CONSIDER A GARDEN FLOATING IN THE STREAM OF CONSCIOUSNESS

A Thesis

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To my wife, Zlata Baum.
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INTRODUCTION

Most of my life I have been actively working with the visual arts. I have also been working professionally with computer systems for the past 25 years. About ten years ago, I began working on a basic problem which unites these paths. That problem is: how can and should creative people pursue the opportunities enabled by the recently developed, inexpensive, and powerful micro-computer systems? As I explored this problem, it became increasingly clear that there are an enormous number of complex and rapidly-evolving issues involved in this question. It also became clear that I would have to simplify the problem if I wished to make any progress in this lifetime.

As a result, in the last five years I have chosen to explore three more limited questions which seem to me to retain the essence of the larger problem but are more focused and manageable. These questions are: How can I best investigate and communicate the structure and significance of electronic space? How can I make a creative place for myself and similar artists in the contemporary electronic landscape? And, what is the basic structure of computerized electronic space as it effects and enables creative activity? Exploring these questions has proved very enlightening.
This thesis is an attempt to address these questions. I will actually try to answer the first two questions. To address the third, I will describe in detail my recent work, a responsive, real-time, multi-media, computerized environment which I created to help me experience and understand the structure and character of a creative electronic space.

I will also discuss some of the general characteristics of electronic space which are suggested by this work. In this way, I hope to convey some of what I have learned and experienced during what has been a truly fascinating period in my quest.
ART-THINK

There are many ways to explore the world and to communicate what one has seen and learned. There is the scientific method, the historical approach, the business method, the engineering method, and the artistic method, to name a few. Each of these methods is a different way of thinking, investigating, and communicating and emphasizes a different combination of processes and products. For example, I suggest that science-think emphasizes the stable conceptual and data model created by rigorously testing hypotheses against experimental results. History-think concentrates on chronologically recording and interpreting human events in order to reveal patterns of social development which can be used to understand and guide contemporary social action. Business-think focuses on the flow of resources between institutions and individuals and the transformation of these resources into value as measured in money. Engineering techno-think emphasizes the creation of physical and logical structures and their application to human life. Art-think emphasizes the creation and sharing of unique expressions of universal, integrated, full-spectrum, human experiences which may be used by institutions and individuals as aesthetic, behavioral, or ideological models.

I believe I can best investigate and communicate the structure and importance of electronic space by using the Art-think model of
investigation and communication. Of course, I also use essential aspects of the other 'thinks', especially science and techno-think. However, since I am chiefly concerned with how people can live and work in relation to the structure of electronic space, I usually use the artistic model with its focus on human experience.

Art-think allows me to use myself as the measure of all things; not in the sense of a model or ideal, but as a stable and sensitive reference point. Art-think allows me to make metaphorical connections and draw analogic conclusions which may be quite evocative but which could not possibly be 'proved'. And, as a process, art-think places a premium on attending to semi-conscious, sensory feedback during an ongoing creative process.

Using the artistic method allows me to integrate cerebral, sensory, individual, social, theoretical, and practical experiences, the experiences which arise during active, creative engagement with people, places, ideas, and things. The artistic method also provides me with the combination of intellectual, sensory, and social feedback which is necessary to keep the work personal, yet accessible and relevant. I believe that this breadth of feedback is especially necessary when working in a new, complex, and insular place like the electronic world.

Of course, using art-think does not free me from the obligation to know the facts, to draw logical conclusions, and to know which end of a cable to plug in. However, using art-think does allow me to view the facts under different lights, correct for correctness, to say 'Boo' to lean
logic, and to tie knots in some of the cables. Without an integrating art-think approach, I doubt that I could have maintained an open-minded, yet consistently human viewpoint in the face of the endless and rapid flow of scientific and technical developments, changing jargon, whirring fans, and evolving systems which characterize the contemporary electronic world.

Having mentioned some of the positive aspects of the artistic method, it is worth mentioning one significant limitation to art-think. Some creations and experiences do not lend themselves to analytic description. All the creative processes, concepts, technical considerations, sensations, and emotions which flowed together in my body-mind to create this work are inextricably interwoven. Even now, as I attempt to write about my work, forms, concepts, and connections which the reader might wish to have neatly separated and logically classified resist categorization and isolation.

Concepts and feelings float and bob in the river of my life where local eddies and currents concentrate and tangle them into assemblies; like branches stuck in a snag or a beaver dam. As with a snag, there is rarely a way to control and manipulate it as a unity. And, as with branches embedded in a dam, when I try to pull out one branch or idea, others may come with it. Or, the branch I grasp may not budge at first. I may be forced to redirect my focus to another branch before the one I want is liberated. And, all the while I am pulling and poking, a beaver or the river is heaping up more branches. Moreover, as the river flows, and as branches and ideas interlock and form dams, the flow of the river itself is changed. For me, the experience and understanding of ideas is
as much the experience of snags forming and the river changing as it is the understanding of any given branch.

This high degree of interconnection among concepts makes it very difficult to write about art-think ideas. The Western, analytic, non-fiction way to write about ideas is to pull them apart, examine them individually, and attempt to show their relation to some whole. While this sounds reasonable on paper, the experience, and therefore the meaning, of a concept cluster changes when its components are disconnected or isolated in time or space, or when they are re-connected to some 'logical' matrix. In particular, using the analytic approach makes it difficult to communicate any truly new connections which are, by definition, at the edge of the current logical matrix. This tendency of analytic writing to disempower experience and to homogenize the unknown is a major reason I present my ideas, even very abstract 'technical' ideas, as experiential 'art'.

In any event, I chose the artistic method, with all its positive and negative aspects, as my way to investigate and communicate the structure and significance of electronic space. And, at first, I was concerned that using this method would prove limiting when exploring a territory as technical and 'logical' as computerized electronic space. However, art-think has revealed itself to be a wonderful way to approach this field, particularly when reinforced by my background in techno and science-think. For example, I have used the analogy of snags in a river as a basis for the formal structure of a piece. In this work, images, substances, and sounds are constantly being literally intertwined and
structurally coupled into a flowing, holistic experience which is responsive to the viewer who can generate, direct, and interrupt the flows and snags at his or her own pace.

