processing and animation.

During the 1989-90 academic year the animation capabilities of Deluxe Paint III were taught for the first time. The animation section was scheduled for three weeks at the end of the quarter. It became my goal to teach this part of the course infused with concepts from traditional animation and cinema. A strong conceptual base would encourage students to explore animating with the computer as a way of expression, as opposed to finding animation tricks that look interesting or complex but have little or no expressive content.

Experimentation with the software revealed several approaches to animation. Each approach seemed to facilitate certain kinds of motion. Demonstrating these approaches became a way to provide technical information while showing a visual example of its creative potential. Viewing and discussion of a variety of animated pieces gave examples of "principles of animation" (THOMAS, JOHNSTON, p. 15) and cinematic concepts at work in animated films. Looking at animated sequences frame by frame shows the exaggerated distortions an animator will use to achieve expressive motion.

The three week time-span allowed for several points at which students would get feedback on their work in progress. The first part of the assignment was to animate a 30 frame sequence as a way of warming up to methods of animating and qualities of motion. Next, storyboards were presented and discussed in class. In addition to the storyboard, students wrote an outline of the processes to be used in creating the piece. The remaining class time for those three weeks became studio time, with much creative and technical problem solving on a one on one basis and as a group.

Observing Motion

The most important skill in animation is an understanding of different qualities of motion. The motions of physical objects in the world, as the basis for observation, do not necessarily determine the subject of the motion. We can observe the way a piece of paper is tossed about by the wind and apply that motion to a baby bird in flight for the first time. We have the impression of a piece of paper, yet with the bird as subject we empathize with the way it is blown about, out of control. For animators, the study of natural motion in the environment is like the study of the figure in an academic fine arts setting.

The practice of studying the actions of a live model began at Disney Studios in the mid 1930's. Walt Disney hired an instructor to conduct classes in the observation of motion for his animators. In addition to working from life they studied film extensively. This broke the motion into discreet units of time, bringing live motion within the realm of the animator. (THOMAS, JOHNSTON, p. 71) The ability to create natural motion evolves into a more personal vocabulary of motion. Very often an animator will develop a "style" of motion. A truly versatile animator will have the ability to create many styles. At their most fundamental level, the elements of any style are really the keen observations of motion over time.

Several books on animation contain illustrated examples of the craft of animating. Through viewing animated works frame by frame the vocabulary of animators is introduced, identifying and describing squash and stretch, overlapping action, anticipation, etc.

Animating On The Computer

Straight ahead Animation

Shamus Culhane emphasizes the importance of "speed drawing," or straight ahead animation. The main goal is to avoid getting bogged down in the individual drawings, allowing the animator to work swiftly through a motion sequence in a way that the feeling of the motion comes through during the act of drawing. An animator will make a "model sheet" to use as reference, sketching the forms or characters from various angles and poses. With the model sheet nearby, the animator begins to sketch out the motions rapidly, working on more than one drawing at a time. (CULHANE)

Animating in this way tends to result in a very spontaneous and energetic quality of motion. The animator anticipates the energy or impulse of the motion with each successive drawing.

There are several ways to approach the generation of motion using the animation software. The user starts by setting the number of frames. Pressing certain keys will advance the frames forward or backward. To make a small dot appear to traverse the screen from left to right, the dot is painted down on the left edge of the screen in the first frame. Advancing the frames one at a time, the dot is painted down slightly to the right of the dot in the previous frame. An animator can easily use the straight ahead animation method in this way.

The animation software offers a shortcut: by holding down a certain key, the frames are advanced at a continuous rate. The dot crossing the screen can be painted with one smooth arm motion. This works very well for shapes that are static as they change position. With practice, an animator can get a feeling for the way a drawn motion will be sampled by the continuously advancing frames, anticipating the timing in an intuitive way.

Motion along a path

Another way to find the positions of shapes over time is by plotting them in advance, sketching in curved lines to use as a guide. The "path" can be sketched in one color, using a second color to mark position points along the path. Varying the spacing of the marks along the path will affect the rate of speed: marks close together will provide slow motion, widely spaced marks will provide fast motion. In this way the timing of an object along a path can accelerate and decelerate. This sketch can be copied to all of the frames. All that is left is to advance through each frame and paint the dot down at the indicated position. The path can be erased later.

Key frame animation

Key framing, or pose to pose, is another traditional technique. The animation software is not able to handle this as elegantly as the traditional use of translucent paper stacked on a light table, but can be approached in several ways. Objects that are flexible change shape as they interact with forces in the environment. The classic example is the bouncing ball. As it hits the ground it squashes into a flattened shape, on the rebound it elongates, arriving at a normal, round shape at the top of the bounce. If the impact with the ground occurs on frame 10, and the height of the bounce is on frame 20, we can sketch the desired shapes for those two frames. These frames become "key frames." Traditional animators working with drawings on top of a light table can superimpose these two drawings and trace in the intermediate steps of the motion, called "in-betweens."

The frames of animation on the computer can only be viewed one at a time. The keys that advance the frames forward and backward are located next to each other, allowing the animator to rapidly flip back and forth between two adjacent frames. A frame can be inserted between these two, sketching the in-between shape on the middle frame. This process can be repeated until the desired number of in-betweens are created. Another way to create in-betweens is similar to using the path as a template for positions. The two keys can be combined into a single frame. This can be used to create a master drawing by roughly sketching the in-betweens right on top of the key frames. By copying this sketch to all of the frames, the animator can go back and make a clean drawing out of each one. Several animators have found other interesting solutions to this problem. (DANIELS, p. 83, HAGEN, p. 56)

The 30 Frame Assignment

The 30 frame assignment was designed as an exercise to introduce the animation software and give students their first leap into animation. The exercise is similar to making a flipbook: animating small sketches on index cards and flipping through the stack to see the motion. By setting up an initial limitation of time, one quickly discovers that time is represented through discreet elements, or frames. A good rule of thumb for beginning animators is, "If you think it will take 5 frames, make it happen in 10."

The objectives are to animate and discover qualities of motion and timing. Several different kinds of motion are demonstrated: a bouncing ball, a slow moving large object, a spastic squiggly line. Students are encouraged to simply try some motion, observe the results carefully, and draw some conclusions as to what qualify has been achieved, perhaps choosing to rework the motion to emphasize that quality.

Computer Animation Methods

The animation software offers the ability to approach animation using both conventional and computer techniques. The conventional methods described above establish an orientation to the technical side of the software, providing a conceptual base for understanding timing and motion. The use of computer animation methods builds upon these skills. Presenting the information in this sequence line methods of animating with the larger goal of exploring qualities in motion.

Interpolation - Exploring Space

In general, the computer can handle the mathematical calculation of distances and timings. in making a dot cross the screen we have to position it for each frame. This is no problem if we don't care how many frames it takes - when the dot reaches the other side we are done. However, if we want the dot to travel from point A to point B in 13 frames, we have to find the distance between those two points and divide by 13 to find out how far the dot travels in each frame. This kind of calculation is called "linear interpolation" and is the basis for computer generated in-betweening. Acceleration and deceleration can also be calculated by the use of sine functions in the linear interpolation equation.

The animation software has a "perspective" mode where cut-out portions of a two dimensional image can be repositioned and rotated in a pseudo-three dimensional space. These positions and rotations can be set as key frames, letting the computer maintain correct perspective as it calculates the in-betweens.

Perspective mode and computerized in-betweening are methods that provide a way of depicting space through motion. Forms in motion travel past the "point of view," or the point of view Is in motion within a space described by forms. The way a space is represented by motion gives unique meaning to the point of view. Trees slowly moving across the screen with static hills in the background might give the feeling of floating down a river. Dodging through a mass of tangled branches could imply a bird in flight. Transitions from one space to another contain metaphors, or show a passage of time; a change from a city scene to the desert could imply a desire to escape to solitude, or the crumbling of a civilization.

Representation of space over time, whether it is two-dimensional or three-dimensional space, creates a dynamic relationship between the forms in motion and the boundaries of the frame. Therefore, composition of forms over time considers that which occurs within the frame as well as implying the existence of forms outside the frame. Offscreen space exists in all cinematic imagery. Its very nature conveys meaning in any context. Naive animators have a tendency to compose events within the edge of the frame; space is represented as static, belonging to the objecthood and space of the picture plane. While perfectly valid, this way of handling space merits a conscious articulation of its use.

Cycling - Exploring Time

In traditional animation repetitive motions can be designed so that the end winds up the same as the beginning. In this way the same sequence of drawings can be repeated in cycles. The animation software offers a great deal of flexibility in cycling.

A "brush" can be created by defining a rectangular region with the mouse. That region becomes like a rubber stamp in that wherever the mouse is clicked a copy of the region is "stamped" down.

The ability to define an area as a brush is extended to the animation capabilities. Once a sequence of motion is drawn, a region containing the motion can be defined as an "animation brush." The brush actually contains each frame of motion, and can be stamped down and repositioned over time. If we are animating a character walking, all we need to do is create the left step and then the right. Once this is defined as an animation brush we can set key frames for the start and end positions, letting the computer interpolate the position for each step as it flips through the walk cycle.

The cycling capabilities of the software offer an interesting way to explore duration, rhythm and subdivisions of time. Once a cycle is created, it can be varied, lengthened, shortened, duplicated and layered. One can envision scores of walk cycles traveling at different rates of speed, moving in different directions over varying distances, ranging from small to large, arranged in rows like soldiers or clusters like children playing.

This concept of theme and variation is most easily identified in musical form. Relating an exercise in theme and variation to music would develop an awareness of how visual ideas in time become layered, linked, juxtaposed or blended when they are constructed into a sequence.

This "construction" of temporal events is a subset of montage. In filmmaking, montage is the cutting and editing of film sequences in such a way that meaning and richness of imagery is created. Animation allows us to approach montage on a different level. Events unfolding over time do not necessarily belong to discreet sequences of film that are literally attached end to end. Animation offers the freedom to conceptualize the construction of time as part of the process of creating it.

Conceptualizing — Ironing out Details

Suggesting a theme

Conceptualizing for animation can be difficult. The arena of imagery is as broad as the imagination. The key to arriving at something of interest is in setting up some creative limitations. These limitations will characterize the uniqueness of individual expression.

Therefore, suggesting a theme actually comes in the form of suggesting limitations. For example, start with a single object — let's say a shoe. Some ideas about the shoe immediately evolve:- is it new, old? a man's or woman's shoe? black, or brown? is it in a storefront window? is it on the closet floor? is it laced? is it dirty? is there a foot in it? where has it been? what is it doing now?

Constructing some imagery connected with the idea of a shoe can lead in many directions. One might animate a "symphony of shoes," celebrating the kinds of observations made above. The "life story of a shoe" might show the many places a shoe has been, traveling far and wide, enduring foul weather, recuperating at the shoe repair.

Personal subject matter offers a rich and imaginative area of imagery. One could animate a self portrait through showing the environment and objects of everyday life. The choice of objects and way they are animated reveals things that are sentimental, routine and part of our culture. Dreams, stream of consciousness, thoughts and observations lend themselves to visual and temporal depiction as well.

An exercise in developing an idea based in personal expression is to start with one word, or image, very much like the evolution of the shoe idea. A mind association session would generate a whole series of connected images. One could represent the mental links through animating between them in such a way that the connection is articulated.

Storyboard and Outline

A storyboard is a series of rough sketches that depict the key moments of the piece. They are accompanied by verbal description if needed.

"Conceptualization is the essential function of the storyboard. And even when the idea you've got in your mind seems absolutely detailed and complete, getting it down on paper is always a creative step. The process of visual thinking releases new energy and new ideas. Best of all, developing a storyboard lets one see the 'problems.'

Many would say that the real creativity starts only after that inner idea has been given a visual and concrete first draft, however informal, via a storyboard. The idea of the movie suddenly becomes accessible in new ways. One is able to step back from the concept and study it with more objective eyes. Various component elements are seen Independently of the central concept." (LAYBOURNE, pp. 79, 80)

This type of conceptual zing method is process oriented, and a vital skill for animators. The time commitment in animation is such that one should work in a way that offers feedback. The storyboard offers a way of testing ideas before many hours are spent animating.

The role of the outline is to plan the technical steps necessary in creating the animation. The work will most likely happen in several phases that will later be combined. For example, a moving background might be painted and animated before adding moving objects to the scene. Presenting the storyboards and outlines in class creates a dialogue that links the concepts of the piece with the working out of technical details.

Cinematic concepts such as point of view, framing or composition, editing and narrative or non-narrative form become part of the storyboard discussion. There are infinite ways in which these concepts are realized in an animated world. Playful, outrageous exaggerations carry a great deal of meaning in the ways in which the animator articulates them.

Animatic

An animatic is the timing out of storyboarded sequences. Storyboard drawings can be digitized and loaded into the animation software, and then repeated each frame for the planned duration of the motion it depicts. (If the storyboard is created on the computer, making an animatic is simple, and a logical step in the process.) The result is a choppy version of the sequence of motion events. It is a valuable aid in making timing decisions, and gives an overall feeling of the piece.

This was an optional phase for the project assignment. Several students discovered ways of incorporating the idea of the animatic into their work process.

Discussing work in progress, or brainstorming

A lot of problem solving goes on during the animation process. When involved in the work of animating it is hard to remove oneself to get an objective look at what has been achieved. Animation is a solitary and painstaking way of making art. Getting together with people and showing the work in progress becomes a valuable activity.

The term "sweatbox" was coined at Disney Studios for this very activity. In film animation, the animators working pencil drawings are filmed and tested before going on to the cell painting phase. Disney would crowd the animators into a small space under a stairwell (the sweatbox), where it was dark enough to view pencil tests on a Movieola. These feedback and brainstorming sessions are the backbone of the many contributions Disney Studios has made to the sophistication of animated imagery and expression. (THOMAS, JOHNSTON, pp. 82-83)

Conclusions

The simplest, most basic conceptual and technical skills of animating with the use of the computer have been brought together. This base consists of:

1. awareness of motion and time

2. applied knowledge of animation terminology

3. practice in animation methods
   how they are used to create unique qualities of motion

4. the evolution of an idea into an animated piece

Demonstrating the technical use of the software as a way to realize these concepts encourages a more conceptual exploration of the software. In the context of an introductory course, this is a reasonable and attainable goal.

Limitations

Students completed 5-10 second pieces, feeling the reward of satisfaction. However, several kinds of problems cropped up in the work through each section of the course:

1. **No concept of different points of view, moving point of view**
   -centralized compositions where the frame is like a stage
   -static point of view

2. **No concept of off screen space**
   -all activity happens in the center of the frame

3. **No concept of montage**
   -continuous shot

4. **Technical ability without a strong conceptual base**
   -ambitious projects
   -direct copying of images and ideas
   -technical proficiency for its own sake
   -infatuation with software

These "problems" are symptoms of a course structure and context that limit the degree to which the cinematic concepts can be incorporated. Although it has not been the purpose of this paper to address contextual issues in curricula, the subject is pertinent to the structuring of course content.

In developing courses for this specialization, there are areas where the computer is incorporated into an existing discipline, and areas where the computer becomes the discipline of study. The latter is logically the newer, less developed approach. Perhaps the theories discussed in this paper lie midway between these two polarities. While the visual properties of computer imagery have yet to acquire the richness and diversity of animation created with paints, charcoal, sand, clay, glass, and so on, the computer does offer methods of animating that extend the articulation of motion to new areas.

Ultimately, how we experience computer animated films is no different than our experience of a traditionally animated piece. We are still responding to an illusion created by sequences of still images flashing rapidly before our eyes. Therefore, we need to extend our notions of cinema along with the new technology, until a point is found where that technology evolves its own syntax for expression.

BIBLIOGRAPHY

BLAIR, Preston, How To Animate Film Cartoons, Wafter Foster Art woks, 430 West 6th St., Tustin, CA 92680

CULHANE, Shamus, Animation From Script to Screen, St. Martin's Press, New York,NY 1988

DANIELS, Eric, "A 12 step guide to animating with Deluxe Paint III: How to Make a Fish Sneeze," Amiga World, Special Issue, 1990

HAGEN, Joel, "Freehand Animation," Amiga World, March 1990

LAYBOURNE, Kit, The Animation Book, Crown Publishers, Inc., New York, NY 1979

RUSSETT, Robert and STARR, Cecile, Experimental Animation: Origins of a New Art, De Capo Press, New York, NY 1988

THOMAS, Frank and JOHNSTON, Ollie, The Illusion of Life, Abbeville Press Publishers, New York, NY 1984

SITNEY, P. Adams Visionary Film, Oxford University Press, New York, NY 1979

WHITAKER, Harold and HALAS, John, Timing for Animation, Focal Press Limited, London and New York,1981

YOUNGBLOOD, Gene, "Cinema and the Code" Leonardo, Computer Art in Context, Supplemental Issue 1989, pp. 27-30

Small Computers and Big Windows: Art Com and New Electronic Space in the Arts

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The application of computing to graphics and music has had a major impact in the arts, as has been well documented in the proceedings of these conferences over the last nine years. Much of this impact has been to bring greater power to traditional tasks of artists, whether they be redrawing graphics, speeding animation, synchronizing multiple audio and video tracks, or revising musical compositions. The enormous quantitative enhancement brought by computers to the powers of the individual artist has been so great as to bring qualitative changes to much of the work, with multimedia performances perhaps the outstanding example.

However, computers offer further potentials for artmaking, potentials more specific to computing, as yet much less explored, and with the possibility of allowing deeper changes in the nature of artmaking. In particular, computers offer unique potentials for interactivity and connectivity, and for combining these features in networking.

Telecommunications networking in the arts is helping to create a new paradigm for artmaking, one suggested by such terms as "telematics," "electronic space," "virtual communities," and others. This phenomenon is hardly unique to the arts – it might be considered part of the larger cultural changes referred to as post-modernism. The creation of this new electronic space offers a range of possibilities to artists, arts educators (including librarians) and other cultural workers. In this paper, I will look at some of these by reporting on our experience at Carnegie Mellon in connecting to the Art Com Electronic Network (ACEN), a project of the Art Com arts organization in San Francisco.

ACEN is only one part of the computer networking going on in the arts, a process which includes the organizing of telematic art events, online journals, e-mail networks and bboard systems. However, Art Com has been active in this area since the beginning, and it encompasses many different aspects of art making in electronic space. At Carnegie Mellon, the connection to the Art Com Electronic Network is through the fine arts reference desk of the library (where I work); we first logged on about a year ago in the fall of 1989. The fine arts reference staff thought we were getting an online electronic journal, and we justified the expenditure as a journal subscription. The administration, however, insisted on treating it as an online bibliographic database subscription. Perhaps this slight initial contortion should have been a warning about the unusual nature of Art Com, for once we started poking around online, we found ourselves in a strange new space indeed. It was a bit like falling through an electronic rabbit hole.

It is true that Art Com does include an online journal, and it does contain a lot of information which we use like a database, so there are solid grounds for those views of it. The journal is **Art Com Magazine**, now a monthly which is published online exclusively, each issue edited by guest editors. It has evolved over time from a more conventional print format. Back issues are retrievable online also, constituting part of the quasi-database nature of Art Com.

A number of other fairly conventional data sources are also online on the Art Com Electronic Network. These have increased in number and size over time and currently include the F.A.S.T. News (a calendar of Fine Arts Science & Technology events compiled by the International Society for Arts, Science & Technology), directories of art spaces and artist housing, and an e-mall (a catalog of arts publications, videotapes and software available through Art Com — these can, of course, be ordered online). Some of these are indicated in the choices on the ACEN welcome banner (Figure 1).

A more heavily used source of information is the collection of bboard topics, which are quite active. These cover a gamut of arts topics, including such general concerns as censorship, the Warhol retrospective, opening one's studio to tours, and art law (Figure 2). Since the Art Com Electronic Network was launched in 1986 "as an 'electronic gathering place' for the creation and dissemination of art projects employing telecommunications," it makes a special contribution in the bboard topics devoted to such areas as "CYBERSPACE ART: Crazy from too much choice?" (Topic 515, 1990-), "ARS ELECTRONICA IN RETROSPECT: THE SERIES!!!!!!!!" (Topic 438, 1989-), "Computer Based Art: Notes on the Context," (Topic 525, based on an address with the same title by Carl Loeffler, 1990-), and digital reproduction of museum collections (Topic 532: "ARTWINDOW: A high tech alternative to gallery & museums?," 1990-). Participants in these discussions include artists active in these areas, programmers and developers, engineers, writers, novice and expert users and others, contributing a wide range of opinion and expertise.

The Art Com Electronic Network also houses an Electronic Art Gallery (1986-) providing access to digital art works. Some of these are visual poetry or compositions such as John Cage's "FIRST MEETING OF THE SATIE SOCIETY" (1985), which are presented as finished works even when, as with Cage's piece, they were created by I Ching inspired computer programs and take the form of mesostics, which permits reading horizontally and/or vertically.[2]

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    /__\  /__/ /    /   / / / / /
   /    \/   \ /   /__ /__/ / / /

Welcome to the Art Com Electronic Network,
dedicated to contemporary art and communication technology.

To view all of ACEN in addition to the conference topics enter
the following lowercase commands at the OK(? for help): prompt.

 newstand - To access ART COM MAGAZINE, current electronic edition.

  acm     - To access back issues of ART COM MAGAZINE
  art     - To access the ELECTRONIC ART GALLERY
  pics    - To access the GRAPHIC ART GALLERY
  info    - For information about ART COM ONLINE and OFFLINE
  emall   - To shop in the ART COM ELECTRONIC MALL
  spaces  - To retrieve information on ART SPACES
 arthouse - For information on HOUSING for ARTISTS
  faf     - To access FINE ARTS FORUM and information on FAST
  usenet  - To access ACEN on USENET

35 new response topics and 29 brand new topics
First topic 4, last 556

Ok (? for help):
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Figure 1: ACEN Welcome Banner

Topic - Number of responses - Header

300 169 LEGAL TALK FOR ARTISTS!!!!!
<linked topic>
302 281 >>>>>>>>>> POETRY VISUALS IV <<<<<<<<<<<<<<
<topic is frozen>
<linked topic>
319 234 ART RIOTS!!!!
338 233 ANDY WARHOL: A RETROSECTIVE (THE CATALOG)!!
369 262 Arts'n'Crap — producing and marketing your work?
374 269 Censorship Clearinghouse
388 209 ART OR FAKE?
393 138 LIVING WITH ART!!!!!!!!!
400 509 CAN SOFTWARE BE ART? 5
403 223 ART IN AUSTRALIA!!!!!!!!!!!!!!!
411 44 IMPACT ON MULTI-CULTURAL COMMUNICATIONS/BORDER AXES
413 124 IMPACT OF NEW TECHNOLOGIES ON MULTI-CULTURAL COMMUNICATIONS/BORDER AXES
415 246 DIGITAL VIDEO INTERACTIVE (DVI) II
441 594 *** USED ART 19 ***
447 231 DOING BY DOING OR NOT DOING??!!? (Y) or (N):
449 45 Art Outdoors
451 426 CYBERNETIC JEWELRY- Wearable Microsystems
480 93 TELEPHONE ART!!!!!!!!
481 68 Anyone do Rubber Stamp Art?
489 45 JACKSON POLLOCK TALK
492 76 xxxxxxxx ART STRIKE !! xxxxxxxxxxx
495 141 COMPUTER GAMES AS ART.
496 47 Mail Art Madness
498 110 The COUEY virtual museum of Descriptions of Art.
500 448 ART OF INSTRUCTIONS IX!!!!!
504 22 CYBErSTUff: THE TOPIC 1
506 89 B E Y O N D   T E X T - Multimedia telecommunications.
507 12 Developments in live/work.
510 120 What Price Exposure: Exhibiting Interactive Art in a Conventional Galley
512 32 CYbEr-Arte TouRs! 1-Chome.
514 16 Where will "great" art come from
515 336 CYBERSPACE ART: Crazy from too much choice?
516 34 Future Fiction Workshop July 29-August 11
524 36 Arts issue of netweaver
529 16 Remote(ly) Art
533 13 Help Define Art Artwork
535 36 Advert for Global Village- an invite
540 33 Environmental Art & Artists
543 38 **A L F R E D   J A R R Y   C L U B**
544 28 YLEM NEWS
546 36 What can be done with a stack of mediocre paintings????
548 56 Let's Create an Art-BBS List & Wish System Here!
553 43 XXXXXXXXXXXXXXXXXXXX INSTANT SALON XXXXXXXXXXXXXXXX
554 7 SECOND INTERNATIONAL SYMPOSIUM ON ELECTRONIC ART (SISEA)
556 6 VIRTUAL CULTURES
<linked topic>

Figure 2: ACEN Topics
An incomplete but representative list.

Other works in the Gallery function in a directly interactive manner. For example, "DIGITAL MUDRA: THE PHILOSOPHER" by Sonya Rapoport (1988) is a programmed guru (a guru program?) which Rapoport describes as "a cross-cultural art project" based in "the world of Kathakali Mudra, a gesture language from Southern India." It offers words of wisdom in response to a dialogue with the online viewer (reader? interlocutor?). Judy Malloy has posted one chapter of her interactive novel, **Uncle Roger** (1988), which requires repeated choices by the reader of which threads to follow, emphasizing the reader's role in constructing the work.

Malloy has also contributed "Bad Information Base" (1986-7), well described by Couey: "Employing a bulletin board topic on the Art Com Electronic Network as a location for 'information' gathering, Malloy invited whoever desired to contribute bad, wrong, silly, misinformation. While amassing a wealth of badinfo, the linear topic also illustrates a process of collective creation, in which participants' info related to their own experience and knowledge base, but also responded to previous entries. Malloy later programmed the badinfo into a database structure, which can be searched for badinfo pertaining to art, technology, religion, sex and numerous other subjects. Here, the actualization of the original art concept is the shared information of public participation – the 'artist' is all who participated, and Malloy structures the type of 'information,' its method of access, and therefore its associations."[3]

Some bboard topics themselves constitute collective artworks with a high degree of interactivity. Gil MinaMora, a systems engineer for Art Com, has designed a digital version of the surrealist free association game, The Exquisite Corpse. The Normals (TM), artists who are always at home in electronic space, have instigated "The COUEY Virtual Museum of Descriptions of Art," (Topic 498, 1990-). The museum is described by its namesake as a project "which invites participants to describe a work of art that they have seen. This project amplifies the intangible nature of networking and its facility for communication of descriptions of experiences. Rather than focussing on the art object, the virtual museum addresses and illustrates the impact and communicative effect of works of art, and turns the translation of visual art into virtual description over to the 'viewer.'"[4]

Almost all of these elements differ from print analogs in one important respect: they are interactive – even if some are more so than others. ACEN's bboards can be helpful information sources even when used only for retrieval (as librarians tend to do), but they are created by many people continuously posting questions and responses to other participants. Housing and art space directories are useful only because many subscribers contribute info and keep it current.

Even the one "proper" database application, "Bad Information Base," was generated by readers contributing their own bad information. This was then programmed by Malloy so that it functions as an interactive, uniquely computer-based artwork, generating "bad" output in response to user queries. This work provides humor and insight in its individual responses and as a whole it serves as reflective commentary on the looming presence of databases in our networked society. In one way or another, and usually in several ways, all the features of Art Com explore interactivity as one of the defining features of computer art.

The other defining feature which computers bring to art is connectivity – the ability to transmit signals in digital form through many electronic connections and applications without degradation. From its inception, the Art Com Electronic Network has put a paramount stress on connectivity, which has determined a series of key technical, economic and artistic choices. Art Com put its network on the WELL, the Whole Earth 'Lectronic Link, created by Stewart Brand and the Whole Earth organization to democratize access to computers. The WELL can be accessed by modem via direct dial-up or more cheaply via Compuserve or PC PURSUIT. It has also recently been made available on USENET. A user can log in from any international phone line, or from network connections in some 70 countries. Indeed, Art Com places this connectivity at such a high priority that it is willing to sacrifice the strong urge among artists to make pictures: to maximize compatibility, all postings are in ASCII text, including the artworks described above. Members use DOS machines, Macs, Amigas, Ataris and UNIX machines (and perhaps others).[5] Connect charges have been kept low enough (at $3 per hour) to allow individual subscribers to constitute ACEN's base.

Among arts networks, this emphasis on maximum connectivity is unique to Art Com. Other networks have been restricted to one type of computer (DOS-based, Apple, etc.) or limited by fickle corporate sponsorship on expensive commercial nets (*e.g.*, Art Box, subsequently ARTEX, on I.P. Sharp). These are live issues, as illustrated by the current debate being hotly waged on ACEN's Topic 548, "Let's Create an Art-BBS List & Wish System Here!" (1990-).

The importance of connectivity is obvious as regards bboards, online publishing and the creation of an Electronic Art Gallery. Connectivity has also been fundamental to artists' use of telecommunications over the last 15 years in a loose series of events which constitute an emerging art of telematics.[6] These are time-specific events (related to performance art) based on the exchange, alteration, response to and the collaborative creation of works by artists connected via telecommunications, no matter how geographically remote. Art Com has used its formidable connectivity to host or co-host various telematic events, including, among others:

* Planetary Network (1986), a project at the Venice Biennale with ARTEX in which participants were asked to comment on the news and submit unreported news;
* Ponton/Mobile Media Art Project (1987) with the German group 235 Video at Documenta 8 in Kassel in which participants were invited to comment on the exhibition;
* Border Axes (1989), a cross-border exchange between artists in Mexico and the United States in which messages were cross-posted between ACEN and mail and fax networks;
* the Ars Electronica (1989) "Network of Systems" festival in Linz, Austria;
* Earth Day Global Network & Impromptu (1990), a telematic exchange connecting artists in California, Vancouver, Chicago, Pittsburgh, Baltimore, Boston, Vienna, Lisbon, Haifa, Campinas (Brazil) and other cities.

Arts networking of this type creates new electronic space. This use of the interactive and connective capacities of computers is quite different from applications of their computing power to drawing or painting or even animation. Art Com's role in this regard has been explicit:

Unlike television, computer networking is characterized as being a participatory communications medium, in which receivers are also senders or controllers; 'information' goes back and forth, is added to and shaped in the process. Artists employing computer networks in their art practice have been concerned with creating participatory communication constructs, that depend on multiple authorship across geographical distance and time – such works can also be accurately termed interactive, in the sense that the 'viewer' actually reciprocates the creative act. . . .

[Art Com] developed and develops according to these underriding principles: electronic space is territory, the shaping of which impacts the development of cultural interaction and virtual communities; and, given that, ACEN seeks to stake a claim in electronic space to facilitate a user determined participatory reality. This could be seen as environmental sculpture. Its constructs are collaboratively conceived and produced by Carl Loeffler, Gilbert MinaMora, Fred Truck and myself [Anna Couey] – and they are used and given meaning by all who participate. . . .

To the extent that they also describe non-hierarchical forums for public interaction, and to the extent that they investigate memory and communication, and to the extent that they claim electronic space, their impact and meaning expands current definitions of art. In contrast to the crisis in representation discussed in more traditional art contexts, computer networking offers a challenge to sculpt in an expanded field – to effect cultural transformation.[7]

At Carnegie Mellon, we have been online with Art Com for about a year, and we have found the experience to be radically different from what we expected. As library staff, we have found ACEN to be a valuable source for retrieving information in esoteric areas of cutting-edge art and technology. It is available at a public access PC at the fine arts reference desk any time a staff member is available to log the patron on (about 70 hours a week). It has also been a valuable teaching resource, since it is far easier to demonstrate (hands on) interactivity than to show slides of it. And since it can be ported to any room with a telephone jack, we have been able to do demonstrations in classrooms and studios as well as the library.

Our use of Art Com has gradually gone beyond these conventional academic uses of online resources, however. As members of the arts community on campus, we have found Art Com's interactivity and connectivity to be an irresistible invitation to participate in this project of "sculpting in an expanded field." It has been a key part of a campus gallery exhibition on arts computing. And when the Digital Art Exchange (DAX) group of electronic artists mounted an ambitious international telematic event to mark Earth Day this year, we were able to use Art Com to add a third level of networking to the slow-scan video and Fax nets which had already been organized for it.[8] Art Com is an extraordinarily accessible window, providing as good a look as is available into the new electronic space which may offer a new paradigm for artmaking.

Carl Loeffler, "The Art Com Electronic Network," **Leonardo**, 1987, p. 320.

[2] *Ibid*, p. 321.

[3] Anna Couey, "Constructing Electronic Space," **New Observations**, Number 76, 1990, p. 21.

[4] *Ibid*, p. 22.

[5] The Art Com Electronic Network is run on Picospan conferencing software on a UNIX-based mainframe in the Bay Area, the host machine of the WELL.

[6] For an overview, see Eric Gidney, **Artists' Use of Interactive Telephone-based Communication Systems from 1977-1984**, thesis, Sydney College of Advanced Education, City Art Institute (Sydney, Australia, 1986); Bruce Breland, editor, **Navigating the Telematic Sea**, special issue of **New Observations** (Number 76, 1990); and Tim Anderson and Wendy Plesniak, guest editors, special issue of **Art Com Magazine** on the Digital Art Exchange (DAX) group (Number 40, August 1990, electronic journal).

[7] Couey, *op. cit.*, pp. 21-22.

[8] **Earth Day Global Network & Impromptu**, catalog edited by Matt Wrbican (Pittsburgh, forthcoming). Art faculty, along with the present writer, have also edited issues of **Art Com Magazine** on robotics and art and on the DAX group.

Personal Computing Technology: The Impact on the Design Industry and Creative Problem Solving

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Lose the EXACTO and Catch the Mouse. There's a War On.

> For many people, the changes involved will be traumatic. Revolutions are messy. People get hurt. It takes some time for new order to emerge out of chaos. But like it or not, the revolution is taking place. The people who benefit from it will be those who understand what is happening and plan their course accordingly.
>
> —Jonathan Seybold
> (Hoffman, 1990)

Graphic Design: A New Perspective

Since 1984, the personal computer and its ever shrinking ancestors—massive mainframes—have been causing a revolution in the various fields of the visual communication industry. The publishing industry is the broadest area affected by the changes. From page design, to typesetting, to manufacturing of film negatives in final stages of prepress work, the desktop computer and its accompanying array of software has changed the work of everyone involved. Writers no longer sit pounding at ancient typewriters only to have typists repeat the keyboarding again and again during the production stages. Once the written piece is in the computer it can be reviewed by the editors, and manipulated by the designers. These designers are quickly taking on the duties of the typesetters whose job it was to fit the type to its assigned spaces. The flat of camera-ready art speeds toward obsolescence.

The publishing industry, once narrowly specialized by both the trades and the machines involved, is now open to anyone with access to a personal computer and a Postscript printer. To those of us long entrenched in the design and publishing industry, this could be a threatening occurrence. And I've heard some designers—myself among them—cursing the desktop hacks who are out there publishing bit- mapped atrocities on day-glow, bubble-gum colored paper.

But to use the invention of the portable personal camera as an example. We now take our own general purpose photos, but when we need something special done exactly right, we call a professional photographer. So small scale personal and business graphics publishing might well move into the hands of the individual, but the designer will remain a designer. We just have new tools.

Besides the publishing industry, other fields of design in and out of the business world are quickly establishing mini publishing units of their own. Any small business can now generate its own graphic and promotional materials. Graphic designers can now generate their own type and final high-resolution graphics without the time and expense of using typesetters and photo houses. They instead output the art and type themselves and use a service bureau to generate the finished camera-ready art or film negative—either of which they can deliver to the printer directly. It's also possible to transmit everything through a network to other work stations on site or over telephone lines via a modem. Advertising agencies can quickly generate finished mock-ups in a variety of designs and colors for clients review and approval. In-house graphics departments can generate sophisticated business graphics including slides, reports, transparencies, animated videos, newsletters, and a variety of other useful and cost efficient materials. Studio artists are, more and more, using computer assisted paint programs to create works of art. Engineers and architects are using PC based CAD-CAM programs to design new products and buildings. Very few fields will be left untouched by the desktop revolution. Each of us can expect to have a personal computer on our desks configured to help us perform whatever task we've been assigned or choose to do.

So when it comes to visual communication, the need to understand and use the personal computer and its variety of applications and interfaces is imperative.

The Computer's Impact on the Creative Process: A Theoretical Perspective

From the stub of burnt charcoal or piece of red ferrous-laden clay scratching against cave walls to a 35 mm transparency at 4000k resolution generated by a computer-driven film recorder, artists have reveled in and been repelled by technological innovations. Like the feared, then honored camera, the computer is here to stay as the latest technological innovation in both the fine and applied arts. The computer is now one of the major devices used in conceptualizing, developing, and producing materials for both the print and electronic mass Communications media, and is swiftly becoming the tool/ medium of choice for a new crop of designers, artists, and—of particular interest to the advertising industry—art directors.

Unlike tools or media previously introduced, the computer possesses its own power and can actually perform tasks for an artist. It's at this level of functioning that these machines may be impacting the entire creative process. Many rudimentary hand manipulations can be performed leaving the designer freedom and time for other tasks. Given this time, is the artist skipping parts of a creative cycle, is he using the time to be more creative? what's really happening when he uses a mouse, stylus, or keyboard instead of a brush? Is he moving away from the meditative sport of blending, shading, smelling and wearing paint? It is imperative that we in academia understand these dynamics, as the technological revolution in visual communication is upon us and we must be prepared to instruct at the edge of it not simply record it as history.

The use of a computer to create or enhance an image began over twenty-five years ago. In this relatively short period of time, no other medium has had such an extraordinary effect on all the visual arts (Goodman, 1987).

The variety of computer-aided, visual communication applications might be grouped into some basic categories such as:

(1) The Fine Arts,
(2) Graphic Design and Prepress Arts,
(3) Computer Aided Architectural and Engineering Design (CAD-CAM),
(4) Scientific Visualization or Mathematically Generated Imagery,
(5) Simulations or Geographic Phenomenon and
(6) Animation.

These categories are not mutually exclusive in that art as well as graphic design or even CAD-CAM could be used in an animation sequence, or animation and architectural design could be a part of a studio art installation.

To better understand the computer's impact on the thought processes, it's important focus on one particular facet of computer aided imaging. For example a scientist creating a graphic simulation of dynamic physical phenomenon(windstorms, tidal movements etc.) might have a much different background and set of cognitive processes than those users who create paintings or graphic designs. This particular study looks at graphic designers and art directors.

Virtually no empirically supported literature exists that attempts to understand the cerebral relationship between the artist and the electronic design station. A better understanding of this relationship will allow us to more effectively teach students the creative processes involved in conceptualizing, developing, and producing materials for future mass communications media. There is not yet a consensus as to whether the computer is indeed a medium unto itself or simply a tool that exists to enhance other media. For brevity and clarity in this work, we will consider the electronic image making device a "tool" that outputs to a "medium". Much work lies ahead in defining where the computer fits into either the creative process or where computer generated images fit into our visual communications vocabulary.

Computers in the Publishing Industry

The computer first nudged its way into the creative communication process when, in the early 1960s, the electronic word processor first began to be used in the publishing industry. Initially these machines where used to enhance typesetting, and eliminate manual spacing of type. It wasn't long until word processors were on reporters' desks, thereby allowing them to perform both the original and final keyboarding of documents. Editors could edit "on screen" and copy was sent, electronically, to typesetting. Many keyboard operators and typesetters were eliminated and the publishing industry was launched into a technological revolution. Type now goes from writer to prepress negative via computer. With all that, the creative process remained relatively untouched until a plethora of writing software flooded the market. Programs now correct content, context, stylistic convention, readability levels, and spelling. Important facets of the writing process can now be executed by the computer (Danielson, 1986). The computer has entered into the writing-editing-thinking process to perform perfunctory tasks, leaving the author free to spend more time in other phases of the creative process.

Word processors have completely revolutionized the working methods of writers, editors, production staffs, and finally publishers. It is my feeling that Computer Imaging hardware and software is doing the same to the creative processes of the graphic designer and quite possibly to the studio artist.

The Computer in the Design Studio

Just as the computer has taken over some perfunctory duties in writing, so too the image generating station can take over calculations and manipulations for the designer and artist. It can— with the use of software—think. In this light it enters into a symbiotic relationship with the artist, allowing him/her to spend more time on high-end tasks such as designing, defining, and refining an image. The storage capacity of the machine allows an artist to make may changes in a work, saving each change separately, thereby offering a more relaxed approach to decision making, all the while allowing more decisions to be made. The artist can save many variations on any theme, be they color, scale, or texture. This flexibility will have a far greater impact on the artist than the word processor has had on the writer, in that the writer still ends with one main document and the artists can end with many variations of a particular image. I expect this to significantly alter the design process. With increased flexibility in the end stages of production the artist might well lengthen the evaluation stages of the process and slight the ideation phases that generally occur earlier in the creative stages. It is expected that the creative processes will experience a shift in working energy expended, experimentation, and even creative play.

In an attempt to investigate the creative process and human/machine interface, I looked to a variety of literature. Those studies that offer the most theoretical or conceptual insight and sound empirical methods stem from work devoted to Creative Behavior and Computers and Human Behavior. Given the rapidly changing visual communications field and raging spread of computer use, a need exists for the most current literature on all phenomenon to be tested and survey instruments with which to test them. These articles are of particular interest because they examine attitudes toward computers, user involvement with computers, gender differences in attitudes, individual differences in creative problem solving style; and the phenomenon of the creative personality and the creative process.

The Creative Process

The cognitive creative process has long been regarded an intangible and unmeasurable phenomenon. Because of these nebulous qualities, no empirical studies and few exploratory analyses on the subject were offered until the 1950s. Most creative models were based on theories in behavioral and humanistic psychology (i.e., the work of Freud and his followers) and on the emotional rather than rational approaches to problem-solving.

Wallas presented a model of the ideation process which identified four steps preparation, incubation, illumination, and verification (Rothenberg and Hausman 1976). Wallas proposed that—conceptually—a thinker would pass through each of these stages, remaining in each phase approximately the same amount of time.

Wallas's early model has been through many derivations, all of them consisting of staging the thought process. Two of the more popular and most used models grew out of the advertising industry and have been applied to a variety of solution seeking fields. In Young's (1975) model, the stages are very similar but renamed and decidedly directional: gather raw materials, organize them, drop the entire subject, wait for the idea to appear, and adapt the new idea for practical use.

Osborn's model, proposed in the 1950s, elaborated on the basic sequential premise of the Wallas model by adding an orientation stage to begin the process (Osborn 1953). Osborn did not however, feel the staging was singularly directed or that the timing of stages was equal. He proposed an individual might move forward and backward through phases until finally reaching a solution. The Osborn model consisted of: orientation, preparation, incubation, illumination, and verification.

Preliminary tests using Osborn's model and conducted with computer imaging students, indicated a shift from the preliminary stages to the later more evaluative stages. Given that there exists no pretested method of evaluating shift in the process phases outlined in Osborn's Model and considering that all these more dated models offer no method of measuring for individual style or tendencies, I move to the most current and proven method of measurement. It is possible to measure a person's individual preference for particular phases of the creative process. If a person prefers to spend time in a particular phase he/she might—when using a computer—shift to other phases. It seems appropriate to use a model of individual style to most accurately examine shifts in preference of creative problem solving. ongoing research into the creative process takes these original models further and provides a method of establishing individual preferences.

Gordon, as discussed by Basadur, Graen, and Wakabayashi (1990) models the process as a circular flow, "Learning and inventing are presented as opposite forces which feed each other in turn." Basadur et. al. most recently added to Gordon's circular flow concept of the creative process when they expanded the process to eight steps existing as a circular flow: problem finding, fact finding, problem defining, generating potential solutions, evaluating potential solutions, planning for action, gaining acceptance, and taking action (See Figure 1.)

Further, Basadur et. al. outlined the concept of dynamic tension consisting of bipolar methods of gaining and using knowledge where each dimension is comprised of two opposite ways of gaining (first dimension) and using (second dimension) knowledge:

gaining knowledge:
    direct, concrete, experiencing, and
    abstract, detached thinking.
using knowledge:
    for ideation (making new possibilities, diverging) and
    for evaluation (assessing new possibilities, converging.)

By considering an individual's particular inclinations for one or the other bipolar methods of gaining and using knowledge, Basadur et. al. posed four possible combinations of personal creative problem solving style. These combinations establish four quadrants as illustrated in Figure 2 and outlined here:

Generators love to get things started, are comfortable in the early phases of creative problem solving, and act as problem starters and challenge finders. They anticipate and sense new problems, changes and opportunities and enjoy fact finding.

Conceptualizers are problem definers and idea developers and are comfortable in the early to middle phases of creative problem solving.

Optimizers are problem solvers, and are more comfortable in the middle to later phases of creative problem solving.