As I tried to build this responsive, art-think analogic structure in electronic space, some of the fascinating properties of the space became clear to me. For example, in electronic space it is possible to literally construct a 'way of thinking', a set of images, text, actions, or sounds, which interrelate and interact with each other in a more or less open-ended pattern determined by the artist and the viewer. The structure of a thought can become the literal structure of a piece. The act of creative thinking or feeling can be explicitly captured. The form generated in this electronic world can be a static image of a thought if you wish, or it can be an endless act of thinking. Analogies, the mainstay of art-think, prove to be particularly easy to construct, to bring to life in an electronic space. And, the potentially multi-dimensional, full-spectrum, active nature of work in electronic space greatly expands the possibilities for 'real-izing' analogous or metaphorical thoughts as images, installations, or other forms.

Of course, thoughts and feelings can be captured and regenerated in many forms of art. A traditional action painting on canvas certainly captures and focuses attention on a complex creative process. However, an electronic action painting, which can be captured as a static image at any time in its development, can also be told to paint and unpaint itself forever on an electronic display. Incidentally, the precursors of this type of work exist now in 1993, in film and video. However, film and video
only capture a finite set of images of a process, while computers can capture a functioning model of the actual process itself.

As an example of the computer's ability to capture actions, I have included a set of diagrams in the chapter on the underlying structure which show a process I have captured in electronic space. I call this particular process an 'unraveler'. This process takes an electronic image with a certain rectangular, composite structure and deconstructs it one element at a time. As the unraveler disassembles the image, it reconstructs the elements as a sound structure. I will describe this process in more detail later. However, it is indicative of the computer's ability to capture actions.

On the face of it, this process is a computer program, laboriously written in an virtually unintelligible, specialized language designed to be used to build music or other time-based structures. Therefore, it may not seem appropriate for me to claim that I have trivially captured an action. However, I believe that this objection will dissolve as programming technology continues its rapid advance. Remember, at one time all photographs had to be laboriously posed. Now stroboscopic lights and high speed cameras can capture the image of a bullet in flight.

To quickly recapitulate, I have decided that I can best investigate and communicate the structure and significance of electronic space by using art-think. I have reached this conclusion because art-think focuses on the use of personal, holistic, sensory experience as a path to understanding, an approach which is appropriate when investigating the
personal, human implications of this question. In addition, my decision has been bolstered as my actual experience with this approach has revealed many interesting possibilities. For example, it appears that the analogies which are often at the heart of art-think are easily translated into active forms in electronic space which makes it easy to compare and contrast the electronic and non-electronic forms of ideas.
MY PLACE

Earlier, I posed a second question: How can I make a creative place for myself and similar persons in the contemporary electronic landscape? During the last three years I used a traditional art-think method to address this question. In order to establish a place for myself in, and to better understand the structure of electronic space, I just moved there, invited other students and artists over to play, and waited to see what would happen.

For example, I moved the major portion of my studio into various computers where I now work regularly. When I say I moved my studio, I mean that I helped create or purchased the tools, workspaces, and devices necessary to create, manipulate, and interact with electronic data, images, and structures. I continued to carefully observe the evolution, particularly as portrayed in the press, of the micro-computer systems and software which enable electronic space.

I collaborated extensively with the programmer who gives form to my electronic place and provides me access to the underlying structure of electronic space. I examined the architecture of electronic space as it is revealed by the process of working in it. By working simultaneously in both, I compared the process of working in an electronic studio to the
process of working in a 'normal' studio. And, I experienced and reflected upon the physical, emotional, social, and ideological effects of moving into and working in electronic space.

During this period, I also tried to understand and communicate my place in the electronic world by showing it to and discussing it with others. I gave repeated and extensive tours of my electronic studio, of the supporting computer systems and software, and of my work processes and the structure it reveals. I created analogous objects in both the electronic and non-electronic worlds which I compared and contrasted. I created electronic course materials which I tried out on students. And, I attempted to lead others into electronic space by creating a responsive, real-time, computerized environment in which participants can generate their own evocative experiences of 'being' in an electronic place.

My conclusion from all these experiences is simple. A good way to make a creative place for yourself in the electronic landscape is just to move there, set about working, and see what happens.
SOME COMPUTER BASICS

I have finally arrived at my third question: what is the basic
structure of electronic space as it effects and enables creative activity?
I have chosen to take a two-pronged approach to this problem. First, I
have developed some basic concepts about computers and electronic space,

enough to allow me to organize my ideas and responses. Second, I have
developed an interactive environment in which I, and others, may
regularly experience this type of space. I assume that this ongoing
experimentation and exploration will ultimately allow us to answer the
question, or better yet, develop new questions. Let me begin this section
by reviewing some basic computer concepts which I have developed to
organize my ideas into an art-think experience; particularly some basic
ideas about electronics and computers, especially microprocessors.

The modern microprocessor is a general purpose, electronic, digital,
programmable device. Each of these attributes contributes to the
computer's unique capabilities. Because it must function as a general
purpose device, the computer is designed to be flexible, adaptable, and
available. It must be useable in business, art, war, and many other
areas, while still permitting mass production, distribution, support, and
pricing. As an electronic device, it can be fast and small, a by-product
of working with electrons traveling near the speed of light. As a digital
device, it deals with simple, controllable signals representing numbers which can be used to represent rigorous language and logic structures.

As a programmable device, the computer has a basic language capability. It performs its functions by following rigorously constructed sets of instructions, programs. This is unlike a simple mechanical device which performs one function by virtue of its fixed physical structure. It is a 'virtual' machine, a device which takes its functional form from language models, from software, instead of hardware, a machine which can seem to be many different things. As a programmable device, it is able to automatically input, store, process, and output the programs and data which define and control its own activities or control other devices. It is a general purpose, electronic device which you can control with language.

These various attributes also work synergistically to provide another capability. As a general purpose device, the computer effectively creates a bridge between the different technological and intellectual environments in which it is used. As an electronic device which easily couples with any other electronic device, it becomes a bridge between different types of electronic systems. As a digital device which can handle signals generated by any process which can be represented numerically, it becomes a bridge between different disciplines and dimensions. As a programmable device, the computer has provided a common set of languages and constructs with which many different processes can be described and automated. In all these cases the computer has become a common denominator linking what were separate islands of knowledge and activity.
This adaptable electronic technology has been easily and intimately coupled to many devices which are based upon other electronic, electromechanical, electromagnetic, or electro-whatever technologies. Where coupling has not been easy, computer technology has been used to construct alternative electronic forms of almost any device for which electro-whatever input or output could be conceived. Once coupled electronically, each device or technology has gained access to the capabilities of all the others. The computer has acquired the powers of the camera, machine tool, telephone network, newspaper, and loom. Each of these, in turn, has gained access to the computer's powers of space compression, time compression, automation, control, and programmability, and the powers of any other device the computer is coupled with. It is this synergistic coupling of computers with existing and emerging technologies, and the networking of these technologies with each other via the computer, which has provided the wide range of capabilities usually attributed to the computer. One implication of this synergy is that, for my purposes here, there is often no way to distinguish between computers and other electronic structures. Computers are merely the active, linguistic component of any electronic system.

Viewed this way, the computer itself seems to have few intrinsic qualities; its identity appears constantly changing, depending upon the particular combination of input, processor, output, and software technologies being used. While true in some ways, this impression can be very misleading. The computer does have a core or intrinsic nature. It is a performer of programs or models made of language. It faithfully executes the more or less well-rehearsed scripts created by its human
programmers using whatever props it has on hand. Soon it will meaningfully contribute to its own scripts. The essential language and performance nature of the computer should not be confused with the various costumes in which computers may be dressed.

But what do we call this synergistic entity, this computer-electronic-network-linguistic active structure? Although there are many possibilities, I suggest we begin by calling this structure a place. A place is a particular physical surroundings or environment, a location for objects or activities. By this logic, when you look into a computer, currently through a screen, you are looking into a place, a real somewhere in which language is alive. Real things live in this place in the form of linguistic constructs: your income tax records and credit history, the map which shows your house and property lines, the parts list for your car, the program that connects your telephone to mine, the list of what the corner supermarket will buy tomorrow, the program that turns off the nuclear reactor, and all your savings. These are just a few of the possible examples of the active language structures which live in computerized electronic space.

Also, a place is usually bigger than you are, it is something you adapt to. A dog is a place to a flea. The flea jumps when the dog scratches. In the same way, human beings have adapted their lives to huge language structures which live in computerized electronic space. For example, American economic, intellectual, and social life is tightly coupled to the massive electronic files maintained by the Internal Revenue Service, to the vast academic and military computer networks, and to
their kissing close cousins, the telephone and television networks which
now span the globe.

Another reason to describe computerized electronic space as a place
is to focus us on the shape of the space and the architecture of
structures built in it. One of the properties of computerized space is
that it has a very flexible topology; linguistic relations can be easily
changed. The programs which live in computers are basically maps of
processes and structures, and maps are easily changed. I believe that in
computers and in human beings, it is reasonable to say that the map is
the terrain. This mapping makes for very adaptable systems. However, it
also means that the maps within the system can become disassociated from
the terrain outside the system.

Expressed as a simple image, computer space is a sea made of
language flooding a landscape which once incorporated separate
 technological and social valleys, lakes, and populations. As the level of
software sea rises, all the inhabitants of these regions are now beginning
to swim and evolve in a single linguistic place. Images, ideas, and
analogy live readily in this sea as active structures. And, since this
fluid language place is flexible, it can ebb and flow quickly in relation to
changing conditions. It can also erode the more rigid and stable
traditional social and technological shores. This is a place where the
map, and language, is the terrain. And, as such, this place bears a
striking resemblance to the human mind. Incidentally, the software sea is
not necessarily a nice or benign place. Living ideas are not necessarily
tame or well-intentioned. And, maps are not inherently correct or sane.
THE EXPERIENCE

Once I set up shop in electronic space, and developed a basic set of concepts to operate with, it became clear that I would have to explore and experience electronic spaces for quite some time before I could hope to really understand and communicate the structure of a creative electronic space. Therefore, I decided to try to construct my own creative space. In any event, I developed an interactive, computerized environment in which I, and others, can explore and experience an art-think electronic space. As I said before, I assume that this ongoing experimentation and exploration will ultimately allow someone to answer the original question, or better yet, develop new questions.

Before I take you on a tour of this environment, I want to take a moment to discuss the issue of interactivity as it relates to computerized structures. The term 'interactive' is generally used to refer to any situation in which a human being can direct the action of a computerized system in real-time. If you pick an item on a menu, and something happens immediately, the system is considered interactive. There are good historical reasons for this usage. For example, any real-time system appears interactive when compared to an overnight batch processing queue.
However, I believe that when a person chooses possible actions from a limited and unchanging set of options, it would be more appropriate to think of the system as 'responsive'. An interactive system would imply a relatively open-ended and changeable system to which the human could actively contribute. The issue of real-time access is important, but not necessarily related to the issue of interactivity. My personal goal is to ultimately produce real-time, interactive systems. However, the system we are about to discuss is properly described as responsive. I use the terms interactive and responsive interchangeably here because, though misleading, interactive is the term commonly used.

Now, let me take you on a tour of the computerized, interactive environment which I recently presented as my M.F.A. thesis show under the title *Random Access Memories: A Computer Performance*. This tour is based upon actual conversations I had with people who attended this performance.