Implementors will get directly involved and experiment until satisfactory implementation is complete. Implementors are problem finishers and are most comfortable in the later phases of creative problem solving.

By measuring a person's individual preference for particular methods of gaining and using knowledge and plotting those preferences along the four axes of the Creative Problem Solving Profile, we are able to establish a diagram of personal style (See Figure 3.) Basadur et. al., after of several years of testing and field use have refined methods of measuring preferences. They have also noticed that an individual's personal style can shift and usually does when there are major job changes causing one to reorganize approaches to problem solving.

If all other parameters of a person's design functions or assignments were held constant and the one major change was the adoption of the computer as a tool, this measure might prove successful in recording a shift in method of reaching design solutions. It is anticipated that there might be a shift toward more evaluative parts of the process. Given that an artist is able reach higher levels of resolution earlier in the process when using the computer, this new tool might well be causing a lesser amount of time to be spent in the preliminary or early stages of the problem solving process.

If there is indeed a shift in the process, new methods of teaching design are in order and we need to think long and hard about when we teach students to bring this device into their search for design solutions. If there is not a shift, then it is possible that all the concern about the "tool taking over" is unwarranted and we can simply strap a little mouse to the hand of each student when they walk in the door.

References

Amabile, T. A., (1983) *The Social Psychology of Creativity*, New York, NY: Springer-Verlag.

Basadur, Min and Graen, George and Wakabayashi, Mitsuau (1990), "Identifying Individual Differences In Creative Problem Solving Style." *Journal of Creative Behavior*, 24(2), 111-131.

Brown, Paul, (1989) "Art and the Information Revolution," in *Computer Art in context Supplemental Issue, Leonardo, Journal of the International Society for the Arts, Sciences and Technology*, 63-66.

Danielson, Wayne, (1986) "The Creative Computer?" *Discovery: Research and Scholarship at the University of Texas at Austin*, Vol. v, (3), 8-10.

Goodman, Cynthia, (1957) "Art in the Computer Age," in *Digital Visions: Computers and Art*, Everson Museum of Art, Syracuse, New York: Harry N. Abrams, Inc., 10.

Hoffman, Kenneth E. with Teeple, Jon, (1990) *Computer Graphics Application: An Introduction to Desktop Publishing & Design, Presentation Graphics, Animation*, Belmont, California: Wadsworth Publishing Company, 125.

Karlins, Marvin, (1972) *"A Note on a New Test of Creativity,"* Journal of Creative Behavior, 6, 95-101.

Osborn, Alex (1953) *Applied Imagination*, 3rd ed. New York, NY: Scribners and Sons.

Shear, Richard R., (1988) "Package Designer Goes High-Tech, Part 2" *Graphic Arts Monthly*, (May), 99-102.

_______________, (1988) "Package Designer Goes High-Tech, Part 3" *Graphic Arts Monthly*, (September), 107-114.

Wallas, Graham, "Stages in the Creative Process," in The Creativity Quest, eds. Albert Rothenberg and Carl R. Hansman, Durham, NC: Duke University Press, 1976, 69-73.

Young, Jones W. (1975) A Technique for Producing Ideas, Lincolnwood, IL: NTC Business Books.

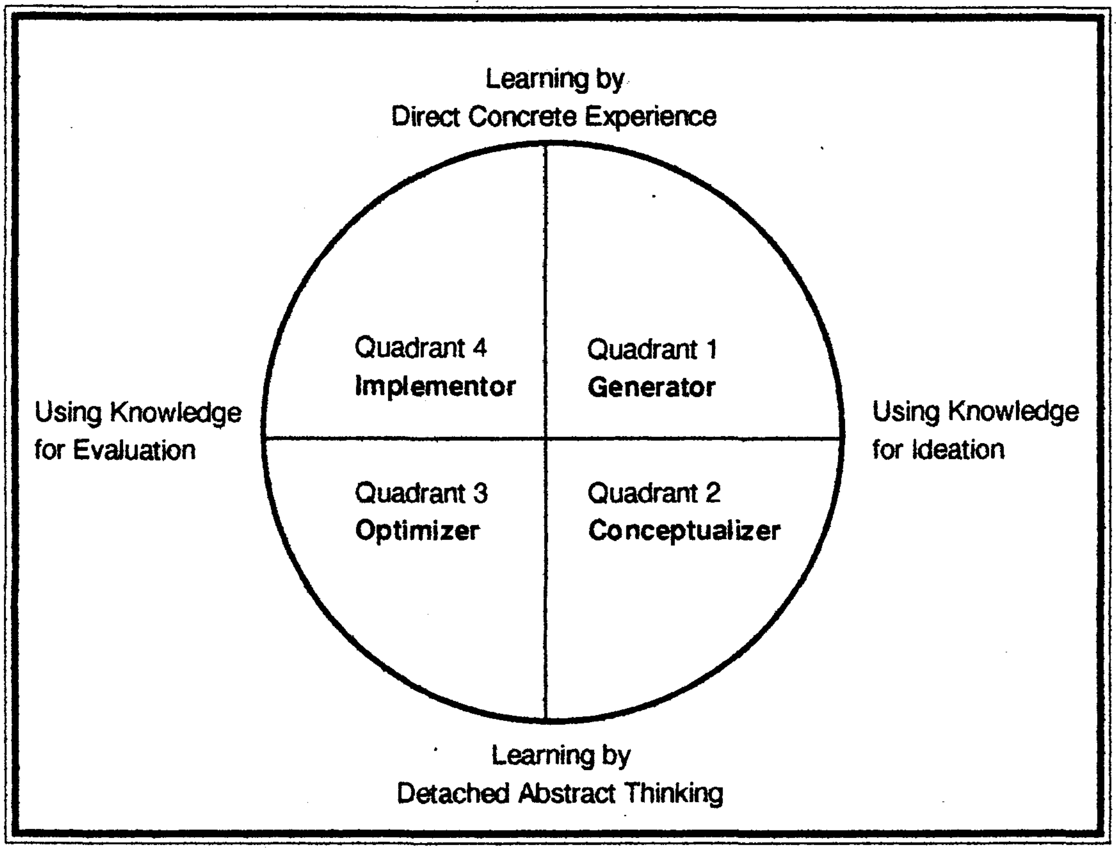

Figure 1: Two Dimensions Comprising Creative Problem Solving Activity and Resulting Creative Problem Solving Profile Quadrants

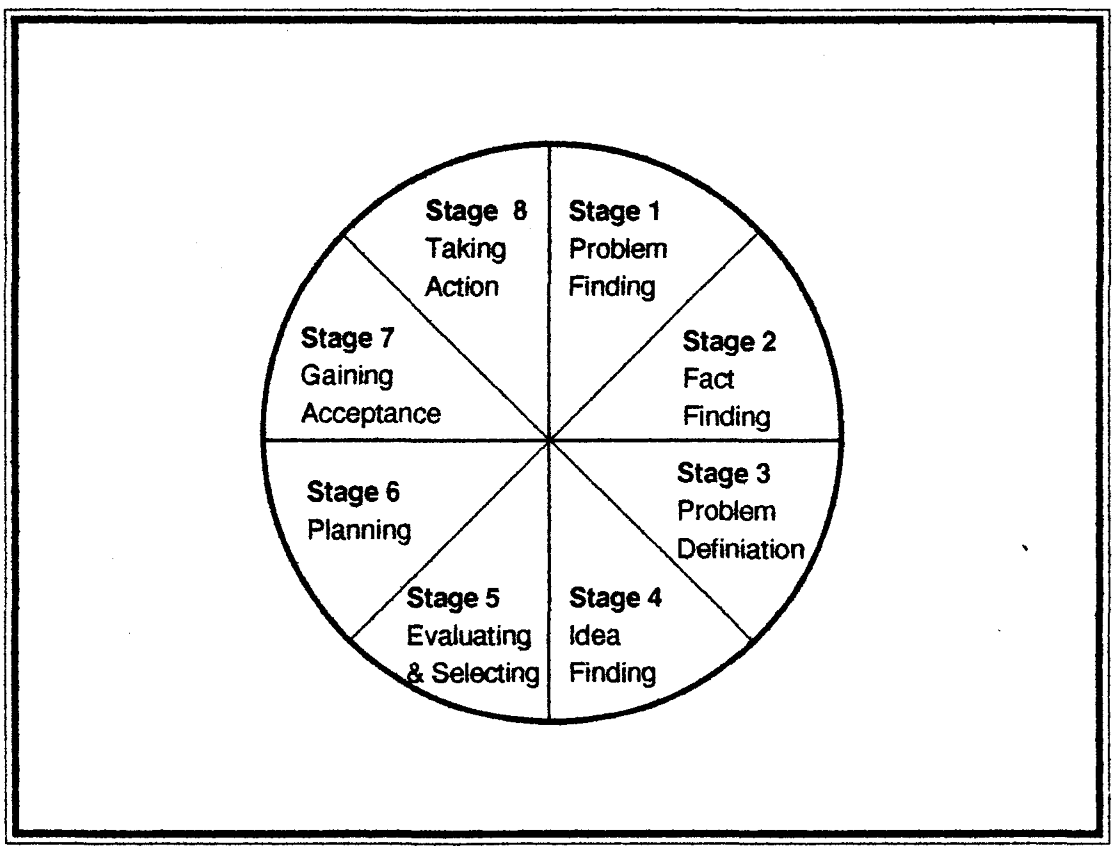

Figure 2: Eight Step Model of a Complete Process of Creative Problem Solving

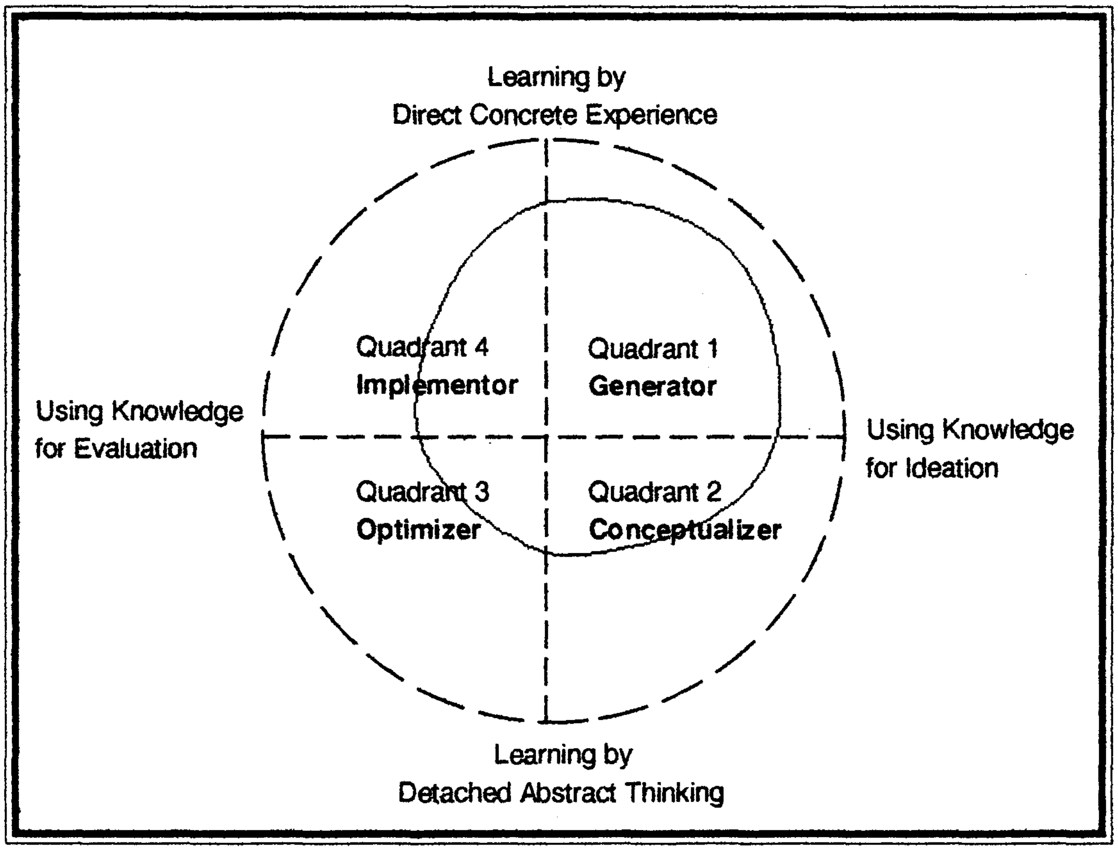

Figure 3: Diagram of Individual Style Scoring High on Learning by Direct Concrete Experience and Using Knowledge for Ideation. Individual Preferences Would be Toward That of a Generator.

Teaching Animation: Changing Technology, Persistent Visions

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Abstract
Animation is a process through which visual images are created, arranged, and displayed in order to achieve the illusion of movement. Although generally associated with cinema and video, animation is independent of any particular media. In fact, physical devices for animation were popular long before the invention of photography.[1] The phenomenon of the persistence of vision, the main perceptual mechanism which makes animation work, can be demonstrated easily by flipping a stack of paper cards on which drawings have be placed. The animation process has evolved along with film, video and computer technology adapting and absorbing the differing aspects of each. How the computer has changed animation and how its changing has influenced the way we teach animation is the subject of this paper.

Introduction

Although advanced computer technology can achieve interactive real-time animation, most animation is created outside of "real-time." In traditional animation, individual drawings are made and later photographed one at a time onto film. Even today's most sophisticated computer animation is generally produced as "frames," each of which may take hours to generate. Only when the film or video is played back at 24 or 30 frames per second is there an image moving in what we call "real-time."

This fact reveals certain characteristics of animation which distinguish it from other time-arts. In real-time media production, like so-called "live-action" cinematography or videography, the subject is generally a real object (person, place or thing) which exists in time and space and moves through this time/space more or less according to the laws of physics. The recording of this movement, which I will call "imaging," causes some form of codification of the event. This codification fragments an image of the object into small particles of the medium being used to store the image (grain of silver metal, magnetic particle, waveform, bytestream, etc.).[2]

This process of fragmentation of the image is a by-product of imaging which is rarely important or even visible to the live-action media artist. To the animation artist, however, fragmentation of the image is accessible and even crucial to the animation process. It is the imaging process which is her/his greatest concern as she/he brings subject matter to life.

One way to describe the difference between an animator and a cinematographer might be to say that the cinematographer is interested in what is out in front of the camera, while the animator is more interested in what is behind the camera: that is, the ideas and processes relating to the creation of the image rather than the object from which the image is made. Thus content includes process to an animation artist. Concepts which motivate the animator often are related to the processes and particulars of the medium used.

When the animator begins using a computer as part of the imaging process, that process is opened up to her/him in ways earlier technology could not equal. The ability to examine and manipulate the single frame image at the level of its fragmentation (pixel or coordinate point, etc.) with accuracy, repeatability and little or no loss through reproduction should mean an increased level of quality and dexterity for the animator. This suggests that animators should now be moving away from merely simulating old methodology; but does it also suggest they should abandon that methodology?

The Materials Approach

The medium and materials used often influence the aesthetic quality of the expression of the animator's concept. For example, puppet animation can be as different from cel animation as sculpture is from painting, even though both may be used within the "character animation" genre. A wealth of experimentation throughout the history of animation has given rise to the use of sand, clay, silhouette and cut paper, beads, pins[3], wax, oil and many other materials. Each of these materials has contributed to an aesthetic difference in the work done by animators.

With the advent of the computer, media and materials have become virtual rather than real elements. Hence one would expect a shift away from the aesthetics of materials toward more conceptual concerns. In certain instances, this shift is not readily apparent. The reason may be that in this early era of computer animation, a great deal of effort has gone into the simulation of materials rather than into the creation of new concepts. One wonders if this is because most visualization software development is directed by scientists instead of by artists— but there is probably no way to know for sure.

Technological evolution seems to progress through a number of stages, the first of which I would call "simulation." Since a new machine or method often replaces an old one, the new thing becomes cloaked in the trappings of that older form. Perhaps we are more comfortable this way, or perhaps we have spent all our imagination on the new invention and have none left to dream of new forms. One remembers that the first automobiles were called "horseless carriages" and were built upon carriage frames. It was the engine which was different, not the function of the vehicle that had changed. Later, the form of the new vehicle begin to fit around the engine and its aerodynamic needs. Traditional materials and methods have been the model for the development of computer generated animation over the last decade. Three-dimensional, solid-modeling techniques and photorealist rendering have begun to provide for animated sequences that are convincing when used by a skilled and inventive animator.

Evans and Sutherland Forever...

Computer animators are concerned with the best ways to create object-oriented data bases. They are constantly searching for better algorithms for squashing, stretching, and transforming three-dimensional shapes in the manner of traditional character animation. Yet the base from which most of this development proceeds is projective geometry as it is applied to engineering graphics.[4] Certainly, the deluge of 3D flying logos in commercial animation for television and the increased use of the computer for special effects in the theatrical motion picture industry has had an impact on our contemporary cultural sensibilities (if there is such a thing). The effect of this impact is that to many people, this style of animation (in truth an evolutionary by-product of CAD/CAM) has come to represent the cutting edge of technology in art.[5] Hmm...

New, more polished routines for lighting and rendering have heightened the realism of the computer animated object and its environment. These techniques are rapidly becoming available to "the rest of us" with the increased power of today's PC's and the development of portable rendering libraries like Pixar's RenderMan interface. This focus on increased capabilities for visualization does not exclude a search for better algorithms for the movement of objects,[6] the timing of events and the linking of sequences, but for those of us who are waiting for these new ideas to "trickle down," it seems like a long wait.

Personal computer based software for animation available within the teaching environment is mostly a spin-off of the scientific and engineering approach to computer visualization. This seems natural to many artists who do not wish to write their own software and there is certainly much to be gained from collaborations between artists and scientists. The main model for educational software, however, remains that of the scientist who is too little guided by the visions of the artist. Thus the propensity toward simulation is perpetuated. IBM clones, Apple IIs, Macintoshes and Amigas, peppered throughout the educational community at all levels are running software packages like Topaz, Autodesk Animator or Macromind Director. These package do their best to imitate workstation level computer animation. But do they encourage the user to invent new approaches to time-art design?

The real challenge to the educator is to use these and other packages to teach animation without getting bogged down in the teaching of the package's user interface. I can think of at least one major private art school whose computer art course descriptions are merely lists of the commercial products they will teach you how to use. Where are the concepts? The graphical user interface, which is becoming inseparable (do we have to use the word, "standard"?) from today's latest PC operating systems, makes many applications easy to use for the novice. Sometimes this ease of use is deceptive. A great word processor cannot make you a great writer. A great paint program cannot make you a great painter. Although there is a certain egalitarian value to the proliferation of the GUI, there is also a real danger in the failure of many people to recognize the difference between the graphical user interface and the underlying process of which the application is merely a simulation.

A Teacher's Tale

I entered into the teaching of computer animation not instantaneously as on a half-shell, but from a side-ways direction like a crab. I had not considered myself an animator or a computer artist at all, rather, I then thought of myself (as artists do who associate themselves with the materials of their medium rather than with the ideas of their culture) as a filmmaker. Furthermore, the tradition with which I identified as a young artist was at that time (1965) called "The New American Cinema."[7]

I first taught animation in 1974 at a small private art school in Chicago, one of those which tried (but failed) to be excluded from the group of so-called "neon sign art schools" whose main staple was commercial art. The major resource for the class was a hand-crank Bolex camera attached to a two-by-four nailed to the wall in a closet. These rather crude beginnings convinced me of the importance of "life-time learning" since I had always to discover ways of building or adapting odd things in order to get the job done. In over fifteen years of teaching, I have yet to encounter a situation where the equipment available didn't fall short of the expectations of students and teachers alike. This undoubtedly comes with the territory. For me, the "shoestring" approach[8] is a basic survival technique.

By the time the personal computer arrived within my sphere of consciousness, I had changed jobs and was teaching animation at the School of the Art Institute in Chicago. I had isolated one major difficulty in the teaching of animation art: a lack of "real-time" feedback. There was just too much of a lag between the time students did their drawings on paper, shot them and the time they could view their finished work on the projection screen. Through the use of "bucket testing" (developing the single framed film sequences in a bucket) I had reduced the whole procedure to a single day, but I still felt the need to speed things up a bit more. If only there was some way to do the drawings faster!

To help put some of these concerns in perspective, I offer the following statistics about doing animation: the projection speed of film in this country is 24 frames per second; animators typically draw 12 drawing, shooting each twice, for every second of projected "full" animation; there are 1440 frames per minute, so shooting "on 2's" requires 720 drawings for each minute of film; a three minute film (say, the ideal semester's project for an animation student) would require 2160 drawings; a proficient animator can produce a finished drawing at the rate of one per half hour; a three minute film, then, would take a minimum of 1080 hours of work, or, at 40 hours per week, it would take 27 weeks—try squeezing that into a 16 week, six contact hours per week semester!

Various projects found their way into my course prospectus during the time I taught at S.A.I.C., including "real-o-scoping," (drawing frame by frame from a live model) and a sort of "stream of consciousness" method where individual frames evolved through successive tracing, much in the way the growth rings of a tree are formed. The one project that has remained in my teaching bag of tricks over the years is the "metamorphosis" project. In this project, each student creates a drawing and makes a tracing which is passed to another. The students then create transitions between their own drawing and the one they have been passed using certain drawing methods I call "inbetweening." My first computer program was a simulation of inbetweening.

In 1981, with an Apple II, a bit pad and a digital plotter, and with a little help from David Glennon, who knew more about programming than I did, the first computer animation program to come out of my brain was born. We called it "Transformation Animation" and it produced metamorphosed drawings on paper, ready for filming. The algorithm was basically a linear interpolation, some array shuffling and some I/O routines. One could trace or draw directly on the graphics tablet, link two different drawings (by the way, both could have different numbers of vertices) and output as many "inbetweened" drawings to the plotter as you had the patience to wait for. I used this program extensively in classes for a number of years and said about it:

"I believe the strength and power of the computer lies in its potential to create new types of images and to become part of the creative process as an extension of human thinking. In my attempt to simulate via the computer a process I was already doing by hand, I gained some valuable insights into that process and began to evolve a tool which will ultimately take me beyond my previous work and change some of my thinking about that work."[9]

"Transformation Animation," and my next programming effort, a 3D wire frame generator and sequencer written for the Apple II with a Number Nine board (16 colors — count 'em!) became the basis for my teaching in computer animation. Where the plotter program had produced drawings for filming (which could be hand-colored), the 3D program drew real computer graphic pixels which could be dumped to a Dunn Instruments film recorder. In true shoestring fashion, I mounted and motorized a Bolex camera to record the single frames. The mechanisms were in place, and they worked. The process of doing animation had been speeded up for me. The problem that began to occupy me constantly then, as it still does, was: how now do I teach animation, and what do I mean by animation.