Imagine that you and I are walking down a hall, chatting with our friend Ann and her daughter, Mia. Ahead on the left, next to a stairway, is a sign announcing that *Random Access Memories* is active inside. Beside the sign is a small map and a brief set of instructions. We stop to read:

Welcome. This map describes the touch sensitive interface that I have provided for you to activate and direct my *Random Access Memories*. This interface is suspended in the middle of the space that you are, I hope, about to enter. You will find the interface under the pale blue light suspended in the middle of the space. To activate the garden, firmly touch the interface as indicated here on the map. For example,
to GO to NODE1 QUICKLY, firmly touch the interface with one finger here:  

At this point, a string of dashes reaches out from the text into the upper left corner of the map where it ends in an arrowhead. While Ann's companion hangs onto one hand, she touches the map with the other. We continue reading:

You can use this technique to travel to any of the 5 available nodes at any of 3 speeds. Or, you may use this technique to evolve the garden, or to ask for help. Just touch the appropriate place as shown on the map. No, you don't need to know what a node is. Yes, you may take off your shoes.

"These" Ann says, "are the same instructions that were on my invitation, aren't they? Well, I guess we can handle that. I hope Mia can't break this thing. Let's not lose her shoes." We turn and start up the stairs next to the sign.

Mia almost stops as we reach the top of the stairs and pass into a big space where the light disappears. She asks, "Where are we going?" Rhythmic sounds are audible, as are the faint sounds of people talking and giggling. Everything seems very black here. On the floor, there is a faint stripe of light. As our eyes adjust to darkness, the stripe gets brighter. We can see dark forms off to the left. Ann coaxes Mia, "Come on, it's OK." As we walk forward, the line on the floor becomes brighter.

The sound is stronger here. It flows and lilts energetically. The line on the floor heads off to the left. We are beginning to be able to see in the dim surroundings. The space seems to have expanded noticeably. A short distance in front of us, a small blue light floats at
chest height. There seems to be a large, rippling pattern of light on the floor just below and beyond the blue glow. "I think that's where we're going, Mia," Ann says. As we walk, the rhythmic sounds seem to diminish as a portion of the floor ahead begins to glow. The changing light reveals that the numerous dark forms are other people standing between us and the now brightly luminous floor. Periodically, the little blue light will disappear as someone stands next to it. "That must be the interface thing," you whisper to Mia as she pulls on Ann's arm.

![Image](image_url)

Figure 1: A Rug at Rest
By now, our eyes are adjusted to the partial darkness. As we look around, it appears that, except for a scattered cluster of people around a pool of light, and the steady loping rhythms, we are in an empty, tall space. Mia has slipped free so we try to follow her towards the edge of the pool. As we pass through the ring of standing people, we hear her over the human chatter and the steady wash of low-frequency sound. "Oooh!" she says. In front of us is a pool of deeply saturated, undulating, colored light. The light seems to be six inches deep and heaped into solid waves. Cyan and violet diamonds float above a crimson field punctuated by fuzzy points of yellow and green. As Mia squats at the edge of the pool, her head and hands dissolve in the flow of light. Suddenly, the red field begins to move. Someone behind us says "I guess that's how you get it going." He appears to be holding the floating blue light between his hands.

It is clear to us that the receding red field is some form of geometric structure composed of many smaller elements. As the image slides away from us each of the elements seems to change and vibrate. The sounds have virtually ceased. The darkening surface seems to be covered with luminous children's blocks, each actively marching off to somewhere. You ask Mia, "What have you got there?" "It's the beach," she says. As you squat down beside her the floor grinds gently, and it becomes clear that there is a layer of sand covering the floor. Looking up, overhead you see three intense circles of light, one red, one green, and one blue. In each circle you see the same pattern of fierce sparks of color. From beside you, Ann says, "Stars in an electronic sky."
The sandy pool has filled with flickering points of light which appear to blink in some ambiguous pattern as they march slowly across the surface. The sounds have also changed and gotten louder. Ann says, "Listen, remember, doesn't that remind you of the monks' procession?". Mia isn't paying attention. She is holding a pile of sand in her palms and raising and lowering it under one of the flickering dots, watching the colors change. Every once in a while a number appears in her cupped hands. We can hear her say "Three, three," as the swaying sounds recede and a cluster of jagged lines slides by on the sand. The lines seem to be sliding up and down mountains which are simultaneously black and brightly colored, like some airplane's shadow on a phosphorescent terrain.

From where I am standing, I see some words sliding by, embedded in what appears to be an advancing grid of pulsing lights. Even though I built this thing, I am amazed at how such complex patterns can be generated by such simple means. I can also hear snippets of people's conversations above the chantlike background. I look around to see someone poking at the blue light. When I return my gaze to the pool, Mia has melted into the sand. Ann taps me on the shoulder, pointing to the colored dots and lines flowing over Mia as if she were some little mountain. Another child is scrambling across the sand trying to catch one particular wiggling light. No parents are complaining.

The pool is getting brighter now. A sharp, pale yellow edge has slid into view above angled lines of deep neon blue and red. A glimmering sunset-orange rectangle is stretching into view followed by a dog-leg hole of waving, almost-black, blue slashes. The sounds have
slowed; they push their way along the floor in resonant dark tones
punctuated by bright patches. Ann says, "It's a carpet. I can see the
kilim and everything. Look at how the orange floats above the blue!." I
reply, "It's the idea of paradise breeding with the idea of the rug.
Everything here is an idea and everything is a rug. I'll show you when
this cycle ends. Listen, you can hear the rugs mating." The radiant
gliding rectangles slowly disappear into the darkness followed again by
the marching map of lights. Beneath quiet conversations, the low
frequency sounds beat tirelessly against the constraints of the space.

It has been less than one minute since we arrived at the edge of
the pool, but Mia is lost to the world. The structure of the space is now
quite clear. It is high and appears empty. We cannot see much above us
because of the intense light coming from what is now obviously some form
of projector. Behind us a little we can see a couple of people handling
some sort of suspended object at the edge of the projection zone. At the
periphery of the space, there appear to be huge light bulbs and various
pale, prismatic surfaces.

A lull in the conversational buzz returns our attention to the
floating images. The marching lights are being superseded by a swath of
green which seems to be composed of a myriad of smaller, fluttering
elements. As the image comes to a stop, it is obviously some flowers and
leaves floating on or above a dark, cross-like form. One of the
participants is heaping up the sand, watching the straight lines bow and
twist over the flexible surface. The colors are intense, saturated, and
almost physically deep. As you reach into the sandy surface, your arm disappears up to the elbow as the edge of a flower climbs up your body.

As we squat there, the surface startles into motion. It seems to move much more quickly than before. The crowd becomes quiet while the chanting rhythms continue softly in the background. Almost immediately, the image comes to rest. The flowers are still there, but the image has been transformed. The bright greens have become muted and pale while the dark cross has completely disappeared. A cream-colored crenelated line now outlines the pool which is covered with an array of floating squares. Mia has taken to standing in the middle of the sand pile, turning slowly with her arms outstretched, her body covered in a hot flowing light.

On that note, let me end this portion of the tour. I hope it gives you some sense of what the experience was like, and how the participants reacted. Incidentally, many adults acted just like the little girl. Dancers danced, talkers talked, and sitters sat in the saturated, gliding imagery and sounds. Some came back for more. Many talked with me at length about how the system works. However, I was particularly touched by one incident. As this event was ending, a parent came up to me to apologize. She had returned home only to discover that one of her children had 'stolen' some of the sand. He was convinced that the sand was magic, and was quite distressed that it did not glow at home as it had in the garden. I, of course, was thrilled.
THE UNDERLYING STRUCTURE

I created the interactive environment which I have just described in order to explore the structure of electronic space and how it effects and enables creative activity. And, playing with the space was very revealing. However, I learned almost as much by working with the structure which underlays the experience. Now I want to introduce you to that structure. *Random Access Memories* is composed of 7 elements:

1. The installation space.
2. The image projection system.
3. The interface to the computerized systems.
4. The computerized system to produce interactive sound structures.
5. The sound synthesis, amplification, and projection system.
6. The computerized system to produce interactive, visual imagery.
7. The conceptual and image structure.

**The Installation Space**

*Random Access Memories* is installed on a sound stage. This is a large, 30'w x 60'l x 25'h, space which allows complete control of ambient light and sound. The acoustic properties of the large space also contribute to the experience of being inside a huge electronic world. The sound stage also provides subtle links to a theatrical tradition. Since I believe that computer programs are living performances, using a sound
stage has a nice resonance. Another extremely important feature of this space is that it has a ten ton traveling crane which makes lifting, locating, and adjusting the projection system relatively easy.

**Table & Chair**
- Power: 220 or 115 volt, 5 amp/gfci
- 4 outlets, 20 amp/5 min.

**Control Zone**
- PC for visuals
- PC for sounds
- Sound system
- Strain relieved power & IO cables
- 8' off floor min.

**Suspended Projection Equipment**
- 300 lb hoist min.
- Counterbalanced projector carriage
- Sony 10810 VGA projector
- Lens 12' off floor
- Strain relieved touch interface & low voltage light source

**Interaction Zone**
- 5' x 7' min.
- Covered with 4'00 lbs bright white sand on a 5' x 7' min. used movie screen

**Viewing Zone**
- 15' dia. min.

**Enclosure**
- Must provide adequate sound & light control.
- Minimum comfortable size: 16'H x 16'W x 24'D
- Absolute minimum size: 15' cube
- Appropriate position to hang a hoist is necessary

**Figure 2: Installation Plan**
Figure 3: Installation Elevation

The Image Projection System

*Random Access Memories* is basically a computer projection where the projector takes the place of a normal computer monitor. However, the single most important structural element in this work is the orientation of
the projection onto the floor, and, by extension, the fact that the images can be projected onto loose sand. To achieve this orientation, the projector is attached to a counterbalanced carrier which dangles from the overhead crane about 15' above the floor. All power, data, and mechanical cables are routed out of sight above the level of the projector's lens. Special cables are required in order to maintain adequate signal quality over the 50' distance from the computer.

The actual images and sounds I have created may be multi-dimensional as they live in electronic space, but they are not affected by gravity, and, when viewed through the 'flat' window of a monitor, they appear small and lifeless. I solved this problem by projecting the images onto sand which returns the visceral sense of dimensionality which would be lost if we viewed them through a monitor. Further, by projecting on the floor, the participant clearly feels as though s/he is in a real place; there is no confusion caused by the computer monitor's small size. Projecting the images on the ground also allows the images to inherit some of sand's weight and gravity.

The sound, bouncing off the invisible walls of the huge sound stage, further enhances the experience of dimensionality by accentuating a sense of infinite space and scale. The images also inherit the sense of power and space communicated by the sounds because they are literally structured by the images. The image data, which is the rug to the computer system, is used to create the sound stream. When we stand in the projection, we experience standing in a real boundary zone where the
electronic and the 'normal' world co-exist. The images and sounds are experienced as real, not virtual constructs.

The Interface

In order to allow participants to interact with the computerized sound and image production systems, some form of electronic interface is required. I have used a small, glass-surfaced, touch sensitive tablet which is suspended from the ceiling at about four feet above the floor, at the edge of the interaction area, and outside the projection cone. A map is visible below the interface surface which shows the participant how to control the motion of Random Access Memories.