I must "time-warp" ahead to the present here to describe recent adventures in the ongoing saga of an animation teacher. I am now teaching at Northern Illinois University in an emphasis we call "Electronic Media." Our program touches on many aspects of computer generated images and time-art— many of the questions I asked myself about the teaching of animation (a nineteenth century art form) in the age of computers are answered, at least partially, by the content of our curriculum. This is pretty much a teacher's joy, to teach and to learn at the same time.

Our school is not untypical of institutions of higher learning: there is feast, and there is famine were equipment is concerned. We have had the good fortune to acquire a Sun workstation with which we hope to produce many gloriously sculpted and rendered images for our next animation projects. Currently, I am thinking of ways to mount and motorize a Bolex camera to shoot from the screen of the Sun. Things change, things remain the same.

Issues in the Teaching of Animation

If the computer has changed animation for me at has done so by broadening the relational base upon which images may be dreamed and realized. I cannot think of renaissance perspective in the design of image space without attaching to that space the potential for rotation, scaling and translation in matrix algebra. When the movement of an object produces rhythms, I relate these to algorithms. I cannot escape seeing the the same forms in the process of programming that attract me when I work out ideas through montage in film. I am not really sure that the pixel is replacing the frame, but I know that it has given the frame a depth and a new elegance. What concerns me about the changes I feel but can not fully analyze is that I am not the same as the students that I teach: I have made the journey, but I can't help looking back; they look to me for guidance but need only to keep their gaze on the future.

Footnotes

[1] J. A. F. Plateau introduced the phenakistoscope in 1832. Zoetropes were common in the 1800's. In 1879, Emil Reynaud used his praxinoscope to project drawings made on transparent film. This predates Edward Muybridge's projection of the "Horse in Motion", a series of still photographs, which utilized the zoopraxiscope. Edison and Lumiere had not yet invented cinema. —from The Shoestring Animator, by Byron Grush, Contemporary Books, Chicago, IL., 1981.

[2] It is worth noting that the smallest part of the traditional animated film is the "frame" —a full tone, two-dimensional surface capable of holding a discernable image suggesting the illusion of 3D spatial reality— while the new technology allows us to address its smallest part, the pixel or other image unit, which is less than an entire discernable image. As animator Mary Beams has said, as the computer has come into play, the frame has begun to disappear.

[3] Push pin animation, pioneered by Alexander Alexeieff and Claire Parker in the 1930's, was perhaps the first pixel manipulation in the history of animation. A large board penetrated with thousands of pins painted black on one side and white on the other was manipulated using rollers to produce "rendered" images which changed, not according to contours, as in conventional animation, but pin by pin. —from Experimental Animation, An Illustrated History, by Robert Russett and Cecile Starr, Van Nostrand Reinhold Company, New York, 1976.

[4] p. 18, Fundamentals of Interactive Computer Graphics, J. D. Foley, A. Van Dam, Addison-Wesley Publishing Company, Reading, Ma., 1982.

[5] As animator Paul Jessel has said, there are just two techniques in (commercial) computer animation: the "fly-through" and the "break-apart". Beyond this there seem few ideas being offered that can't be done better through traditional means.

[6] motion aliasing, etc.

[7] p. 100, An Introduction to the American Underground Film, by Sheldon Renan, E. P. Dutton & Co., Inc., New York, 1967.

[8] My book, The Shoestring Animator, is based upon the idea of "doing what you can with what you got."
[9] Presentation notes: "Animation Techniques", National Computer Graphics Association Conference, Chicago, IL., 1983.

Computer-Assisted Improvisation

Dr. David K. Barton
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A Postmodern Improvisation Ensemble
&
Associate Professor of Music Theory &Composition
Director, IUSB Computer Music Studio
Division of the Arts
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Abstract
This presentation describes my computer-assisted improvisation ensemble, PLATO & the Western Tradition, which has served as a laboratory for the development of some pragmatic suggestions about computer-assisted improvisation, which I present and discuss.

For nearly three years I have been the coordinator of PLATO & the Western Tradition, A Postmodern Improvisation Ensemble. Since January, 1988, the performers collectively known as PLATO have produced 235 audio pieces, some two dozen of these as soundtracks to video pieces, and a number of public performances in our region of the country. Everything which PLATO has done has been improvised; indeed, even the makeup of the ensemble is ad hoc, depending on who can get together on a particular occasion. PLATO in private is primarily a computer-assisted musical improvisation ensemble; in public performances we include dance and video, both improvised. Over these years we have developed a musical language and style which is best described as being eclectic, experimental, conceptual, and unlike most other computer-assisted musics. I believe that I have some insights to share about the pragmatic things which we have learned about computer-assisted improvisation; even though I will speak primarily about musical things, I hope that computer artists in other disciplines will be able to apply my insights to their own work.

Why is improvisation such an essential part of high-tech art? For me it is the culmination of twenty years of work in electronic and computer music, years in which I performed my compositions in tiny closets called electronic music studios, spending hours putting sound on tape, mixing down, and doing all of the performance things all by myself. What I usually presented to an audience was the very undramatic and unmusical spectacle of someone turning on a tape recorder when the piece began, and turning it off when it was over. Of course, I used dancers, visuals, all sorts of things to give the audience something to watch, but the music was always canned, pre-recorded, performed without any risk that it would be different this time than it was the last time.

The advent of inexpensive computer music systems, computer sequencers, and MIDI represented to me a realization of my dream of performing electronic music as a live, performed musical art. But I quickly realized that there was no difference between turning on a tape recorder and turning on a sequencer—I still wasn't performing on the stage. So I got together with a friend who had a computer and a keyboard, we set up a sound system and tape deck, and recorded the first PLATO tape in late January, 1988.

By the end of 1988 we had created 105 audio pieces, performed a dozen concerts, added two more people to the core ensemble and played occasionally with half a dozen more, and began to include improvised dance, vocals and texts, and video in our private and public performances. In both public and private PLATO sessions the most gratifying element to me was and is that it is live music; that even though some elements of the musical or visual textures may be precomposed using computer technology such as sequencers, voice programming, video and audio effects palettes etc, the piece itself is cognitively created at the moment of performance. Any precomposed bits are just materials which happen to prove useful to the performers at that time.

Improvisation implies danger. One runs the risk that one will make a mistake and in public, no less. One's ability to improvise depends upon one's total store of knowledge of the art form in which improvisation is taking place, as well as upon one's ability to control and manipulate the tools with which one is improvising, be they computers, keyboards, software packages such as LIVE, cameras and monitors, etc. An improvising ensemble of musicians, camera people, dancers, video artists must develop a common shared vocabulary of all of the elements which they are bringing together; risks must be taken together and the consequences shared.

Eventually, I believe, an ensemble like PLATO becomes another way of living, a mode of being which one enters into while performing, and can revisit in a different way when listening to or watching the artifacts resulting from performance. We improvise for ourselves, as a communal group of diverse artists making art together right here! Right now! Before your very eyes and ears! If there is an audience, and if one person in that audience is changed by our art, so much the better. I hope to send some of you away from this symposium with the inspiration to form your own improvising artistic cooperatives.

II.

PLATO is an idea: "WHAT IF we put all of our equipment AND all of our talents in one place to make something?

PLATO is an attitude: "Turn on the tape recorder and/or the VCR and accept as a representation of our selves WHATEVER happens."

Never Rehearse, Always perform.

PLATO is people:

I am the Coordinator, for want of a better term. In my other life I am a Professor of Music Theory & Composition and Director of the Computer Music Studio at a small, but excellent Midwestern University.

Boyd is a journalist, musician, filmmaker, and video artist.

Lina is a library computer operator, singer/songwriter, dancer, and graphic artist.

Phil is a bookstore clerk and a composition major in the music program at my University.

Beyond this core of four, PLATO is:

Walter, a video software engineer for Truevision in Indianapolis.

Mickey, a stained glass artistan from Grand Rapids.

Donald, a stockbroker for A G Edwards, Inc.

Fred, a recently-laid-off software designer for Bendix.

Kurt, a free lance audio engineer.

And, a number of other musicians and other artists

Whenever two or more of us gather to make art using the idea and attitude of PLATO, PLATO happens.

PLATO is computer-assisted improvisation:

Of course the keyboards are special purpose computers; and, MIDI is a digital communications system. The actual computers are used in two ways:

1) we make some sequences at home before PLATO meets, use them when and if we want to. Just because a sequence is available to be used doesn't mean that it has to be used.

2) we use the computers to record PLATO (in MIDI code, of course), use the recorded information later in the same piece, in another PLATO piece, or in a composition which will have nothing to do with PLATO. Recently, however, the computers have stayed home, and everything has been created "live".

III.

I have learned a lot of things from the PLATO experience. One thing is that there are no rules, only some guidelines, which I would like to present to you, with the caveat that these guidelines, no matter how dogmatically I present them, have been true for me in particular and may not be true for you. Even some of my colleagues might not agree with everything which I will say.

Guidelines for computer-assisted improvisation:

1) Prepare computer materials in advance; but do not feel compelled to use them when performing. Always be open to the opportunities to use them in ways which you didn't foresee. Make sequences, set up video pallettes, organize audio treatment systems (MIDI controlled effects processors chained together in specific configurations), get out your controllers, cameras, microphones, and homemade instruments—everything should be available, but plan very lightly and vaguely.

2) Most prepared materials should be as generic as possible. Musical things should be things which can be played with or against, let the leads happen in response to a bass, a rhythm thing, a tiny melodic idea, a noise. When you bring in a strong lead sequence, be prepared to do something with it or against it. Your colleagues will always surprise you with their responses to your material.

3) If you goof—wrong note, wrong key, wrong colors, the most awful sounding voice (that horrible preset brass on the CZ1000 for example)—stay with it until you have made something of it. Actually, there are no wrong notes, keys, voices. If you stay with your "mistake", the ensemble will make something of it with you.

4) In general, avoid the familiar. Don't fall back on etudes, pieces you know, pop tunes. But, if you do get into some- thing which is known, make something of it. I find that a sense of playful irony is the best attitude to take to those bits of the musical present and past which unavoidably crop up.

5) Don't play all the time. The more people you are playing with, the less you have to play. In every improvisation your fellows will occasionally leave you hanging—out there BY YOURSELF while they're changing voices (or their minds). Don't panic, just play.

6) If you and your colleagues are at all congenial, you will discover about the second time that you play together that you will be making changes at the same time, without any communication other than the music which you are making. This is one of the most intriguing aspects of conceptual improvisation: everyone playing will go to exactly the right (different) new thing at the same moment. Wonder about it, enjoy it, don't try to force it, your minds will take care of this for you.

7) Often, it is fun to play against the group—to play ugly when the ensemble is pretty, or vice versa. Usually you will become the catalyst for change, so be prepared to lead for a while.

8) Beginnings are easy. Just pick a voice, setting, and play something. Endings are hard—the rock 'n' roll fade at the end of the tape is the easy way out. "Classical" endings—cadences, cadential gestures are much harder, but much more rewarding when they work.

9) When it is important to you, talk with your colleagues. Call out the key or whatever you need to say to realize your idea. PLATO doesn't do much of this, but it has been useful. Usually the only verbal cue which we use is that the person watching the tape deck will say "this is the ending", which means that we will stay with whatever we are on until the fade or ending has been finished.

10) Whack out your instruments and computers. Since we are using consumer gear, remember that the settings of the voices and effects are preset for a narrow range of what the engineers perceive to be musically useful IN A COMMERCIAL ENVIRONMENT ("pop" music). But, the range of numbers which can be plugged into the data slots is much wider than that narrow range. Use the extremes—very large or very small numbers. This advice is particularly useful with regard to effects processors.

11) Make your own instruments. Use the "acoustic" instruments of the world. A paper towel tube with a bassoon reed and a microphone is a marvelously expressive instrument. If you can find a cellist or whatever kind of player who isn't bound by his training and literature your music will be much richer in textures and associations. This is tricky, though. We began with a sax player, a very good one and a very nice person. But we found that he played too many jazz riffs, and that he wouldn't stop playing. We felt frantic and dominated, and soon went our separate ways.

12) The synthesized or sampled versions of "real" instruments or families in our systems are only metaphors for the "real thing". I use a brass voice not because I believe that I can actually sound like a trumpet or horn, or play on a keyboard with the nuances of technique and articulation which a brass player would use, but because it is useful for me to evoke in my own or my listeners' minds all of the emotional and cultural information with which I or they have been programmed by our culture to experience when we perceive these sounds. The same attitude informs my use of older and newer recognizable styles of music; a Baroque, or New Age sound evokes certain responses which may be useful if only because they can provide moments of familiar territory in your conceptual drama.

13) Style. Anything goes, as long as it works. It really depends upon your ensemble. If you are into jazz, you will improvise jazz, for example. We don't do jazz, but it's because we look to Satie, Cage and Stockhausen as our mentors, (and Phil Glass as someone to emulate with tongue in cheek).

14) Make up a language. You will find that certain voices, styles, riffs, sequences, sounds, techniques, become a collection of tools upon which you will draw for improvisation. This is your language. For example, the voices in my DX7 have been relatively constant for PLATO for nearly two years. My colleagues have some reasonable expectations about what I will do in a given context, and I know the same about them. BUT, keep changing and moving. Add something new, take something away. Look for the new "What if I..." situations. Be unpredictable. When you can afford it, add a new piece of gear to your ensemble, and whack it out!!

15) A common criticism of computer music is that it is too precise, that it has an inhuman regularity to it. True enough. But I believe that we should exploit this new capability, that we should find the musical ways to create meaningful art using very precise systems. If my sequencer allows me to create something which a human couldn't play, it still is my creation, not the computer's. Computers realize our ideas. A sequence which sounds "normal" at 120 beats per minute sounds very different at a whacked-out 444 beats per minute!

16) Perform in public when you get the opportunity. Some insights about public performances:
You will confound and confuse your audience's expectations.

We can do amazingly complex things with one finger, our physical gestures are small compared to those of a pianist or a rock guitarist. Most of the work of a computer-assisted improvisation is mental, we cognitively create the piece while we are playing it, we haven't had to learn the complex physical gestures of conventional musicians. If you are just doing music, there is very little for an audience to watch, and they expect to have something to watch.

So, find a dancer, find a video freak, and improvise dance and video along with your music. If you are a video person and want to get into improvisation, find some musicians to provide an aural environment for your images. Bring as many arts together in one space as you can. Actors can move, and do texts. A painter could paint, a sculptor sculpt. Build something in the performance space. Eat your lunch while performing.

If you are doing so-called experimental or conceptual art, expect your audience to dislike it at first. After all, most of them have never experienced anything like you ever before, and they do not have the acquired mindset which would enable them to cognitively create your piece along with you. Some of our most innocuous moments have been described as Satanic. We use program notes to try to orient our audiences, describing our pieces as dramas to which each member of the audience is invited to contribute their own scenario.

17) Never judge your work until you have heard the audio tape or seen the videotape. Each of us, and everyone with whom we have played has reported a similar experience the first time or two. "I felt like what I was doing was so stupid, that I wasn't contributing anything at all." Yet the artifact created while those feelings were happening usually is very much worth keeping and enjoying. I still feel out of it sometimes, but I know that this is a feeling, and not reality.

18) Above all, have FUN. PLATO has created 235 audio pieces, two dozen video pieces, presented public performances and workshops all around our region, and kept us all in touch with the creative potential in each of us. We have no expectations of fame and fortune. If that should happen, we'd be delighted, of course. But we do it because it is more fun than anything else we can think of to do.

The kinds of tools and the complexity of materials which computer-assisted artistic systems have placed literally at the fingertips and in the hands of artists of all disciplines is phenomenal. We have control which we never had, we can be ever so precise (up to the limits of our systems, of course). Improvisation allows us to create situations in which we can be spontaneous in our use of these tools and materials, situations in which we can create art which has never before been seen or heard. You may not care for what PLATO does, but I hope that those feelings will not prevent you from trying out your own kinds of improvisations.

Curriculum Issues in Computer Graphics in the Visual Arts

Deborah Sokolove
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Nearly 200 professional art schools, two- and four-year colleges and universities are listed in the latest version of the "Computer Graphics Arts Directory: Computer Graphics for the Arts, Architecture and Design," which is compiled by Barbara Mones-Hattal and published in the ACM/SIGGRAPH journal, *Computer Graphics* .[1] All of these schools say that they teach computer graphics in one or more of the following areas of the visual arts: fine arts, interior design, environmental design, architecture and/or exhibition design; animation; graphic design, commercial art, advertising design, illustration, typography and/or videotex; TV production, art video, film and video, and/or interactive videodisk; industrial design, CAD, and/or product design; electronic publishing; image processing and/or programming; textiles, sculpture, printmaking, music, theater, an/or teacher training; general. Degree programs in some or all of these areas are offered at the Associate of Arts, Bachelor of Art, Bachelor of Fine Arts, and Graduate levels, and certificate programs are offered at all levels from undergraduate and technical to post-graduate.

It is obvious from this list that there is considerable overlap between and among the programs. It should also be obvious that there is great diversity. A graphic designer, an animator, and a sculptor, for example, need to know different things about computer graphics. Therefore, what is appropriate to teach at one institution or in one program might be completely inappropriate at another institution or even in another program within the same institution. In 1987, an Educators Workshop was offered at SIGGRAPH which described the scope and content of a number of these programs.[2] By 1988, some arts educators were beginning to think about standards, guidelines, recommendations. Institutions that knew they needed to add something called "computer graphics" to their curricula but didn't know how were asking for help; established programs were facing decision points as interest and enrollments soared and both curricula and equipment became inadequate or obsolete; prospective students, industry and institutions all wanted to know what the various certificates and degrees in computer graphics meant.

The "Dream Curriculum Survey"[3] was an attempt to address these questions and problems by asking arts educators about their personal approach to making art with computers and how they saw the purpose and direction of computer graphics education in the visual arts. The survey was sent to over 400 individual educators and institutions, and included the following questions:

1. What role do computers play in your work? Do you use a computer as part of the design process? How does the direct output (hardcopy) contribute to the finished artwork?

2. Do you program? Do you think that it is important for artists who use computers to know how to program? Why?

3. Should computer graphics be included in the foundations courses in an art department? If so, should it be a standalone course or be included within the context of existing courses?

4. Should computer graphics be a separate option or major for art students? List the course titles and/or course content that would go into such an option or major or include a copy of the catalog if such a program exists, noting any changes or additions that you would like to make.

5. Is computer graphics more appropriate for students concentrating in design or studio arts?

6. What is the "original" of a computer-assisted artwork? Should this issue be raised in the context of a class?

7. What are your proposed goals in introducing computers in the arts?

8. In your dream curriculum, which course(s) might be established as a universal class that could be targeted all over the US, meeting some of your proposed goals? Please describe the content of this course or attach a course outline if you thing you have developed this course already.

9. Are most of your students motivated by job possibilities in the field or purely by the content of the curriculum?

The 58 respondents to the survey were on the whole articulate and very eager to air their often-passionate viewpoints. Because the questions were deliberately open-ended, to stimulate thought and debate, many educators wrote several pages of considered response. Many set sample syllabi, course descriptions, catalogs of current programs, and equipment lists. In reading the responses, it became clear that there are some clear lines of division regarding what is to be taught and how to teach it, and the many of these lines occur along the lines that divide disciplines within the arts.

For instance, there is the question of whether artists should learn to write computer programs or use off-the-shelf hardware. In general, most interdisciplinary and many fine arts programs tend to favor the artist-as-programmer approach, which most graphic design-oriented programs favor the artist-as-user approach.

Another area of difference lies in the question of whether computer graphics can or should be a separate major, a specialization within the Art major, or simply integrated into courses as appropriate. Answers to this, too, tended to fall along discipline lines. In general, programs that specialize in the various design areas see the computer as a tool which art students should master along with the traditional hand tools. Many respondents with a fine arts orientation expressed similar notions, adding that computer art is too amorphous an idea to be a major, but it might be a field of specialization within an art major.

Those who argued for a major in computer graphics were largely those whose orientation was toward interactive, multimedia and/or interdisciplinary artforms in which computer graphics is central.

From the sample course outlines and lists of topics for first or universal courses that were submitted, it became clear that there was some core body of knowledge regarding computer graphics that most arts educators believed that every one using computers in the arts should know; and that at least some of this should be taught to all art students, regardless of their intentions to use computers as an expressive tool or medium in the future.

Early in 1990, ten artist/educators working in diverse field utilizing computer graphics, at all post-secondary levels, met over three days with Samuel Hope, the administrative director of the National Association of Schools of Art and Design (NASAD)[4] to discuss the curriculum issues addressed by the Dream Curriculum Survey. Out of these discussion, position papers were produced by small working groups. These position papers were used in the formulation of curriculum guidelines, and included the following recommendation for computer graphics as a part of the foundational studies of all art students:[5]

> ...as computers are becoming a ubiquitous tool in the visual arts, computer graphics deserves a place in the general foundations courses for all art students, along with graphite, charcoal and paint. They find that computer systems provide a natural vehicle for

teaching students design principles, color theory and for stimulating creative thinking. Computers provide immediate feedback and can be used in a spontaneous, fluid manner for exploring the visual dynamics of a composition. Increasingly students are familiar with how computers work and can use them effectively in the learning process. More important, however, is the significant potential of the computer in the evolution and development of new modes of artistic expression. The computer is a multi-dimensional medium that provides the artist and designer with different modes of communicating or expressing concepts or ideas. These modes include visual imagery, text, sound or music and movement or animation. No other tool or medium provides this diversity of expression in one device. The computer studio allows the artist and designer to work in these different dimensions of human experience individually or simultaneously.6

The guidelines for foundational studies in computer graphics were written as a series of competencies. Respecting the notion frequently expressed by respondents to the Dream Curriculum Survey that it is not possible to prescribe a universal class, the workshop focused on a series of skills and understandings that students should get at the foundation level, preparing them to move on to more advanced work. The foundation level competencies are as follows:

1. Basic understanding of computer vocabularies, terminologies and concepts including an overview of types of hardware and software, programming, storage, networking, and the nature of technological development of computers and computer graphics.

2. Basic skills in use of computer graphic tools, related technologies and interactive processes.

3. Orientation to achievements and prospects in computer production of work in 2D, 3D, animation, sound and interactive environments.

4. Orientation to theories and conceptual organizations concerned with light and color, input and output devices, and interactive devices.

5. Ability to solve simple visual problems using the computer and peripheral devices.[7]

Institutions may implement these competencies in any way that is reasonable within their various programs. Some may find that it is useful to integrate computer graphics studies into existing foundations of art courses. Others may wish to have a separate computer graphics course, which is required of all art majors. Still others may combine both approaches, using the computer within general foundations courses to teach art and design principles, and the separate computer graphics course to explore more fully the issues and skills specific to computer graphics.

Appendix: Dream Curriculum Survey Summary

The following is a summary of the responses to the Dream Curriculum Survey.

1. What role do computers play in your work? Do you use a computer as part of the design process? How does the direct output (hardcopy) contribute to the finished artwork?

A number of respondents said that the use of computers was essential or central to their work. Specific uses or application areas included the following:

- teach computer graphics
- teach color and composition
- desktop or electronic publishing
- interactive installations
- software development
- charts, graphs, posters
- problem solving
- design for sculpture
- animation/video

Of those who responded to "Do you use a computer as a part of the design process?" most said or implied yes, 2 said no, and one said it played a small part.

Hardcopy was variously described as:

- slides
- cibachrome prints
- laserprints/inkjet prints
- plotter drawings

typography/imagesetting
videotape/animation
other/mixed media

One respondent said that hardcopy was irrelevant, another said it was not essential except as a rough or comp, and several said that it was difficult to get good quality hard copy.

2. Do you program? Do you think that it is important for artists who use computers to know how to program? Why?

Several respondents said that they know how to program, but either not sufficiently to be very useful, or no longer bothered. These are included in the "yes" category.

yes	32
no	26
	total 58

Most of the respondents here replied in terms of whether art student should learn programming as part of their computer graphics instruction

yes	23
no	21
maybe/no answer/it depends	14
	total 58

Many who said "maybe/it depends" were those who said they programmed "a little." However, some who said that they don't program themselves believe it to be a good thing to teach to students.

Reasons given most often why artists should learn to program:

increase understanding/breadth education
extend limits/control
truth to the medium

Reasons given most often why artists don't need to program:

sophisticated affordable graphics available
interferes with creative process
waste of time

3. Should computer graphics be included in the foundations courses in an art department? If so, should it be a standalone course or be included within the context of existing courses?

yes, as a standalone course	17
yes, in existing courses	26
not clear/both	6
no	7
depends on presentation	2
	total 58

4. Should computer graphics be a separate option or major for art students? List the course titles and/or course content that would go into such an option or major or include a copy of the catalog if such a program exists, noting any changes or additions that you would like to make.

A majority of the respondents said that computer graphics should be either an option or a major for art students. Of those who said no, most said that it should be incorporated into the general art and and/or design curriculum.

yes	37
no	8
maybe/it depends	5
no answer/unclear	8
	total 58

5. Is computer graphics more appropriate for students concentrating in design or studio arts?

Many respondents mentioned that needs are different for different types of students, suggesting different orientations to courses.

design	9
studio arts/fine arts	3
both	38
don't know/no opinion	8
	total 58

6. What is the "original" of a computer-assisted artwork? Should this issue be raised in the context of a class?

the original is:

not important/irrelevant	14
program or data	6
hardcopy	4
an interesting question	25
in the mind of the artist	3
no answer	6
	total 58

Is this an important issue to raise with students?

yes	37
no	7
no answer	14
	total 58

7. What are your proposed goals in introducing computers in the arts?

The goals mostly fall into these categories, with many respondents stating multiple goals:

innovation in the arts	42
career/job training	18
reconcile art and science	3
build existing program	8

8. In your dream curriculum, which course(s) might be established as a universal class that could be targeted all over the US, meeting some of your proposed goals? Please describe the content of this course or attach a course outline if you thing you have developed this course already.

A number of respondents gave ambiguous and/or overlapping answers. The results need further analysis.

no answer/don't know	12
shouldn't be a universal course	8
referred to existing curricula	12
an intro to CG course	15

Most course outlines submitted included a survey of hardware and software. In addition, many respondents stressed the importance of:

- history of computer graphics
- relationship of computer graphics to the rest of art and society
- critical perspective on technology and art
- language skills
- good design basics
- versatile nature of the computer

9. Are most of your students motivated by job possibilities in the field or purely by the content of the curriculum?

jobs	21
content	6
both	27
don't know/no answer/other	4
	total 58

NOTES:

[1] Barbara Mones-Hattal, "Computer Graphics Arts Directory: Computer Graphics for the Arts, Architecture and Design," ACM/SIGGRAPH *Computer Graphics*, June, 1990.

[2] Donna Cox, Isaac Kerlow, Barbara Mones-Hattal and Kenneth O'Connell, SIGGRAPH'87 Workshop art track.

[3] See appendix

[4] NASAD is the major accrediting agency for post-secondary education in the visual arts.

[5] Participants in the workshop were:
Tim Binkley, School of Visual Art
Sharon Ford, Rancho Santiago Community College
Craig Hickman, University of Oregon, Eugene
Samuel Hope, National Assn. Of Schools of Art and Design
Gail Jamieson, Phoenix Community College
Tony Longson, California State University, Los Angeles
Barbara Mones-Hattal, George Mason University
Ken O'Connell, University of Oregon, Eugene
Anne Seidman, Moore College of Art
Deborah Sokolove, George Mason University
Joan Truckenbrod, School of the Art Institute of Chicago
Much of the language in the guidelines document came from the participants.

[6] Barbara Mones-Hattal, Kenneth O'Connell and Deborah Sokolove, "Dream Curriculum Survey Summary," ACM/SIGGRAPH *Computer Graphics*, June, 1990.

[7] ibid.

Seven Keys to New Poetry

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The computer program is a polymorph. It shapes itself into sinuous dances, music from instruments unimaginable, surreal art, poetry that no book could contain.

In this paper, I'll consider seven different ways the computer can be used to create new poetry. These are seven programming techniques for writing poetry software: interaction, branching, information storage, graphics, motion, sound and randomness. Three aspects: interaction, branching and information storage are closely connected, so Ill discuss them together. Graphics, motion and sound are used in similar ways, so I'll look at them together also.

Before we turn to these specifics, let's look at the more general computer scene in literature. There is a division in the way computers are being used by artists. Some artists are using software written by others to produce their new works. Others are programming software that itself is the new work - this is what I do.

The distinction is between <u>using</u> software as a tool and <u>writing</u> software that is an artwork. Software that is artwork I will call artware. Such artware is usually played by the audience on a home computer and viewed directly on their monitor.

An example of software as a tool is the word-processor: a souped up typewriter that takes care of the dirty-work of correct spelling, neat margins and so on. Other software tools are the many wonderful painting programs available. I've used one called deluxe Paint to make concrete poems.

An example of combination software (tool + artware) is Kale Chatfield's "Poetry Tutor". Some sections are tools to help you write a poem by teaching you different forms, or to help you understand a poem by asking and answering questions about selected poems. Some sections are artworks that generate computer poetry.

An example of software as artware is "Racter", a manic off- the-wall, interactive storytelling program by Tom Etter. Another example is "Mindwheel", somewhat in the adventure genre, and very artistic.

Software tools are wonderful, enabling non-programmers to work with computers, They do, however, confine the artist to the limits of the program. There are also very few tools to help writers do interesting projects. By far the most useful is "INRAC", a marvelous, high-level programming language that enables the author to create sophisticated interactive literature. "Poetry Tutor" is written in this language. But even this wonderful language imposes limits. And this is why I decided to join the group of artists that do their own programming.

In experimenting with different kinds of poetry programming, I've found seven things that have been especially valuable to me. These are aspects of programming that can be used in creating artware. Each is a device I use or hope to use in writing programs to be played by the reader on a home computer and viewed on the monitor.

Lets look at the first three: interaction, branching, and information storage.

I use these to write my favorite poetry - a kind of Adventure poem where you are presented with some poetry and then asked to respond by typing instructions or choices on the keyboard. The poem branches to one or another stanza depending on what you have input.

Think about interaction: Normally I'd have to be some kind of minstrel - to be present along with my poem - in order to make it to suit your individual mood. I could watch your face for clues, perhaps, or listen for your laughter in order to present you with the style of story that entertained you best. The audience would be limited to those listening to me. With a book, the number of readers is not limited, many copies can be distributed, but each copy is the same, unable to respond to the individual reader. An artware book, however, can be programmed to respond to your typed input by itself, so there can be many copies, each one like a minstrel, branching to different phrases, stories, endings, depending how it interprets what you have typed in.

Think about branching: I am a member of the "dendritic school" of interactive writing, since I'm particularly interested in the branching capabilities of computer writing. This is actually how I got involved with the whole business: someone gave me an Adventure game. I could talk to the story, wander around the different branches, make it do all sorts of interesting things, because my choices made it branch to different events. It was wonderful!

Adventure games have a kind of branching I call decision branching - in this you make a decision at various points to determine the path of the story. In adventures, there are many branches, but usually only one "Best branch" - the one that solves the mystery, that leads you to the pot of rubies. On the other branches all kinds of disasters occur. In these quests you adapt to the book, trying to input instructions that will get you to where the author wants you to go.

There are many types of decision branching: some where you solve puzzles (e.g. can you figure out how to stop the bulldozer from running you over), some where you make moral choices (e.g. do you risk your life to save the drowning Martian?) some just random - (e.g. do you run right or left?)

But there is a special type of decision branching that interests me most, one especially good for poetry. I put it in its own category: this is mood-responsive branching. In this, based on your input, the program tries to figure out what mood you are in and provide you with the poem that would most suit that mood. So, in a mood-responsive poem, all branches are best, where you go depends on what your mood, personality and interests lie. My goal here is to have the book adapt to you, rather than you adapt to the book.

How can this be done? What are good ways you can get the program to branch?

The simplest is this: give the reader a multiple choice. An example from my poem "Allegro-Penseroso" is the two choice question, "Do you hear an oriole singing quietly or excited people talking?". This dual choice uses projective questions to glean your mood. If you hear a bird, I assume you are in a contemplative mood and you end up in the country. If you hear excited people, you are probably feeling more extraverted, and you end up in the city. The poem continues asking such questions, and branches to happy or sad poems, etc.

But the computer has more to offer. Think about information storage. In most adventure games, you can pick things up and keep them. First the computer does a word match - did you type "take sword", or "take ice cream". The computer then stores that information in it's memory, and looks there to make decisions. If you are in the meadow with the dragon AND you have taken the sword with you, you kill the dragon. If the program looks in your storage place and just finds ice cream - you'll end up being dessert for the dragon. Another example: you carry gold, and it adds to the gold you had before - the information can be weighted, and added.

I use a similar technique, but I search for keywords in a sentence that match words indicating a mood. For example, I'm writing a program called Mood Haiku, which looks through your sentence and tries to find things you see, then guess your mood.

Mood Haiku has a parser to tell which the subject and object of a simple sentence is. Words that are in the object nounphrase - adjectives and nouns - that match words in the program's dictionary are the keywords. Each word in the dictionary has a second section consisting of an identifying number. So frowning and gun each have the number 6. These numbers mark a position in an array, the mood array. Mood (I) is happy words, mood(2) is sad words ...mood(6) is angry words. Each time the program identifies an angry word, it adds one to the sixth position in the mood array. Whichever variable ends up being the largest determines which of eight moods you are in to see whether you get a happy, sad, loving, hating, peaceful, angry, humble or proud haiku.

This is the technique I'm working on for a poem called Isagel. Each word in Isagel's dictionary has a set of identifiers attached to it, one is for your mood and one for your personality type. A third relates to subject matter and a fourth is for special actions. So a lot of information can be stored and actions can be taken. Information can be corrected when new information comes in. Information can be used at a future time rather than at the present time. In Isagel I make a record of the reader's choices. Each mood has an identifier as before. But I use an array to make a record of your choices instead of just adding the choice identifiers together. This way, as the array gets filled up changes in mood can be seen, and a more accurate picture of the viewer can be gathered.

Another simple way to use information storage is demonstrated in a children's poem, Magic City. At the story's beginning, the child inputs some favorite items he wishes he owned. Later he finds them in a big gift. The words come out in all different sizes, fonts and motions. Here the child's own words are kept in special variables for later use.

Magic City just uses a few words, but by using information storage and interaction, a computer poem can let the reader be co-author of itself! The reader inputs sentences that are stored and combined with other sentences that are computer generated or previously programmed. The distinction between reader and author fades completely, with communal poetry the result.

But interaction, branching and information storage are only three of the ways computers can free poetry. Let's think about the next three neat things computers can do: Graphics, motion and sound.

Think about graphics. Programming graphics is instant feedback! I don't try to do realistic pictures. I'd just end up fighting with the pixels. I like creating graphics that are unique to computers rather than trying techniques that look better in other media. If you program artware, you want to keep in mind which computers the audience owns. For this reason, I've mainly used text graphics, and programmed on the PC, (though my children's program is on the apple, more common in schools) which means they can be run on any IBM clone, even those without standard graphics boards.

Think about motion. It combines with graphics to enhance writing, to focus attention and emphasize parts of the poem.

Abstract graphics climb up in random curves to emphasize an aspiring theme in a mountain climbing poem. In a somber poem, at the end blackness sweeps up from the corner and wipes out the page.

High-resolution abstract graphics based on mathematical formulas can look absolutely incredible, They can grow magically from a dot into lovely glittering strange patterns. The drawback is that it's harder to program and narrows your readership to those with computers having graphics capabilities. However, this is pretty common now, so I am using more of this kind.

Think about sound - here is another area for programming. It could personalize the poetry, as well as being used, as graphics are used, to emphasize, focus and enhance the writing. And you can get sounds out of the PC. In fact there's at least one public domain program to make your Pc talk. (It's called PC-Talk.) I haven't used sound yet for a poem, but it could be very important, particularly for viewers in whom the auditory sense is strong.

There is one more computer specialty to think about. This is the use of randomness. Randomness can lead to surprising and wonderful word connections. It is the heart of computer generated verse, where randomly chosen words or phrases are put in some poetic, grammatically correct form. But present day programming cannot generate meaning. Unless is it very narrowly restricted, computer generated verse is just logical hash - though the reader may discover meaning, just as is done with "Found Poetry". I've experimented a bit with computer generated poetry - letting the viewer choose the mood, so that each poem is a kind of tone poem. The dictionary of words available to the computer here goes from dark, gloomy words to very happy ones, so you get a tone poem. I did this because although computer generated poetry is logically meaningless, in this way, at least you could get some emotional meaning.

But if the randomness is restricted enough, it can lead to delightful and refreshing word combinations. I use it in Allegro-Penseroso to add variety when rereading the poem - here are some rereadings of the same lines: "Do I see a green bird or a black stone?" "Do I see a singing ginger flower or a mire?" "Do I see a dancing almond tree or a mad snake?" Each time the words are new and different, but restricted enough so that the poem is not just nonsense. And in an interactive poems, rereading is very likely to occur since the poem may loop back, or have several "twigs" from a single branch. Even in poems that skip branches you are still apt to find a scene you have encountered at some earlier reading. Poetry is better suited to rereading than other literary forms, because it is compact and rich. Good poetry often has many levels to touch different senses at different times. But more than this, more than just eliminating boredom, randomness has it's own special charm. Words get juxtaposed that I'd never think of together, yet when I see them, I love them, they are quite breathtaking.

So these are ways in which the computer can enlarge our vision of poetry. Poetry becomes interactive, branching, able to remember facts about us, able to respond to our mood and personality. Poetry is enhanced and focussed with graphics motion and sound. And it gains variety and wonder through randomness.

There is a danger to this programming. The danger is chat it's so much fun to design gimmicks, that you can lose emotional depth. You have to keep in mind what your goal is, otherwise you can distract both yourself and your reader from the meaning of the poetry. There is a place for tricks and entertainment, and the programmer may want to focus simply on that: pure entertainment. But this should be a conscious decision, not a default. From experience, I know how tempting it is to spend hours and hours making adorable pictures that have nothing to do with anything and then spend hours and hours jamming them into a program where they are about as appropriate as a stray dog wandering onto the stage of a serious play.

Of all the freedom computers bring, I think that interaction promises most for future poetry. And the area of interaction that promises the most may be mood-responsive interaction. The poem can respond to you, providing you with poetry that matches your frame of mind at the very moment you read it. In this way it can be most meaningful, speak to you most deeply.

Closely related to this, consider one more view of a responsive poem. Suppose the poem recognizes both your mood and personality type. So you see the poem. But remember, the poem sees you! It makes a hypothesis about you. As you go on reading and making decisions about what you want to read, the poem stores a map of the paths you select. It notes if you use bright cheery words or dark somber ones. It is making a model of you. At the end, the poem provides a picture of your state of mind, or your personality type - in short it could actually be a diagnostic tool - a sort of rorschach test. It would entertain you, so it wouldn't be as oppressive as a psychological test. It could also be used for self-monitoring.

But most important is to explore all aspects of interactive writing, and all aspects of computers in the arts. Computer literature of all sorts will flourish. Someday mood-responsive writing will take you anywhere your feelings and imagination suggest, and farther, as your computer responds to you with mind-expanding fantasies.

Genetic Sculpture

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Introduction

Over the last few years, I have been experimenting with methods of using computers to design sculpture. My work currently follows three separate lines of investigation: developing techniques of using computers to simulate traditional methods of designing sculpture; generating sculptural forms from sequential statistics; and developing three-dimensional forms using principles of genetic evolution. This paper focuses on my efforts to develop a design approach based on principles of genetic evolution and presents speculations on the effects this approach may have on the process of making art.

Background

At last year's SCAN Symposium, I presented examples of my earlier efforts to create sculptural forms from sequential statistics. There are strong analogies between institutional entities, such as corporations, and organic entities, such as plants or animals. An institutional entity grows, adapts or diminishes according dynamic changes which are both internal and external to itself. This is very similar to the way an organic entity grows and changes. The dynamic changes of an institutional entity are measured and recorded as statistical data. In nature we see the record of changes in physical forms such as the annual rings of trees, the spiral growth of shells and the growth patterns of coral. The statistical measurement of an institutional entity and the physical measurement of an organic entity are analogous and interchangeable in recording an entity's development or form. From this premise, I developed methods of using statistical data to make three-dimensional, organic representations of institutional entities.

Statistical Sculpture

Creating visual representations of statistical information is commonplace in statistical analysis. Whereas analytic simulations attempt to verify suppositions and identify trends, my efforts to create three-dimensional forms from statistical data attempt to use statistical data as a source of personal experience and as a raw material for self-expression. I try to respond to statistical data in the same way I would appreciate the patterns in the grain of wood or carve a form from the trunk of a tree.

Computers provide the best way to process statistical data and to render the data as a sculptural form. In my first attempts, I used off-the-shelf software. I used a spreadsheet package to enter the raw statistical data in one column and to calculate of these values in several more columns. I then used a three-dimensional package to apply these values by a set procedure to create and render a three-dimensional form. Eventually, I streamlined the data processing and form creation procedures by writing my own programs. These programs read a set of statistics and write the file for the object which the three-dimensional software renders. Different sets of statistics create different forms.

This method of designing sculptural forms by following set procedures alters the role for the artist. Once the procedures are established by the artist, creating further sculptures using these same procedures no longer require the artist present. To successfully design sculpture in this way, requires the artist to take on new responsibilities. The artist must determine which statistical data to use; must clearly define and document his procedures; and must anticipate the potential compositions of future sculptures to assure that the resulting forms are acceptable.

Cumulative Selection

After the sculpture panel presentation, I spoke with Roman Verostko from the Minneapolis College of Art and Design. I mentioned to him that the analogy between institutional and organic entities could be extended further. I believed that an institutional entity must have an equivalent of a chromosome - the unique essence of an organic entity. If such a genetic seed could be identified, sculptures could be generated from this source rather than from the raw statistics. My limited knowledge of genetics hampered me from taking this line of speculation further. Roman suggested I read Richard Dawkins' book, The Selfish Gene. This advise brought me to a new approach to designing sculpture using principles of genetic evolution.

In The Selfish Gene and The Blind Watchmaker, Richard Dawkins presents several intriguing concepts about genetic evolution. First, Dawkins explains that Darwin's theories of natural selection and survival of the fittest apply best at the level of genetics rather than at the level of the individual or the species. According to Dawkins, the gene is the primary living unit which tries to guarantee its own survival. The living structures of plants and animals are elaborate physical extensions of genes which evolved from simple molecular configurations. These complex structures evolved because they assisted in the genes' survival. Dawkins further explains that this incredible evolution is possible through a process called cumulative selection.

In genetic evolution, cumulative selection is a process by which genes evolve into more complex genetic structures through a series of slight changes over numerous generations. With each generation, many genes are produced with minor variations. Even though the characteristics of all the new genes are based on the same "parent" gene, many of the "offspring" genes may be slightly different from the "parent" gene for a number of reasons. The most successful genes are those with a combination of characteristics which provide advantages in survival over the other genes. The successful genes become the "parent" genes whose "offspring" genes are more likely to carry the advantageous traits. Successful characteristics often mean a greater degree of complexity or specialization. Thus, from generation to generation, increasingly complex and specialized characteristics arise through a selection process governed by survival abilities. One important point in this process is that evolution through cumulative selection does not progress towards a pre-determined goal. Rather, evolution follows any direction of development that offers advantages for immediate survival.

To graphically demonstrate the process of cumulative selection, Dawkins has written an interactive computer program for his book the Blind Watchmaker. This program displays a simple two-dimensional shape in the center of the screen and a row of several boxes across the top of the screen. The central shape is the gene and each box corresponds to a genetic characteristic of the gene. In the Dawkins' program, characteristics are methods of altering the central shape. Examples of such characteristics are stretching, flipping or mirroring a two-dimensional shape. Values appear in each box indicating the likelihood and the degree of change for each characteristic. Within a small range of random variation, these values are inherited from generation to generation. The program generates and displays an array of several variants of the central shape. The person operating the program, selects one of the variants which then becomes the central shape. The new central shape, with its own set of values for each characteristic, becomes the source from which another generation of variant shapes are generated. With each new generation of variants, the program operator determines which form is the most successful design. The central shape very quickly becomes a highly complex or specialized two-dimensional design. Dawkins compares the development of the two-dimensional designs in his program to the evolution of complex, specialized organic structures.