<table>
<thead>
<tr>
<th>GO to NODE 1:</th>
<th>GO to NODE 2:</th>
<th>EVOLVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>slowly</td>
<td>slowly</td>
<td></td>
</tr>
<tr>
<td>quickly</td>
<td>quickly</td>
<td></td>
</tr>
<tr>
<td>instantly</td>
<td>instantly</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GO to NODE 3:</th>
<th>GO to NODE 4:</th>
<th>GO to NODE 5:</th>
<th>HELP??</th>
</tr>
</thead>
<tbody>
<tr>
<td>slowly</td>
<td>instantly</td>
<td>instantly</td>
<td></td>
</tr>
<tr>
<td>quickly</td>
<td>quickly</td>
<td>slowly</td>
<td></td>
</tr>
<tr>
<td>instantly</td>
<td>slowly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4: The Interface
The map illustrated above shows the organization of the touch interface used by participants to control the motion of my images and memories. This map, at roughly this scale, is placed beneath the glass surface of the interface which is illuminated by a low voltage light source. The interface map is designed to allow participants to use one simple set of actions to control the motion and sound of the memories, i.e. the magic carpet, under all conditions. The interface is based upon three verbs, GO TO \{node n\}, EVOLVE, and HELP, and three adverbs, INSTANTLY, QUICKLY, and SLOWLY. These words act in the same manner no matter where the work, or the participant, is located. The words are included on the interface map for those participants who, for whatever reason, will refuse to handle an unlabeled interface.

I use this type of spatially organized map primarily so that the interface, and the memories/rugs, can be handled like objects. Also, the electronic interface itself has to be incredibly simple to use so that strangers can use it without socialization. In addition, people have to use the interface in a way that doesn't interrupt their senses, in a way that doesn't interrupt the experience. By handling the electronic interface, the participant should get the feeling of a simple, natural action; this is something s/he does all the time. The participant should not need to know anything about computers, mice, menus, or cursors.

In practice, many participants seem to ignore the words and just poke at the interface until it does what they want. It is common to have one group handle the interface while another group plays in the sand. After a while, the groups change places. It was my intention that
participants handle the interface, and therefore my work, as though they were simultaneously handling a small, weighty, opaque object and a huge, light, crystalline structure. The participant gets this impression by handling either the 'real' interface or the sand.

Ironically, the sense of interactivity, control, and dimensionality in this work largely comes from projecting on loose sand. The sand is perceived as an interface by participants. Handling the sand, which has no 'real' effect, manages to convey genuine interactivity and engage the senses. By handling the sand the participant may fuse the map and the terrain and get the feeling of directly interacting with the variables and dimensions which exist in computer space. As a result, while the work is merely responsive, it feels interactive. And, while the system is synthetic, it feels natural and accessible.

Whenever a participant touches the electronic interface, images jump or slide while breeding with each other. The particular trajectory and speed of motion is determined by the exact place that the participant touches on the interface. While the small scale of the interface is determined by technical considerations, it helps suggest a highly leveraged relationship with the system, as well as the sensitive dependence upon initial conditions which mark a non-linear, dynamical system. Once a motion is chosen, the image production system sends a message to the sound production system which adjusts the sound structure appropriately. If the participant pays attention, s/he can deduce the crystalline structure of the work and effectively control the magic carpet. By touching the edge of the interface, the participant can change the color
structure of the work, thereby dramatically changing the visual relations within the work and the experience.

**The Computerized Sound Production System**

The computerized sound production system is an IBM PC based musical instrument digital interface (MIDI) control system running specialized sound software. The sound system is linked to the image production systems which handles and relays all user interaction requests. The heart of the system is the sound software written by John Dunn, with whom I have collaborated for many years. This software, called the Kinetic Music Machine (KMM), runs on IBM compatible personal computers, even the slow PC's I can afford. This software drives all the sound in Random Access Memories.

KMM is basically a real-time, algorithmic MIDI control language. You place functional entities on a work surface and they become immediately alive; there are clock modules, indexers, switches, boolean operators, etc. You plug the program modules together into structures as you would analog synthesizer modules. The module structures generate a real-time MIDI data stream that feeds an electronic synthesizer. A Proteus/1 16 bit multi-timbral digital sound module turns the MIDI data stream into sound using the sampled sounds it has stored in memory. The sounds are amplified and projected using a high quality Hafler stereo power amplifier and DCM stereo speakers. In the future, it would be possible and interesting to use this sound structure to drive a multi-channel amplifier and speaker array which could magnify the sense of dimensionality significantly.
For Random Access Memories, I used KMM to program a rug unraveler. The KMM sound structure takes the data from the images of the rugs as they float across the projection zone, and uses them to generate sound. This code structure splits the rugs into image and color components. Each component stream drives a group of voices. Each unique interaction between rugs, i.e. each pattern of sliding images, generates a unique sonic stream. I try to give each stream interesting rhythms and tones appropriate to the images and ideas, but the sounds are largely structural byproducts of the interaction. The rugs and ideas are being unraveled, one knot at a time.

This code controls autoprogram indexing based on MIDI program change numbers sent from a Vango session running on a remote PC. Each unique program number activates a particular aspect of the sound structure.

Figure 6: A Page From the Unraveler
The Computerized Image Production System

The computerized image production system is a 486/33 IBM PC AT compatible computer with a fast display sub-system optimized for character mode graphics running specialized animation software. Again, the heart of this system is the innovative software written by John Dunn. When John built KMM, he used the IBM PC's speedy character modes to build the necessary real-time interface. This issue warrants some further explanation. On a PC, ASCII characters are stored as objects in hardware. Also, you only need four thousand characters to fill the screen on a medium resolution VGA display. By contrast, there are about three hundred thousand pixels on the same screen, and there is no pixel specific hardware on a traditional stock PC. Therefore, using characters to display information is very fast, while using

Figure 6: The Visual Structure of One Rug
pixels is very slow. When John completed KMM, he realized that he could create real-time animation on a cheap PC if he used characters. The package he created is called Vango.

**Vango** is a unique blend of hypertext, animation, and a paint system. The objects you can paint with are characters, the elements of the ASCII character set. However, you can jump or slide through a two-dimensional hyperspace. In addition, although you can only use 16 colors at a time, you can jump between sixty-four different color maps. Vango can also send MIDI control messages which can be received by KMM.

![Figure 7: Vango in Authoring Mode](image)
All the images in *Random Access Memories* are created using *Vango*, using the ASCII character set, the building blocks of the computer age. *Vango* also has one other very unusual ability. As you jump, slide, and movie through hyperspace, you can 'breed' images. In essence ASCII characters are very simple objects with three inheritable attributes: character code, foreground color code, and background color code (CFB). *Vango* can take any two images built with these objects and join them in real-time to create a third image which inherits different combinations of these CFB attributes. Mom and Dad make Baby in real time.

When John asked me to see what I could do with this program, I didn't realize just what it would be capable of. In fact, it seemed very limiting. But then, charcoal is a very simple tool capable of very expressive results. Also, I am always interested in any system which will run on inexpensive equipment since these types of program can be the most useful for artists and teachers. Anyway, I gave it a try.

A few hundred hours later, it became clear to me that, coupled with KMM, I could amplify this apparently simple system's intrinsic structure to create interactive experiences which would communicate some of my most basic ideas. For example, I believe that all form is generated through interaction, that programs are alive in electronic space, and that art addresses the boundary between virtual and real systems. The ideas and analogies I like to work with seemed to come alive naturally in *Vango*’s image/object breeding and intersecting space; especially when the images were projected into non-electronic space. These ideas seemed to want to be explored in the type of system KMM and Vango offered. Further, this
system seemed like a wonderful example of a system which explored the creative possibilities of electronic space.

After I worked with Vango for a while longer, I also realized I could use it to explore transparency. This was very significant to me because I believe that the idea of transparency expresses the flow across time of what is 'important' in a system. For example, Baby has her father's eyes and her mother's mouth, therefore she is transparent to her parents. Joe treats women the way his father treated women, and women react to Joe like his mother reacted to his father. Joe is transparent to his parents' values and behaviors. I call this structural transparency. You can see genetic and social dynamics flowing through the structures of transparency.

The Conceptual Structure

In order to figure out how this new system worked, I needed a way to travel around, a way to structure time and motion in hyperspace. Since I love Oriental rugs, and since rugs lend themselves to being treated as tiled structures, as linked group of simple objects, I decided to try to weave some rugs, and to fly them around in hyperspace to see what would happen.

I quickly realized that it would be a very good idea to develop the rug metaphor further in spite of the hackneyed Arabian Nights flying carpet image. First of all, a flying carpet is a nice way to get around in electronic space; it is a clear and common 'magical' metaphor in a strange place. But more important, the structure and evolution of Oriental
carpets, especially the tribal knotted rugs, seemed to have many wonderful parallels with the structure and evolution of computer systems and software.

I began to see tribal rugs very much as pieces of portable software, developed using memory constrained processes in a network environment; all puns intended. Also, I began to think of the rug as a virtual garden, a real piece of furniture, a slow-loading raster image, and as a graphical interface to God; literally. By building rugs to explore electronic space, I could build an image world of archaic systems, networks, and software in a parallel modern linguistic world of systems, networks, and software. I decided to use the structure of rug creation as the literal, physical structure of my work believing that the structure of rugs would resonate with, and reveal, the analogous structure of electronic space itself. And, in my opinion, it did.

Therefore, most of the images used in this work were developed from these knotted tribal rug forms and processes; basically, they are modern forms of the nomad's magic carpet. However, a rug can also be seen as the physical output of a dynamic social and intellectual process, or as an ideological form which is structurally transparent to a set of core ideas. In my mind, the idea of the rug is derived from the interactions of four other ideas: the idea of sanctuary, the idea of paradise, the idea of the garden, and the idea of weaving. These ideas flow around in a cultural stream where they interact and breed. Various artists, usually anonymous women artists, then give form to these ideas within the limits of their memory and time resources.
The map above shows the physical and conceptual organization of the images, colors, trajectories, and sounds which I used to generate the experience of Random Access Memories. As I mentioned before, my visual and sonic effects are all based on the real time structural coupling, i.e. breeding, of a very simple set of objects and ideas which are organized into images. The set of objects is the ASCII character set and their associated attributes. The participant sees the literal interaction of my image/ideas about sanctuary, paradise, rugs, gardens, weaving, as well as the process of structural coupling which is expressed as transparency. There are also a number of supporting idea/images which participate in the structure of the piece. These are: values can be drawn; life, art, and language are non-linear dynamical systems; fractals are the marks left by these types of systems; language is alive in computers; and, the map is the terrain.

The images and trajectories are organized around a pyramid-shaped, molecular, crystalline armature. The armature describes the relative locations of images and the motions between and through images. I created this pyramidal shape to satisfy both my need for compelling interactions between idea/images and my need for an extremely simple, spatially-oriented, object-like interface.
CONCLUSION

I began this work with three questions. These questions have been a convenient way to focus and organize my efforts. Maybe I have actually answered some of them. However, any answers I have provided must be provisional. As James Baldwin said: "The purpose of art is to lay bare the questions which have been hidden by the answers."

I hope I have communicated some of the possibilities enabled by the new, hybrid, real electronic world. I certainly have tried to raise a few new questions about living and creating in electronic space by creating an interactive environment which can be experienced as responsive, real, social-scale, colorful, pulsating, dimensional, crystalline, yet non-linear, and dynamical; a place/system and object/process located in the boundary zone between electronic and non-electronic space; a place where structural dynamics effect the shape of ideas and language as well as the shape of plants and clouds.

The work I have described here is my attempt to provide myself and others with a joyful and valuable experience of a real place where language is alive, where a crystal is a process, where rugs are portable software, where color is three dimensional, where interactions generate form, where ideas breed in real-time, and where the act of being yourself
literally changes the shape of the world. This work is also my attempt to understand the social and personal implications of living and creating in a world where drifting sand can generate code and magic carpets can sing.
APPENDIX A: CONCEPTUAL SNAGS
Below is a more exhaustive version of the snags and dams analogy mentioned earlier in the section on Art-think.