Genetic Sculpture

Dawkins' computer program served as a model in my attempts to apply the principles genetic evolution to designing three-dimensional forms. The most significant aspect of this approach is the way cumulative selection provides a method for creating a form through a highly structured but open-ended progression of development. By generating variations of a form, the computer provides a method for the artist to consider many options. By building upon inherited characteristics, the program provides a method for the artist to develop a form which becomes increasingly more specialized. This combination of providing both options and methods of selection gives the artist the essentials for artistic expression.

The three-dimensional programs I have written which use cumulative selection are relatively simple. They work with elementary shapes, use very few characteristics and rely on commercial software to render the resulting forms. My programs create two ASCII text files for each form: one for storing the data for rendering the form; and one for storing the inherited characteristics and their values. A typical program starts with a tetrahedron. The data file contains the numerical coordinates of the points and the numerical order of connecting the points to form the proper surface polygons of the object. The characteristics file stores the types of modifications with their weighted values. The weighted values determine the modification's probability of selection and the degree of change. Typical characteristics include modifications such as moving one of the points of the object away from the center of form by a specified distance; dividing one of the polygons into three polygons; mirroring the entire object; and deleting a portion of the form by removing one of the points.

When a program begins, the values associated with each characteristic are set for equal probability. The program reads the data file and the characteristics file for the initial form and adjusts the coordinates of the form in a variety of ways according to the modifications called by the characteristic file. The program adjusts the values for each characteristic by a random amount within a limited range and, thus, the program produces many variations of the initial object. For each variation, a new data file and a new characteristic file are created. The forms are then rendered by the commercial three-dimensional software. The artist selects one of the variations and that object becomes the form whose data and characteristic files are used to generate new variations. With each generation, the three-dimensional forms become more complex or more specialized according to the artist's selections. These preliminary programs have produce some exciting and unexpected results. They also suggest several new approaches and possibilities for further development.

Pattern Recognition

The field of artificial intelligence includes the study of pattern recognition. The weighting of probability values in my genetic sculpture programs is a rudimentary form of pattern recognition found in artificial intelligence applications. By weighting the probability values of the function which selects the point or polygon to be modified, the program attempts to anticipate which point the artist will most likely want altered. The techniques which determine the weighting of the values, try to include information about previous selections. By extending the characteristics file to include more historical information about the development of the form, and by using several simple pattern recognition tests to the historical values, the program could more accurately anticipate the most likely, successful characteristics. The pattern recognition tests of historical data could replace the measured random weighting of characteristics.

Whereas randomly weighted values within a specified range assure a measured development of a form, elementary pattern tests of historical data would provide a method of designing a three-dimensional in a manner akin to expert systems. The result of the expert design systems is that successful three-dimensional forms could be developed more quickly. Well constructed pattern tests could be included easily in my programs as just another modifying characteristic. A battery of such historical pattern tests would be an essential component of this type of expert design software. More sophisticated programs could even query the artist to identify which characteristics and which pattern tests to use and how to set their initial weighted values.

Applications

Three-dimensional expert design programs could be used in many fields such as architecture, car design and product design. Each design application would require specialized design databases consisting of a unique combination of three-dimensional primitives, modifying characteristics and historical or expert pattern tests. The design databases could store information such as visual experiences, aesthetic principles and methods of fabrication. Artists would play an important role in developing these databases.

One of the more interesting potential applications of expert design programs is creating infinite, personalized, three-dimensional landscapes for artificial reality programs. Rather than a displaying an array of objects on the screen, the program would generate several landscape options displayed in 360 degrees. The artist would select a preferred landscape simply by moving towards the chosen terrain. With each step the artificial world around the artist would change and new landscape options would evolve around him. Within a few steps, the artist could move from a barren desert to a jungle or to a canyon or up a mountain. The new landscapes would be created as he moves. Three-dimensional creativity could be achieved just by walking around in artificial space.

Expert systems for designing three-dimensional products and art work are an inevitable development. Such systems will produce specialized designs of acceptable quality in less time and by people with less skill than that required of designers and artists today. By percentage, these systems will produce better design options; will visually present the options and the ramifications of the those options more clearly; and will be highly adaptive to new trends and new interpretations of basic aesthetic principles. Within the context of the today's design methods, expert design systems may seem to offer what might be called "design-by-multiple-choice". Although this prospect may seem dehumanizing and unnatural to making art, it will, nevertheless, attract the serious attention of many good artists. These artists will see the potentials for new resources in personal experience and new tools for self-expression. Artists who understand these goals have the opportunity to influence the direction of development of expert design systems and assure that these values are inherent to such systems.

Traditional or Technological? A Graphic Design Educator's Dilemma

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For over 400 years, printers needed to learn and understand a wide range of processes and techniques to be able to create printed words. As we approach the end of the twentieth century, many artists and technicians are learning to use computers as their first and primary graphic production tool, thus giving them access to techniques previously available only to the highly trained. Unfortunately, computers are too often used to create dull, unimaginative graphics because of the operator's lack of understanding of the entire graphic production process. Producing creative graphic designs on a computer with aesthetics, imagination, and originality requires a knowledge of the entire process again as printers had traditionally. More than ever, graphic communications educators need to teach their students to understand all parts of the graphic production process.

The first broad era in the history of mechanized printing dates from the advent of movable type and extends into the Industrial Revolution and the development of the Linotype. In 1455 Johann Gutenberg perfected the use of individual reusable letter blocks to print the Bible. It took only a few decades more to progress from the art of the calligrapher, when 50 or 60 writers toiled for two years to produce 200 volumes, to the art of the printer, when one man could publish 24,000 copies of a book in a matter of months. This technology was one of history's major innovations and stood for over four centuries. Ottmar Merganthaler invented the Linotype in 1884, the next quantum leap in printing technology, which allowed one operator to set, cast, and redistribute entire lines of type at speeds previously unimaginable. This advance dominated for less than a hundred years, with the computer coming into widespread use for type composition by the 1950's.

With the change to computer typesetting and type generated on photographic paper came the proliferation of lithographic printing which relied on photographic means to transfer images to flat printing plates. Computer typesetting increased the possible output speed astronomically and also opened up many new possibilities for the design and use of the printed letter. Today the computer has not only become easier to operate than most of the printing machinery used for decades, it can provide, at relatively low cost, the capabilities of a fully equipped production print shop.

Through most of this history, the printer had to possess a wide range of skills for his profession. As late as the sixteenth and seventeenth centuries he had to create all his own punches and molds to manufacture the type he used. Into the early part of the twentieth century, years of apprenticeship were still required for the printer to understand all aspects of the trade. This century, however, saw the increase in complexity of machinery used to accomplish many steps in the graphic production process, and so necessitated the specialization of graphic technicians to master many of these machines. The graphic designer became separate from the printer. While accomplished designers still maintained a complete understanding of the production process, few needed to actually operate camera or press equipment; that was left to the technicians. This artist had many tools and media of his own to master: pencils, various ruling and sketching pens, airbrush, watercolors, inks, markers, razor knife, rubber cement, T-square, triangles, circle and ellipse templates, lettering guides, transfer type, ruling tape, etc. Since proficiency in the use of many of these may require years of practice, most artists concentrate on a relatively small range of techniques, specializing in some area such as illustration, paste-up, or logo design.

The software used for graphic design and production initially emulated traditional artist's tools such as pen, brush, and scissors. Now since programs and their abilities have increased in complexity, and as laser printers and outline drawing routines like PostScript have become common, new design "tools" which could not have previously existed have emerged. Many, such as bezier and spline curves, are based on sophisticated mathematical formulas and could not be used easily or at all if not for the power of the computer. Some commands, such as "lasso," "clone," "group" and "ungroup," have no counterpart in the hand methods, but evolved out of the need to manipulate elements of artwork on the computer.

Now, much of the production work can be and is done on a computer by the graphic designer. This same computer can take designs from the thumbnail stage through to final comprehensive sketches and camera-ready art. In fact, it can yield press-ready negatives, eliminating a whole series of production steps. To do this well, today's artist must also be a technician. It is not enough to be able to recognize good or bad halftones, one must now also understand how screen resolution and angles affect a picture and exactly what screens are the best in any given situation.

The advent of the "desktop publishing revolution" made all the processes traditionally done by several specialists possible on one machine. The end result of this does not necessarily give one the power of these tools, but rather the burden of knowing how to use them. If it took years to become a proficient operator of the manual counterparts of these electronic devices, we cannot expect the artist with a desktop publishing computer to use those processes with any true skill without years of practice. For that matter, if we are faced with so many tools and operations at our beck and call, how can we really ever develop a profiency in all of them, or are we just going to dilute our ability to master one or two by spreading ourselves too thinly as artist and technician?

This brings us to the crux of the dilemma. Good aesthetic choices for computer-manipulated art and graphics are still the same as good aesthetic choices with pencil and paper. A motivated student of graphic design can go to an art school to learn basic design principles. The technical knowledge needed to understand the now computer-based field of graphic production can be gained in technical schools or on-the-job training. However, with the disappearance of the apprentice/journeyman training system in this century, it has become increasingly difficult to acquire a comprehensive overview of the graphic design and production field. It is precisely because today's students will be required to be both artist and technician that it is imperative that graphic design educators provide not just a basic design background and up-to-date technical knowledge, but also a solid understanding of the complete production process and its requirements. We may question whether it is preferable to teach computer graphic design by first teaching the traditional methods then introducing the computer, or whether we have reached a stage where we can teach all new methods, starting out with a computer as the primary tool? The key to discussion of this problem lies in deciding how far along we are toward completely replacing the traditional manual techniques of editing, cutting, and pasting with computer-manipulated tools and methods.

As recently as the 1960's it was felt that to truly understand how type should be set, it should be studied as it progressed historically: one would learn how to set individual letters by hand, then study how the Linotype worked. Finally typography students would learn how to adapt this knowledge to computer-controlled typesetting equipment. The modern electronic equipment was at that time based almost entirely on emulating the traditional methods of type, using terminology that, in some cases, dated back to Gutenberg.

Since the 1980's, however, computers have progressed to the point where they are able to control far more of the graphic production process than just the assembly of type. The era of "demand publishing," when books, magazines, newspapers, and many other publications will be custom produced to order has been predicted for some time. The technology for this is now available: Xerox Corporation recently announced the release of a completely new system, the DocuTech Production Publisher, by which original masters, from typed sheets or pages in a book to input from other computers, can be scanned and stored as digital data. The machine operator can manipulate this data to enable editing; rearranging; omission of sections; addition of copy; even merging of text, illustrations, and photographs from another source. The final desired result is printed out on a self-contained laser printer at the rate of over two pages per second, collated, and glue bound or stitched automatically within the machine. Additionally, the computer will manage the bookkeeping for up to 10,000 accounts. This one machine can now replace the equipment in an entire print shop: printing press, darkroom, platemaker, stat camera, film processor, light tables, photocopier, accounting computer, collator, binding equipment, etc.

If we are moving into an era of new methods and equipment which have no basis in traditional production, is there still a need to go through the teaching of graphic design by retracing the steps used before the revolution of computer-based desktop production? After all, typography is generally no longer taught by having students hand set foundry type. So many print shops and graphics houses process all their film with automatic machines that fewer technicians even know how to process film in a tray. The question remains, can an adequate background in the graphic arts be achieved without working one's way up technically from the days of Gutenberg, Linotype, and X-Acto knives, or is it possible for today's student to jump right into Macintosh technology and still become an accomplished and well-rounded graphic designer?

Twenty years ago one needed a wide range of manual skills and the ability to understand the entire technical process of graphic reproduction in order to be able to succeed in various capacities such as paste-up artist, production manager, or art director. My own background and training brought me through the ranks of letterpress printing, tray-processed color separations and stripping, and the creation of logos and designs with compasses, straight edges, and ruling pens. I frequently worked in situations where I did not have access to the most sophisticated equipment available at that time, but was able to achieve good results by using my knowledge of the graphic reproduction process. I also always believed that I was a better graphic designer and computer artist because of my understanding of how it was all done by hand.

Students today face a different situation after graduation than I did twenty years ago. They start to work for companies who now do most of their graphic production processes with desktop computer systems. Everything from designing, illustrating, typesetting, and photo retouching, to paste-up, color separation, and stripping is now being accomplished with a Macintosh. A fully-equipped desktop production system is within the range of affordability of even small firms and freelancers, which means that most of the production process can now be controlled in-house. Computers will get even easier and more intuitive to use, and demand publishing systems will become widespread, with every business capable of being a publisher. The result is this dilemma: the computer is making all sorts of previously highly technical procedures possible to be done by less and less skilled people. On one hand it has put the technology for the entire graphic production process into the hands of the artist and the layperson without needing to rely on the technician as before. On the other hand, the artist is now being forced to be the technician in order to be able to maintain this control.

In the next few years, today's students will be controlling the design and production of the printed word from start to finish much as the printer of the seventeenth or eighteenth century did. That printer needed a thorough understanding of all procedures used in preparing a manuscript for production. The graphic artist of today will likewise need to understand what can and should happen to all elements of a manuscript or design in publishing it. The tools have changed, and this will mean that the technical details of production will be quite different from those of the last century, or even from those of two or three decades ago, but it is still necessary to learn the principles of good graphic design and the needs of high quality graphic production. Only with a thorough understanding of the entire process from thumbnail sketch to comprehensive design, from typesetting and illustration to sizing artwork and paste-up, from negative stripping and color separation to printing, collating, and binding, can the graphic designer of the twenty-first century excel. It is therefore imperative that graphic design and communications educators recognize that, more than ever before, we need to provide our students with well-rounded training and a holistic approach to graphic production.

A Magic Link Between the Computer and the Camera

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Author for Holt, Rinehart and Winston Publishers

Abstract
In a few brief years, electronic imaging has swept away 150 years of traditional photographic materials and processes. Yet in many ways, the computer has strengthened the historic role of photography, providing relatively simple alternative approaches to on-the-scene as well as darkroom procedures that would otherwise be difficult, tedious and costly. The creation of electronic light, colorization, montage, multiple repeats, local stretching and shrinking of various elements within the photograph, proportion and scale changes, complex superimpositions of images on varied transparency levels and the instant transmission of imagery, to name but a few possibilities, have the capacity to transform the medium. And, we have only begun to communicate with the technology.

The Historic Past

Electronic imaging has at one fell swoop altered the physical processes used almost without change for 150 years by photographers ever since Louis Mande Daguerre first recorded that early image of the artist's studio. At the same time it has been strengthening many of photography's most traditional functions.

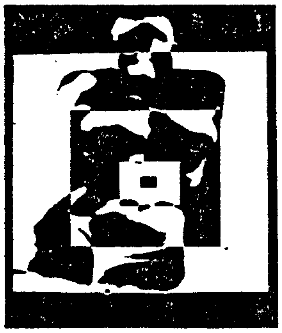
There is a magic moment for all of us who work in any phase of photography, when the eye, the lens, and the happening in front of us combine almost as a reflex action to form the arresting image. Such decisive instants in time and space cannot always be captured by conventional photographic means. Moments may slip by before we can make the necessary equipment adjustments. Or, the photographer may be personally too involved in the event, too close to view it objectively. sometimes, the observer's presence alone drastically affects what occurs, indeed often shaping the thrust of the images caught by the camera However, there are other electronic alternatives open to photographers that may bypass these problems.

For the last few years I have been working with a computer as an image-altering device that has allowed me to transform my pictures through various digital procedures. Many of these options replicate with ease what conventional photographic techniques, on the scene or in the darkroom, can produce only with great difficulty.

Louis Daguerre The Artist's Studio 1837

My initial attraction to photography as a career was much influenced by the editorial photographs of the late 1940's and the early 1950's, when *LIFE*, *LOOK* and *Fortune* dramatically changed what news presentations were all about. I was trained on the job in the use of a 4" x 5" *Speed Graphic*, and I longed to produce with my camera the impact of *LIFE*'s pictures that somehow transcended the events they recorded while they never lost touch with the real world. In my own way, I discovered that by using an untraditional perspective, my pictures frequently attracted attention. I also had to learn the intricacies of the studio view camera with its various swings and potentials for adjustment from what I saw in front of me. With that same camera, I first learned to shoot conventional portraits for the general public, determining also how to eliminate blemishes, double chins and the like by retouching the negative...no fun at all.

From those beginnings, my work has often continued to reach toward the alterable aspects of a photograph, and I acquired an airbrush, which I have always found a marvelous tool, both for photoretouching and for direct renderings as well. Recently, video imaging has become my primary route to producing special photographs. I convert my photographic images to the digital realm by taking a picture of my picture with a video scanner. In this way, I find that most of my energies have been directed toward an art that lies conceptually between conventional camera shots and traditional printmaking. The union of the camera with the computer is so rich in potential power that surprisingly enough, I have been drawn back to my earliest explorations which strike close to the heart of pure photography. The only major drawback in producing high-level computerized photographs, is ending with print quality as good as what is generally standard in negative to positive photographs.


Stella Russell Eve 1986


Stella Russell Troubador, Belgium

Perhaps, before we launch into the possibilities of computer magic, it might be wise to review the basic processes we use to translate a picture into a computer image. For photographers, the conversion of a photograph to an electronic signal is as simple as the focusing of our own cameras. Similar to any photo-copy set-up, an electronically operated scanner will trap an image, changing its size, by being positioned further or closer to the original. Other revolutionary still-video cameras that scan in (digitize) pictures do not use film at all. A part of the camera mechanism converts the photographed image into computer signals, using a minuscule silicon chip that holds hundreds of thousands of microscopic photoreceptors. The more of these picture elements—the goal is millions—the smoother will be the final results. These electronic signals permit an image to reappear on a television-like monitor connected to it. Minor adjustments can be made to reduce the contrast and to better preserve the intermediary tones of the original photograph. Then, voila, it is there. And, the real fun begins.

The more sophisticated programs are of course able to provide the greatest range of special effects, but some very simple operations have proven to be the most effective for me. The very first image that I made eight years ago happens to have garnered more prizes for me than any I have since produced. Reworking an image of a model whom I had photographed in one of the classes I taught, I made use of a box-like feature called *windows* from the software program known as *IMAGES:* Thereby,I was able to reduce the image of the figure to a series of squares.

The New York Times art critic reviewed this piece somewhat glowingly.

> *Eve was the Mother Of All Things* is particularly successful. The strange nonreality of undefinable electronic space is astutely handled by designing the figure to fall into four superimposed geometric areas. The equally unreal electronic light has been channeled to give the appearance of multiple illumination sources, as if a different time and place is being shown simultaneously. Remarkable too, for computer art, is the way an emphatic glow plays over fully rounded fleshy body contours. The piece manages to be sophisticated and at the same time frankly machine-assisted and modern.

All of this is fairly straightforward. But it is the relatively simple possibilities of montaging photographs or even elements from photographs that I find almost mind-boggling. While, assuredly, photographs do not lie, it is immediately apparent that they can be made *not* to tell the truth. We can colorize a black and white work and we can change its original proportions;... enlarging, reducing, repeating, montaging, and in fact, making so many alterations in so many easy ways that what you saw before the camera need not at all be the photograph that you end up with.

Particularly remarkable is the computer's ability to fuse several photographs together, but unlike a typical double or triple camera exposure, which by its very nature becomes a "washed out" overlylighted image, the computerized union of photographs utilizes - various level of transparency on each shot so that the identity of every component may be preserved. An effect is created that is at once real yet almost surreal in execution. The mundane may be transformed into the memorable, but never so altered that its real origins are lost.

Echoing, perhaps, the fracturing of our society into splinter groupings, the stretching of the facts to suit political advantage, and the minimizing of our weaknesses to avoid attention, the computer, with the right software, can distort every element of a photograph, pushing, pulling, bending, expanding and contracting to suit any purpose. We can caricature the truth or we can give the appearance of authenticity to the lie. It's all a matter of utilizing the right program to create any effect we wish.

The potential of the union between computer and camera has indeed barely been tapped. One of the most impressive uses of electronic technology may be the seductive impact of large-scale images. Like the media, which frequently presents imagery in segments, or sometimes in repeated sections, video walls developed recently, offer digitized still shots, assembled on individual monitors. Such stacked multi-monitor displays draw crowds wherever they appear and entertain consumers even in shopping malls. Their very presence two years ago was an attraction. Today, however. it takes more than a few stacked monitors to amaze people. Video-wall developers have invented bigger, better and more innovative products. And at the forefront of this image race is a new generation of video-wall technology—the "seamless" rear-screen projection multi-image display, an alternative that eliminates the obtrusive lines formed by monitor grids. By using rear-screen projectors (behind every screen), the wall of cubes appears seamless.

A final bit of electronic technology must be noted. The ability to send an electronic image via standard phone lines in only minutes offers exciting possibilities. In these many ways, instead of eliminating

Stella Russell Madeleine Burnside

conventional photography, today's phototechnology is permitting fresh new creative opportunities with which computer artist-photographers can experiment. Because of our limitations of space and time here, I have concentrated only upon a few of the aesthetic alternatives with which the computer can expand the photographer's world. We have only begun to communicate with the technology. The best of traditional conventional photography will no doubt survive, but the future for many of us may lie with the computer in the more specialized fields of computerized photography, such as sports, science, medicine, and even photography under the seas or in outer space. The future is already with us now. Will you step back from it, or will you try your hand at something new? Let me help you.

Peter Voci The Set 1987

Summary

Phototechnology has transformed the 150 year old medium of photography so drastically that the camera's images are popping up today from computer-run systems that eliminate film and chemical processing altogether. The basic ingredient is now electronics, recording a vision digitally with a scanner or a video camera ...either photographing from life or from a copy of an existing picture... and then storing it on a computer for later use. When this digitized visual material is accessed later, an artist can rework an image a thousand ways. We can colorize, as everyone knows. We can enlarge, reduce, repeat, montage, and make alterations in so many ways that what you saw before the camera need not at all be what you must stay with. In particular, the magic of photo-computer graphics may be its ability to combine photographic prints with live action and other more traditional effects that can result in a bonanza of arresting images.

ILLUSTRATIONS

Figure 1. Louis Daguerre The Artist's Studio
Daguerrotype 1837

Figure 2. Stella Russell Troubador, Belgium
Kodabromide 1951

Figure 3. Stella Russell Eve Was The Mother
Comp. Photo 1986

Figure 4. Stella Russell Madeleine Burnside
Comp. Photo 1990

Figure 5. Peter Voci The Set
Comp. Photo 1987

Computer Literacy for Film and Video Majors

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Abstract
A sequence of undergraduate courses was designed for students to develop computer skills currently in use in the film and video professions. The courses are arranged in a sequence which focuses on developing a broad range of skills over three years, starting in the sophomore year. Each course is meant to build upon the previous one. There are three main areas that this curriculum emphasizes; 1) scriptwriting, storyboarding and production planning, 2) paint system skills and 2D animation, and 3) 3D modeling and animation skills.

Introduction
Film and Video production are areas that require a high degree of planning to function effectively. Because of the high cost, the production process is broken down into many steps: 1)Preproduction: where the script is written, the storyboard is produced and the production is planned in detail, 2) Production: where the actual live action is shot or the animation is created, 3) Postproduction: where the editing is done, sound track finished, titles added, etc. In recent years, personal computers are becoming increasingly used in all three phases of this process.

As a means to prepare students for these professions, a sequence of courses was developed at the School of Visual Arts Computer Art Center. The idea was to give students computer skills that could be used after graduation. The three areas mentioned above are addressed in a variety of courses. Students may take any of the courses, but they are arranged so that each type of course is a prerequisite for the next advanced level. The courses are listed as Electives in the Computer Art, Media and Film Departments. In addition, some of the courses are required of Animation majors.

Curriculum Sequence

Sophomore Year
Computers for Film and Video
Computer Graphics and Animation
Introduction to 3D Modeling for Animation

Junior Year
Scripting, Storyboards and Animation
Intermediate Graphics Workshop
for Film and Video
3D Modeling and Animation

Senior Year
Intermediate 3D Modeling and Animation
Desktop Animation

The curriculum is spread over three years. It is designed so that each year builds upon the previous one. It is assumed that a single semester is not enough to fully master one's software skills. The sophomore level focuses on an understanding of how the machine works and a few basic software programs. The second year assumes a basic working knowledge and builds upon that knowledge. Students refine their software skills and learn some new programs and techniques. The third year focuses more on long term assignments and the concept to completion approach. For instance, a student would write a script, design a storyboard and complete a short two or three dimensional animation.

Sophomore Year

This year focuses on basic Macintosh and IBM PC skills. Operation of the machine is reviewed, along with basic word processing, paint system and page layout skills.

Computers for Film and Video is an entry level course using the Macintosh computer. Students who enroll in this course have had no computer experience. The course begins with the basic operation of a Macintosh. The next step is to learn a basic paint system, such as Fullpaint or PixelPaint. From there, students start to study sequential imagery through the Overview mode of Macromind Director. Scriptwriting using a word processor, such as Macwrite or Microsoft Word, is also taught. The use of bit mapped and object-oriented programs for designing storyboards and titles is also reviewed. Finally, the integration of scripts and storyboards into a total script is demonstrated. This is done through a basic introduction to Pagemaker. Only the features useful for this process are taught. The advanced features of Pagemaker are saved for future courses.

Computers and Animation is an IBM based course. It covers the basic operation of paint systems (TIPS), DOS and RGB color theory. Students also learn two dimensional animation programs. Further instruction is given in Video Rotoscoping. Through proprietary software, students are able to frame-accurately grab images from videotape and store them to hard disk. The frames are then drawn on or processed and rerecorded to videotape.

Introduction to 3D Modeling for Animation is a course using three dimensional modeling software. Students are introduced to the XYZ space, taught basic modelbuilding, surface assignments, lighting and rendering. Modelmate software is used on IBM compatible machines.

Junior Year

This year now helps the students to bring their skills to a more professional level. Each of the three courses is an advanced counterpart to the previous one.

Scripting, Storyboards and Animation takes off where Computers for Film and Video ended. Students are assumed to have basic working knowledge of the Macintosh computer. The course examines and breaks down the necessary tasks in the preproduction process of creating graphics, animation and special effects for film and video. Students are now working in color. PixelPaint and Macromind Director are used to created complex storyboards and animatics. Pagemaker is used to put together treatments, storyboards and scripts.

Intermediate Graphic Workshop for Film and Video is an IBM compatible based course using TARGA graphics boards and 3/4" editing decks. Various animation principles and techniques including motion graphics and frame-by-frame animation will be covered. The use of the computer in overall production is discussed. The more advanced paint systems, Lumena and Rio, are covered in detail. Students use video rotoscoping software and the Fairlight CVI for image processing.

3D Modeling and Animation starts from a basic knowledge of three dimensional modeling. Students are taught motion scripting and various techniques of 3D animation. Rendering is covered in detail. Various types of filtering, anti-aliasing, sampling, texture maps and shaders are discussed. Students learn how to record their rendered animations to videotape. Digital compositing of images, as well as how to do dissolves and fades, is demonstrated. Videotapes of commercials and computer animations are shown and analyzed in class.

Senior Year

The advanced courses assume a well developed knowledge of software operation. Time is spent on developing more ambitious projects. Considerable in class critiquing is done. Portfolios are assembled with titles and samples of 2D and 3D animation.

Intermediate 3D Modeling and Animation lets students work on production of three dimensional animation and illustrations. Advanced topics in lighting, surfaces and motion scripting are covered. The different types of motion paths and kinetics are demonstrated. The creation of batch files and advanced DOS operations are discussed.

Desktop Animation allows the student to explore the Macintosh IIci as a tool for animation. The students fine tune their skills in scriptwritng, storyboarding and set design and will learn new software as it relates to color graphics and animation. A variety of video presentations using Macromind Director are demonstrated, including animation, test commercials, business presentations, etc.

Hardware / Software

The School of Visual Arts Computer Art Center is comprised of six classrooms. It is used by both undergraduate and continuing education classes. Four of the rooms are equipped with Macintosh computers and two of them are equipped with IBM compatible machines.

Macintosh Classroom

The classroom used for the Macintosh based classes described in this paper consists of 15 Macintosh IIci computers with 8MB of RAM and a 80 MB hard disk. They have 8 bit video cards. One station is equipped with a Truevision Nuvista board with 4MB of RAM that outputs to a Sony BVU 800 3/4" editing deck. This allows the students to output their work directly to videotape. There are also two Laserwriter II NTX printers. All machines are connected to a server consisting of a Mac Plus and a 40 MB hard drive. This network is used to store software that is less often used and for large file storage.

The software used in these courses consists of Macromind Director, Microsoft Word, Pagemaker, PixelPaint, Superpaint and Photoshop.

IBM Classroom

This room is composed of IBM AT compatible computers having from 2-4 MB of RAM and 20-80 MB hard disks. There are a total of six stations. Two of them are connected to a video rack that has two Sony BVU 800 3/4" editing decks, two Fairlight Computer Video Instruments, an audio system consisting of a six channel mixer, cassette deck and CD player, and a patch bay which allows both video and audio connections to be made between any of the machines. There is also a digitizing area to allowing images to be input with a color video camera.

The software available in the room includes paint systems (TIPS, Lumena, Rio), 3D modeling software (Digital Arts, Modelmate), programming software (Turbo C and RT/1) and animation software (IPS and proprietary video rotoscoping software).

Conclusion

The curriculum has been in place for three years. The first students through the sequence graduated in June of 1990. The response to the curriculum has been positive. The first year had a total of 20 students. This year, there are closer to 50. Film students who otherwise would not have been exposed to computers are now using word processing programs to write scripts and other software to design and manage productions. Many of the students use 3D animation for the titles of their sample reels. Special effects are also included using video rotoscoping and image processing techniques. It is hoped that the concepts taught can be applied to high-end systems outside of the educational environment. Because of the similarity in their design concept, students that are familiar with PC-based paint systems can be more easily taught the Quantel Paint Box when they are employed in a production studio. Students who have had three semesters of 3D modeling and animation will more easily learn high-end animation systems like Alias, TDI and Wavefront. Other students whose aspirations include directing and producing now have a broad frame of reference and familiarity with word processing, paint systems and two and three dimensional animation. This gives them a vocabulary which prepares them to work in a film or video production environment.

About the Author

Bruce Wands is the Faculty Advisor to the MFA Computer Art Program at the School of Visual Arts in New York. He also teaches graduate and undergraduate courses in 3D Animation, 2D Animation and Computer Video. In 1989, he was awarded an NCGA Educator Scholarship. He is an award-winning independent producer who has produced animation, titles and music for such clients as AT&T, United Technologies, General Motors, Air Safety Foundation, RCA International and others. He became involved with computer animation in 1976 when he was an animator for the Spectacolor computer animated billboard in Times Square, New York. While there, he designed the computer animated opening for NBC's Saturday Night Live. He has a BA from Lafayette College and an MS from Syracuse University.

Digital Typography: Letterform Literacy in the Electronic Environment

Renée LeWinter

In this special focus section on education I would like to address typographic concerns from two perspectives. First, from the aspect of design and art programs; and the second from the viewpoint of business communication.

Graphic design and, indeed art making in general are in a state of flux. The introduction of powerful, low-cost microcomputer systems into everyday life has begun to change how people create and communicate. Just as the invention of moveable type and the use of the printing press affected art and design during the Renaissance and the Reformation by establishing new vehicles for visual communication, today's new technologies are having a major impact on contemporary design and use of typography.

Digital type technology and its integration into digitally based layout programs has encouraged the jettisoning of traditional work flow structures within the graphic arts industry. Control of the creation and production process has shifted from a small select group of specialists to generalists. More and more, origination and composition of typography is being vested into the hands of the designer. Service bureaus rather than the rapidly declining full service type house are becoming the norm.

At first glance this may seem wonderful, but calligraphy, type design and customized typography have not been part of the mainstream college art curriculums, and many designers are not prepared to handle the new tools well. Philip Meggs in his provocative article, *The Obscene Typography Machine* for PRINT Magazine[1] acknowledges this trend's dark side. He writes, "Unfortunately, the ease of the computer use puts potent graphic capabilities into the hands of people who are devoid of any aesthetic sense about typography and have little or no understanding of the most basic principles of design. We are seeing type distorted in violation of everything that has been learned over the past 500 years about making functional and beautiful letterforms."

As educators, we need to acknowledge this change by re-examining how and under what circumstances typographic education is integrated into the curriculum of art and design programs, as well be an integral part of computer graphics education. Given as Matt Carter presented at TYPE90 this past September, the industry goal of making typography "device independent", controlling typographic input and page geometry will become a question only of access.[2] At a minimum, designers, to establish their role as standards bearers will need to demonstrate knowledge in 1. the design of type, 2. the application of typography, and 3. the craft of the typographer.

Additionally, the discussion needs to be inclusive and go beyond the "star" art schools, to the certificate programs, to the junior and community colleges, to the design instructor who is one amongst many in a liberal arts college. If the students and faculty at these kinds of institutions are not reached, then professional standards will clearly suffer. A caste society will emerge to the detriment of the design profession.

Though we may be tempted, the solution to this chaos is not served by adding a single computer based course in calligraphy, or lettering, or type design or typesetting. This course would probably be run as an infrequently offered elective, subject to budget support for part time faculty, and inaccessible to the majority of students enrolled in the program. I believe such approaches only offer temporary band-aid solutions to our difficulties. There must be a clear commitment to the importance of typographic fundamentals as concepts, not subservient to image or as mere how-to techniques of computer based application.

What I suggest is a sequence of courses which present digital typographic design and craft concepts within the broader spectrum of required graphic design courses. Compartmentalization would be discouraged. These courses will, following the parameter of "tool independence", include both traditional as well as computer based methodologies. This will enable tenured faculty, only now becoming computer literate, to offer their insights without prejudice.

The underlying criteria for the courseware would be the creation an academic environment which encourages students to develop new thinking processes and cognitive skills, understand the hows and whys in the context of design problem solving, and to define new possibilities for design aesthetics and tools development through experimentation freed from the constraints of a production schedule.

Additionally, program development cannot ignore the needs of practicing professionals, who as the popularity of the **Type Design on the Mac** workshops at Type90 demonstrated, are feeling at sea as well. One hour lectures, half-day or weekend tutorials on software like Fontographer or Ikarus M will not be any more than stop-gap measures. Rather, under the auspices of the local design society and nearby educational institutions, courseware can be developed which allows for individual experimentation and conceptual thinking. This courseware can take the form of a series of lectures and hands-on experiences using traditional and computer based tools. More than how-to sessions, stylistic and technological factors would be examined for their impact on aesthetic vision and design process. To compare and contrast design solutions reference could be made to the work of past and contemporary type designers.

At Type90 it was also noted that the business community and the public at large had discovered typography as a tool for effective communication. Marketing managers, lawyers and others can now distinguish the difference between Times Roman and Courier or Helvetica and will specify a specific font for their reports. Digital typography has encouraged this new pluralism.

Fernand Baudin, chair of the Type90 education town meeting spoke of it this way, "The computer technology and more specifically desktop publishing is knocking down all the social partitions and physical impediments which mechanization had erected between any number of writing methods."[3] Baudin was describing the shift from hand generated books (an open ended process) to a mechanized assembly (a closed process relying on specialists) to digital generation (again an open ended inclusive process).

Acknowledgement of this cultural shift in attitudes was not limited to the Type 90 town meetings, but also included the screening of BBC developed programing.To stimulate discussion by the conference participants, two of the BBC's programs discussing type identification, the large number of type faces available to customize the look or feel you want, and the changing state of publishing were shown. After seeing the programs I came away with the feeling that these shows had barely scratched the surface. The broader concern— what are we supposed to do with it?", with its implications on design literacy was missing and still needed to be addressed.

Some software developers of page layout programs in an attempt to fill this literacy gap are marketing style sheet and template programs. And some designers have become information specialists advising clients on how to fully integrate style standards throughout the corporate structure. They are providing templates to create forms and other examples of common business communication.

But these responses, as well as the abundance of articles which appear in business publications providing helpful hints, are again only stop-gap measures to a much larger issue — the visual and letterform literacy of the public at large.

Recently, there was a discussion about elective offerings for non-art majors in our university. One possibility was a course entitled **Graphic Design for Non-majors.** This single eleven week course was primarily for business college undergraduates. In it students would gain some knowledge about typography, word and image concepts and some basics about production. But, as I indicated on the subject of courses for designers, one course alone cannot resolve what is lacking in primary and secondary school education. The universities and colleges should not be expected to do remedial education in basic fundamentals of visual and letterform literacy in the context of electronically based communication processes. Such curriculum needs to be an integral part of the educational process from preschool on.

In the United States today, there is a great deal of discussion concerning the state of our educational system. Listening and reading in the general media speeches made by politicians and educators, I hoped to see stressed the need for increased visual literacy. To the best of my knowledge, no one did. In my quest I do not argue against the need for students to know geography or to do algebraic equations, but too often in this era of budget tightening, art and design skills are considered a luxury. With computer and video technologies continuing to break down artificially imposed barriers and encouraging a larger global perspective, this viewpoint is shortsighted.

In the teaching of language skills, we introduce the alphabet as representing sounds. This approach serves to present only one form of communication — a linear non-graphic approach. In this era of CNN, multi-national corporations and icon based menus we have come to communicate more and more like the Chinese, with universal pictographs that can represent more than one dialect. This return to older forms underscores the need for the individual letters of the alphabet to be seen also as objects which are made up of black lines and white spaces. The student, in controlling and using these objects, can learn to communicate ideas that cannot be represented by phonetic sounds. Vocabulary skills would be broaden and enriched. Students would be empowered and able to participate in the emerging, electronically based cultural experience. The full potential of digital typography and design could be enjoyed by everyone. The common everyday art experiences would be enhanced for us all.

Footnotes

[1] Meggs, Phillip B.,*The Obscene Typography Machine*, PRINT Magazine, September/October 1989 XLIII:V pages 163-164.

[2] Carter, Matthew *The Impact of Technology on Type Design* Type90, September 3, 1990. Oxford University. Sponsored by Association Typographique Internationale (ATypI).

[3] Baudin, Fernand *Educating the Educators* Type90, September *1, 1990.* Oxford University. Sponsored by Association Typographique Internationale (ATypI).

Fractal Vomit

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The MAC II piece entitled **Fractal Vomit** plays with relationships between fractal mathematics, expressionistic action painting, and concepts and images found in Tibetan Buddhist art. The distasteful title reflects my own distaste for (1) the domination of mathematics in computer art (a paternalistic domination which renders the artist as a childish voyeur into a mathematical world) and (2) the aggression and abuse perpetrated by intelligent technical people onto shy sensitive people in the world of commercial computer graphics. I've worked and studied with creative, aggressive computer scientists who later formed companies that exploited and abused people.

The Theme

The scripted piece can be perceived as a computer book, with animated pictures and words to convey a poetic message.

The basic idea for the piece came from a visit I made to a small Tibetan monastery on Staten Island, New York. There a guide explained that the animals in the center of a "Wheel of Life" painting were not biting their tails, but were vomiting each other out in a recursive circle. A snake (representing "lust") vomits a chicken ("hatred"), who, in turn, vomits a pig ("ignorance"), who vomits a snake ("lust" again), etc. So, when I designed my fractal paint splash program, I saw similarities with this and other Tibetan ideas and worked the wheel-of-life concept into the piece.

Center Hub of*the Tibetan Wheel of Life*

Further relevant ideas occurred to me when I gave a presentation of my paintings and computer art works to a group of artists and Jungian Psychologists in a Tibetan Monastery in Woodstock, New York. I was amazed how similar my early paintings (1969 - 1970) were to the Tibetan *Thang-ka* scrolls hanging on the wall. The imagery in my paintings reflected my feelings the first time that I worked as a programmer in a computer graphics developmental environment.

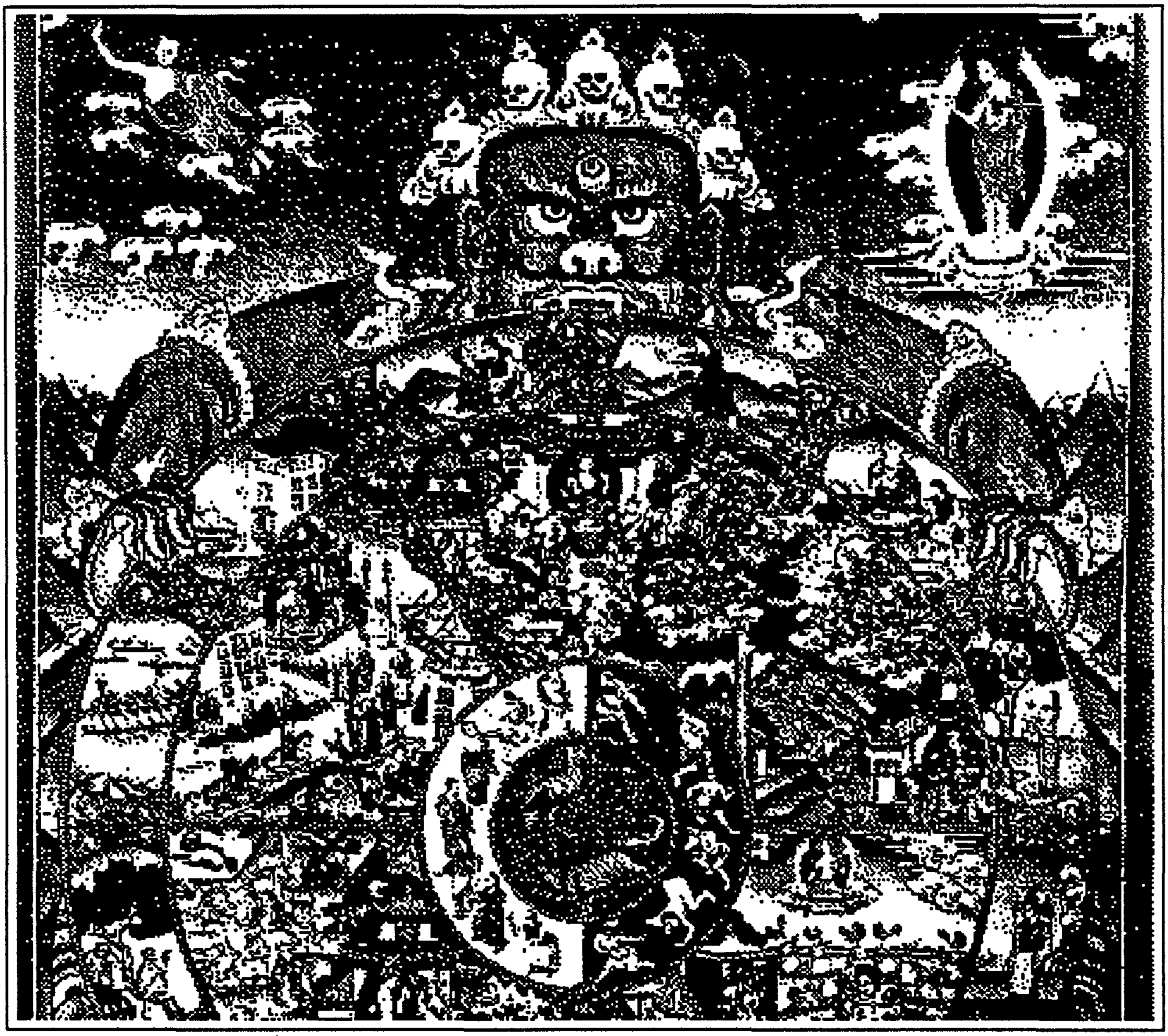
These associations prompted me to do research on Tibetan Buddhist mythology. The Tibetan imagery that resemble my paintings reflects a nomadic, herdsman culture whose mythology deals with aggression and the spiritual ramification of it. As a contemporary reflection of this culture, my piece uses their imagery to reflect aggression and intimidation which I've experienced in work environments populated by nomadic people who stress highly intellectual pursuits. Within the mythology, the central figure

"Yama" is the "Lord of Death" and represents the small voice of morality within each of us. After a person dies, Yama plays a large role in judging the dead person's fate by reflecting his past life back to him so he can see the consequences of his behavior. Yama, as an aggressive wrathful deity, supposedly will be seen by the deceased in his wrathful form if the intellect has been emphasized and feelings suppressed during the deceased lifetime. In response to my perception that the separation of the intellect and feelings is pervasive in our aggressive computer-oriented culture, I've made a conscious effort to artistically integrate both strong intellectual ideas and strong feelings into this Mac II piece.

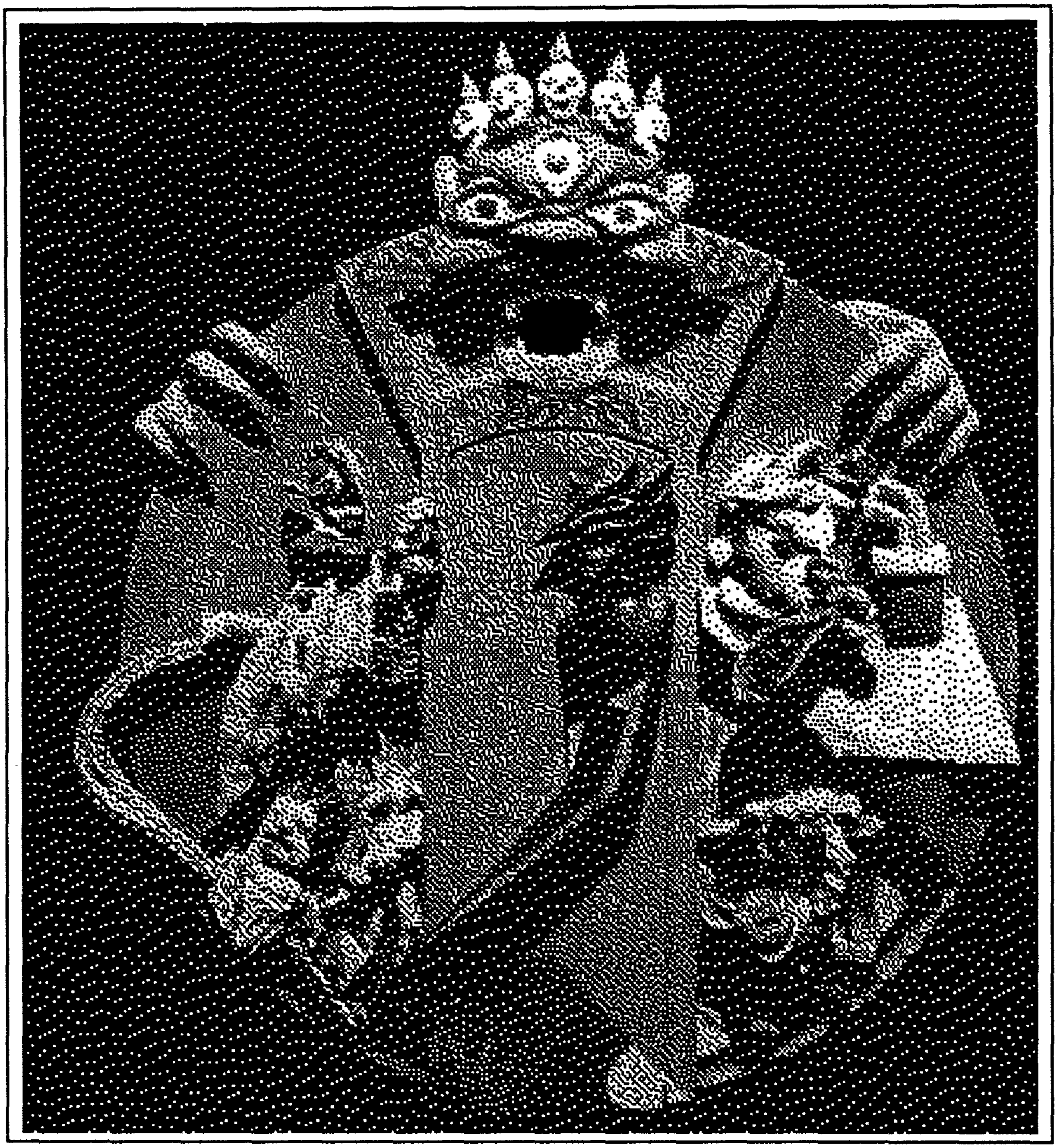
The Program

Although the content of the piece is scripted to run recurrently in a consistent manner for approximately 7 minutes (with 30 seconds of dead time between) on Mac II computers, the painterly aspect of the piece is different on each run. The program generates "paint splashes" that simulates the process of throwing paint on the canvas. The splashes sometimes even drip into each other.

If the user interrupts the piece by pressing the mouse button or pressing selected keys, he can draw relatively-controllable action splashes, give them size, color, and direction, and even have them drip.



The Tibetan Wheel of Life (Yama is the figure at the top).



"The Hell Disk"— a sculpted illustration for "Hell— a Computer C-itcom" is a crucial image in **Fractal Vomit.** This sculpture, part of a multi-media installation piece, reflects the relationship between the "Hell C-itcom" and the Tibetan Wheel of Life. For an explanation of the "Hell C-itcom", see **Leonardo**, vol. 23, Iss. 2 (Oct., 1990), or the 1987 SCAN Proceedings.

Basically, he can use all the effects seen in the scripted piece and more. There is even an option to make simulated spinning art pieces like those produced in carnival booths, where customers make "art" by throwing paint onto paper tacked to spinning wheels.

If the user procrastinates in making a decision or allows his paint splash effect to run too long, the program (like Yama) aggressively interrupts him, "kills" the piece he's working on, and shows him the scripted animation instead.

Parts of the computer program are quite intellectually sophisticated. The program generates fractal paint splashes differently every time by (1) making randomly radiating nodes from a central point, (2) ordering them in a clockwise fashion, (3) giving them shape, (4) putting webbing between the nodes to connect them, and (5) finally fractally refining the outside edge of the form to give a watery appearance. In true fractal form, the program varies the complexity of the edge resolution for different size splashes. On the Macintosh computer, each splash is rendered as a single polygon filled with color— except for splashes chosen to be generated in "3D". In that case, the splashes are organized as complex data structures and rendered with simple three- or four-sided polygons to represent the 3D form. You can see this at the end of the scripted animation. Since the program was written in a fairly portable computer language called 'C', it should be little effort to port it over to a faster 3D workstation where the 3D splashes can play a more glamorous role.

I have provided some artificial intelligence to parts of **Fractal Vomit**. In the section of the animation where the splashes transform into manlike heads that vomit other splashes which will, in turn, transform into manlike heads, the program decides which of the four splash heads to choose for the one who regurgitates. It tries to choose the largest of the heads facing towards the center of the screen. This prevents the recursive splashes from wandering off the edge. If the computer algorithm can't make a choice, which is not very often, it gives up by creating a new splash near the center and letting it go from there.

The animation is scripted into 6 separate scenes with three parallel tracks of action in each scene. The tracks consist of key-hit tokens (which force preprogrammed actions to occur) and numbers representing time intervals to wait between tokens. Although I worked on each scene separately, I took special care to ensure good transitions between scenes to prevent the seams from showing.

Show and Tell

Fractal Vomit, shown in this year's SCAN Art Show, was also shown in the art exhibit presented at **Infinite Illusions** (the Smithsonian National Symposium on Computer Graphics in Washington, D. C., in September, 1990). At the Smithsonian conference I gave a presentation which included an explanation of the concepts involved.

REFERENCES

1. Sierksma, F., **Tibet's Terrifying Deities**. Rutland, Vermont: Charles E. Tuttle Co., 1966.

2. Govinda, Lama Anagarika, **Foundations of Tibetan Mysticism**. New York: E. P. Dutton & Co., 1960.

3-D Design Education Survey

Dr. Bill Kolomyjec
Pixar

Background

In mid-May 1990 "3-D Design Survey" questionnaires were sent to a population identified in the 1989 ACM SIGGRAPH Computer Graphics Magazine[1] as the arts, architecture and design group (approximately 130 entities). The purpose of the survey was to obtain data for Pixar marketing research regarding the scope of 3-D design activity in the design education arena. Tom Porter and Bill Kolomyjec co-designed the survey (questionnaire). The survey questions are given below. Note, the response to be obtained from the respondent is indicate in parentheses.

1. Are you currently using computers in your department for instruction or research in 3-D Design? (Indicate Yes or No)

2. What hardware resources (include display card) do you use for 3-D Design? (Open ended)

3. What software packages do you use in the 3-D design process? (Open ended)

4. How many faculty, grad students, and undergraduates are using this software and hardware in 3-D design? (Open ended)

Identification data: Name, University, Address, City/State/Zip and Phone Number. (give address and phone data)

Finally, indicate if you would like a complimentary exhibition pass for SIGGRAPH 1990.(checkbox)

This article represents an analysis of the data received from our effort.

Hypotheses

The motivation for this survey was to provide some information relative to three question areas of interest to Pixar concerning 3-D design education. These questions areas can be transformed into three roughly stated hypotheses. 1) What is the current scope of activity in 3-D design education in arts, architecture and design? 2) What kinds of hardware and software are currently being used for this purpose? And, 3) How many faculty and students are currently involved in this educational process?

Results

Response rate. Of the approximately 130 questionnaires sent out, 5 were returned as undeliverable and 44 were returned completed as of June 15, 1990. (44/(130-5) = 0.352). The survey response rate was "significant" at 35.2%.

Methodology used for evaluating open ended questions

A "tally" technique was used to evaluate the open ended questions in this survey. (Questions numbers 2 and 3). This method consists of reading all the responses to an open ended question and enumerating the mentions of particular hardware and software items, in this case the categories are hardware platforms, graphics cards and 3-D graphics software packages. The number of mentions of each item in each category is tallied as well as the total number of mentions within each category. Item frequency is divided by total number of items within a category and a relative frequency percent is determined. The relative frequency percent does not take into account how many of each item there are at any particular institution rather, whether an item is present (or being used) at an institution. The purpose of question 4 was to give us an idea of "how many?"

Response data summary and observations

Question 1.

Forty-one (41) of the forty-four (44) respondents, 93.2%, stated that they were (in varying degrees) currently using 3-D computer graphics for either instruction or research in the design education process.

Question 2.

Hardware. Tables #1 and #2 summarize data extracted from questionnaires using the previously described tally method.

Computer platforms.

In terms of relative frequency percentages, PC's and Mac's seem to have an equal footing in 3-D design education environments. with 38.86 and 36.11% respectively. SGI and Amiga follow way behind with 6.94% each.

Graphics cards.

Again, In terms of relative frequency percentages, Truevision products appear to predominate this market with 47.62% across all platforms. This breaks down into 38.10% on PC's and 9.52% on Mac's. Apple's 8 bit color card is the most pervasive on the Mac at 14.29% more so than RasterOps, 9.52%, Truevision NuVista, 9.52% and Radius 2.38%. One interesting note is that VGA cards seem to play a minor role in this category at 19.05%.

Question 3.

Software. Table #3 summarize data extracted from questionnaires using the previously described tally method.

Response data suggests that on all platforms there are dominant leaders. Competitive software packages in each group are bunched up significantly behind these leaders. It's anybody's call as to who is in second place.

In 3-D design education on the PC, Autodesk products predominate at 31.91%. On the Mac, Paracomp's Swivel 3D is the clear leader at 43.75%. On the Amiga, it's Sculpt4D at 60.00%. On the larger SGI platform, Alias beats Wavefront 3 to 1.

Question 4.

Usage. From response data there is evidence that a fair amount of 3-D training is taking place at the post-secondary level. Faculty devoted to this activity range from 5 at one institution to less than one (part-time) at most of the others. Three-D education seems to be more a part of an undergraduate curriculum than a graduate program. (This makes sense because graphics are a means to an end. Undergraduates are specifically taught these skills where graduate students apply them.)

Number of students varies widely with as many as 300 per year at one institution to as little as 5 at another. The data suggests that the mean number of student using 3-D design (aggregating grad and undergraduate totals) over 41 respondents is approximately 50 students per institution per year.

Conclusions

The schools surveyed for this research project represent a biased sample of the total educational institution population, i.e., we only sampled schools that were part of the ACM SIGGRAPH listing. We are sure that if a truly representative survey of all schools of arts, architecture and design was conducted that 3-D computer-assisted design education would be much lower. We feel it is only a matter of time (and money) before most design programs have 3-D computer graphics training as integral parts of their curricula.

So disclaimed, we feel this effort has given us some indication of what is currently happening at arts, architecture and design schools. Pixar is digesting this information and should make good use of it in its product marketing efforts.

References

1. Computer Graphics Career Information Handbook. Computer Graphics. Volume 23, Number 1. February, 1989. Published by ACM SIGGRAPH. pp 103-114.

Table1

Table 1. Hardware - Piatform			
Platform	freq.	%	
PC - generic	17	23.61%	
PC - 386	11	15.28%	
subtotal PC			38.89%
Mac - SE	1	1.39%	
Mac - II genereic	11	15.28%	
Mac - cx	10	13.89%	
Mac - ci	2	2.78%	
Mac - fx	2	2.78%	
subtotal Mac			36.11%
Amiga	5	6.94%	
PS/2 - generic	2	2.78%	
SGI	5	6.94%	
HP 9000	1	1.39%	
Atrai	1	1.39%	
Vax	1	1.39%	
NeXT	1	1.39%	
Sun 386i	1	1.39%	
Pixar	1	1.39%	
			25.00%
total	72		100.00%

Table2

Table 2. Hardware - graphics card			
Card type	freq.	%	
PC - EGA	1	2.38%	
PC - VGA	7	16.67%	
PC - Super VGA	1	2.38%	
subtotal PC - VGA			19.05%
Targa16 (targa generic)	11	26.19%	
Targa24	1	2.38%	
Targa32	1	2.38%	
ATVista	3	7.14%	
Number9	1	2.38%	
Vectrex	1	2.38%	
Mac - NuBus Vista	4	9.52%	
Mac - Apple 8 bit	6	14.29%	
Mac - RasterOps 8/24	4	9.52%	
Mac - Radius	1	2.38%	
total	42	100.00%	
subtotal Truevision products			47.62%

Table 3. Software				
Platform / Product	Freq.		%	
PC				
AutoCad	13		27.66%	
AutoSolid	1		2.13%	
AutoShade	1		2.13%	
subtotal Autodesk		15		31.91%
GenericCAD	2		4.26%	
DataCAD	3		6.38%	
Cadkey	2		4.26%	
VersaCAD	1		2.13%	
Digital Arts	3		6.38%	
CubiComp	4		8.51%	
GSL - Topas	2		4.26%	
GSL - RIO	2		4.26%	
TIPS	1		2.13%	
Genigraphics	1		2.13%	
Crystal3D	4		8.51%	
Pan. StudioWorks	3		6.38%	
Other	4		8.51%	
PC total		47		
Mac				
Swivel3D	14		43.75%	
Architron	1		3.13%	
Stratavision	3		9.38%	
MacroMind Director	4		12.50%	
Dimensions	1		3.13%	
Dynaperspective	1		3.13%	
Mac3D	1		3.13%	
Pro3D	2		6.25%	
Super3D	2		6.25%	
ModelShop	3		9.38%	
Mac total		32		
Amiga				
Sculpt4D	3		60.00%	
VideoScape	1		20.00%	
Turbo Silver ???	1		20.00%	
Amiga total		5		
SGI				
Alias	3		75.00%	
Wavefront	1		25.00%	
SGI total		4		

A VISUAL INSTRUMENT

Walter Wright

Introduction

I'd always wanted to play the organ but, when my school made me choose between Art and Music, I chose Art. But the urge to play an instrument stuck with me. I wanted a visual instrument. Architecture and film, I tried both, lacked immediacy. I wanted instant feedback, instant gratification, realtime image synthesis. I hooked up Moog sythesizer modules to an oscilloscope. I moved to New York city and became a video animator on Computer Image Corporation's Scanimate system. I hung out at the Kitchen where I met Nam June Paik, Woody & Steina Vasulka, and Ralph Hocking from the Experimental Television Center (ETC). I left the world of advertising, a world without redeeming virtues, and joined the ETC. I worked with the Paik/Abe Video Synthesizer and with equipment being developed by David Jones the ETC engineer. I performed on the Paik/Abe system at public access studios around NY State. I met Gary Hill from Woodstock Community Video and, for a short while, we cablecast live video & audio synthesis. But we were coming to the end of an era. Woody & Steina left the Kitchen to join Media Studies in Buffalo.

We all started thinking digital. David Jones & Don McArthur designed frame buffers for the ETC. Gary Hill built a video system combining an analog music synth and David's digital video modules. Woody started to build a computer controlled video synthesizer. Digital was taking over. We bought computer kits, toggled rows of switches, stared at LEDs for hours. It occurred to me that I might create a visual instrument on the computer.

In 1976 I wrote a paper for NUTS & VOLTS, a conference for artists sponsored by Media Studies SUNY at Buffalo. The paper outlined proposed software for The ETC's computer based video synthesizer. The proposed software would include commands to control -

points, lines and basic geometric shapes,

textures and patterns,

mattes, areas and boundaries,

object/field relationships,

hue, saturation and value,

sequences of images, timing patterns,

balance and symmetry,

depth, scale and proportion,

focal points,

harmony, rhythm and counterpoint,

translation, rotation and warping.

The software would speak the artist's language. It would require little more than high school math and the development of specialized hardware to control the imaging process. The program would be minimally intelligent. What follows is a substantial part of that paper, written in the mid '70s.

PAPER WITHIN A PAPER

I'm not a computer scientist. I'm an artist. I see software from a different angle. I start with the image. The video image is the play of light on the surface of the screen. It's also a waveform containing spatial and temporal information. A portion of the waveform is visible on the screen as the image, the balance is used for synchronizing the imaging system. A video image is made up of 525 horizontal lines per frame or 262 1/2 per field, 2 fields = 1 frame. Odd & even lines are interleaved field by field to complete a frame. The image is redrawn each 1/30th of a second.

Objects in the image don't move. Video, like film, is a sequnce of still images. The illusion of fluid motion is so powerful that we often ignore other possibilties for sequencing images such as fast sequential switching or single frame editing. Different images related or by composition, impact or whatever, can be sequenced field by field, frame by frame, or mutiples thereof.

The video image is subject the basic rules of composition, the elements and attributes of design. It can be thought of as 1/4 million pixels; as raster lines, which on the Rutt/Etra video synthesizer can dynamically reposition themselves; as texture derived from noise or from high speed oscillators. Areas of the image can be defined by texture and pattern. Elements such as hue, saturation and value define color space. These are a few of the design elements which make up an image. Looking at groups of elements within the field/frame, we can talk about balance or imbalance, symmetry or assymetry, focal points, proportion, scale, depth, object/field relationships, form, and so on. Sequences, shots, groupings of fields/frames can be considered in relation to attributes of harmony, rhythm, counterpoint, movement vectors, rotation, and warping.

This may seem a peculiar way to design software but, I think, programmers tend to forget that they are creating images, forget the basic rules of composition. The program should direct the flow or sequencing of images, analyze an image or group of images, synthesize new images, and must be able to recognize a score.

Computers shouldn't be used to maintain dossiers on subversives or direct nuclear warheads. Why can't computers be used imaginatively and creatively? The proposed software would use simple mathematics. A degree in computer science has little to do with imagination or creativity. I've always looked elsewhere for my inspiration in programming.

Systems are governed by feedback. The computer, the video synthesizer, and the artist must interact. Granted the program may never learn to be creative but, like the artist, it can be unpredictable. Joel Chadabe suggests using a random number generator in a system where the artist and the computer can improvise together. In the simplest case, software reprograms the synthesizer towards some goal. This requires modules to analyze the system output, providing information to the program concerning texture, value, scale, balance, symmetry, rhythm, etc. This can be done in several ways such as being aware of the patching together or routing of the signals in the system, or by analyzing the output image. Now the program can respond in a less willy-nilly or random manner. The software might even allow the artist to identify what is an acceptable image and what is not, probable or less probable images or sequences of images. The computer should be programmed to reprogram itself.

Artists' software must be concerned with composition, with the elements and attributes of design. It should be capable of analyzing and synthesizing images. It should have a mind of its own, capable of reprogramming the synthesizer and itself. It must interact with the artist in realtime. It must cost next to nothing.

MEDITATION

I pursued this heads on approach for a number of years. I programmed a number of systems in assembler, FORTH, C, and so on without ever producing an instrument. As the size of the program increased my control over it decreased. I was distracted by hands on alternatives. I became interested in process, means over ends. Making art became important. I realized that a program for making art should model the process of making art. Experimentally, I applied programming algorithms to painting, painting techniques to music. I abstracted methods of composition and applied them across media. I was not alone. The formal traditions of music composition were coming apart. Visual art was becoming postmodern, collapsing time and space, in an effort to have meaning in the Global Village created by Television. I became less interested in narrative, trying to tell a story, and more interested in abstract, or as Brakhage says, lyric art. My videos, films, painting and music described the processes by which they were created. Realtime composition, gesture, and improvisation, these became my techniques of choice. I abandon previsualization, scripting, traditional methods of composition. It was time for algorithmic art.

ALGORITHMIC ART

As yet, mind had not triumphed over matter. I didn't have my visual instrument. Could algorithmic art be the engine I needed ? Traditional instruments have high bandwidth interfaces, that is, a great deal of control in realtime. This large measure of control allows the performer to achieve the nuances of expression which define style. Try and achieve nuance with a keyboard and a mouse. But, if these inputs could be factored out, extended using programming algorithms, could the bandwidth be increased enough to provide truly expressive output ?

A number of programs, from algorithmic drawing on a plotter to today's intelligent music systems, indicate that it's possible. These program use controlled randomness to vary a preset template. Some launch out from a given reference, constantly reshuffling their parameters. Others can 'tween between presets. These algorithms are known to artists. We recognize the importance of having rules in order to bend them. Recently fractal generators have been incorporated into a number of programs. I've heard the output of a fractal generator referred to as natural randomness, an interesting phrase. Where is the line between order and chaos ?

ENOUGH ALREADY

This is a list of systems/programs which I have used as "visual instruments" -

Scanimate: Computer Image Corporations raster manipulation system for video animation, analog.

Paik/Abe Video Synthesizer: built by Nam June Paik & Shuya Abe; colorizing, video effects and raster manipulation.

Experimental Television Center Studio: includes a large number of modules, both analog & digital, for synthesizing sound & image; colorizing, mixing, keying are all computer controlled.

Painter Power: a quirky paint program with a realtime performance mode, used animated brushes and boolean drawing modes.

CEEMAC: an interactive graphics language for the Apple II written by Brooke Boering, now available on the PC.

Visual/Aurals: a sound or MIDI driven interactive performance graphics system for the Amiga.

There are more including the Rutt/Etra video synthesizer, Woody & Steina Vasulka's studio, the Chromatron, Richard Monkhouse's EML video synthesizer, Gary Hill's sound & image synthesis system, the Fairlight CVI, ProVideo on the PC, and Ovaltune on the MAC.

Do I have my visual instrument ? No, I still haven't found one enough control and freedom of expression but it's just a matter of time !