Concepts and feelings float and bob in the river of my life where local eddies and currents concentrate and tangle them into assemblies; like branches stuck in a snag or a beaver dam. As with branches embedded in a dam, when one tries to pull out one branch or idea, others may come with it. And, all the while one is pulling and poking, a beaver or the river is heaping up more branches. Moreover, the dams and snags change the flow of the river itself. The experience and understanding of ideas or of systems is as much the experience of snags forming and the river changing as it is the understanding of any given branch. Therefore, in order to understand my work, it is useful to see some of the original dams and snags. Following is a picture of a set of well-pruned snags; a snapshot of some of the entangled assumptions and ideas underlying my work.

Begin Snag. Central branch: ideas

Ideas are real and alive. Ideas require hosts in which to live and breed. Ideas breed by structural coupling. Structure grows around ideas and their hosts like pearls around sand. Intuition is chaotic structural thinking focusing on the flow of ideas and the relations between flows. Intuition has trouble with specifics. Intuition is about climate first, weather second. Intuition is analogous thinking. Analogy is self-similarity. Ideas are little weather systems.

End Snag.
Begin Snag. Central branch: Consciousness

Consciousness exists whenever a modulator of external signals generates additional signals as a product of its own activity.
Consciousness builds a map of the world in real time. Consciousness is the story you tell yourself. Stories can be built with language.
Sensations are stories too. Consciousness changes the shape of the world, changes the effective fractal dimension of the interface between you and your environment. Consciousness enables the map to become the terrain.

End Snag.

Begin Snag. Central branch: Computers

Computers are places. A place is something bigger than you are. A dog is a place to a flea. A star was not a place to our ancestors.
Language is alive in computers. As photography trivialized the capture of images, and film/video the capture of images of processes, so computers trivialize the capture of processes as more or less stable language structures which carry the values of their creators. In computers, the word is God and God is the word. Snags and dams can live in electronic space as open-ended processes. Objects are just slow processes.
Computer programs and data structures act as our electronic alter egos. Taken in aggregate, computers are the place where a social-scale child is being conceived.

End Snag.

Begin Snag. Central branch: Maps

New technologies enable new realities. A significant portion of the world's material and social structure is flowing into computerized
linguistic space where the map is the terrain. When the nodes on a map are loosely coupled, the map easily and quickly folds, convolutes, or flows. Folding a map may indirectly fold the world. DNA is folded, the brain is convoluted. Migrating material and social structures will undergo a phase change as they move into computer space; structures which were solid in space or time will become fluid. The boundary between electro-linguistic space and 'normal' space is a coastline dotted with conceptual ports of call and eroded by dialectical seas. Ports are receptors. As material and social structures venture into the turbulent software sea they will become subject to new evolutionary forces.

End Snag.

Begin Snag. Central branch: Transparency

Everything is related. You cannot observe or experience anything without effecting it. There is limited bandwidth. Limits of validity can be expressed as regions of transparency. Dimensions can be transparent. Time is a dimension. Value systems tend to be transparent. The things you take for granted are transparent. The process/object transformation can be seen as a change in transparency. Structural transparency is seeing the mother's eyes and the father's voice in the child's face. Structural transparency reveals genetic dynamics.

End Snag.

Begin Snag. Central branch: Rugs

An Oriental knotted carpet is a virtual garden and a real place. Tribal rugs are portable software. Rug images are remembered as quasi-device-independent algorithmic structures. Rug knotting is a memory
constrained, iterative compilation process. Rugs are rasters. Rugs are stored in stacks and heaps. Rugs evolve along a network where related ideas develop at different scales; court, city, village, and nomad. Rugs are generated through the interaction of four ideas: sanctuary, paradise, the garden, and weaving. Rugs are cross sections of the turbulent flow of visual ideas within a cultural river. Rugs are magic vehicles which can take you to your heart's desire.

End Snag.

**Begin Snag. Central branch: Experience**

Intuition and a sense of place is developed through experience. Full spectrum experience is generated by the direct manipulation of objects and processes. Experience enables humans to extract maps of the dimensions relevant to their lives. A value system is a weighted dimensional map. Any dimension may be fractional. A value system can be drawn. Ideas attach to receptors on value systems. People want the world to flow around them. To stay even near the center in computer space, people must develop scalable value systems which address the relations between many dimensions. Surfing changing value systems takes experience.

End Snag.
APPENDIX B: HARDWARE & SOFTWARE CONFIGURATION
Following is a description of the hardware and software I used to present *Random Access Memories: A Computer Performance* as my M.F.A. thesis show. The installation was composed of seven elements:

1. The installation space.
2. The image projection system.
3. The interface to the computerized systems.
4. The computerized system to produce interactive sound structures.
5. The sound synthesis, amplification, and projection system.
6. The computerized system to produce interactive, animated, visual imagery.
7. The conceptual and image structure.

The specific configuration of each element or system is listed below. Other configurations are certainly possible.

1. Configuration of the installation space:

   Hardware
   - The space was approximately 30'w x 60'l x 25'h.
   - The space was a sound stage which allowed almost total control of ambient light and sound.
   - A short hall and stairway led to the space providing light buffered entry and exit.
   - The space contained a ten-ton traveling crane which simplified lifting, locating, and adjusting the projection system.
   - The computer and sound systems were placed at a distance from the projection zone behind a black cloth modesty screen.
   - All light producing elements on the computers, monitor, and sound system were blacked out during the performance.

2. Configuration of the image projection system:

   Hardware
   - Sony VP-1031Q Multiscan video projector with VGA projection capability. Please note: only late serial numbers of this model have VGA capability.
   - Extron RGB108 RGB converter with power supply and 50' RGB cable. Please note: Special Extron cables are required to connect the RGB108 to the VGA monitor and to the Sony 1031Q projector.
   - Projector carrier with integral hoist connector and counterweight hangers. Please note: the carrier, projector, and balance counterweights weigh approximately 300 pounds.
   - 400 pounds of medium fine, bright white sand to cover a 5' x 7' area to the depth of 2".
   - A 5' x 7' used, glass bead movie screen to act as a base for the sand.
   - Appropriate grounded power, data, and mechanical support cables, connectors, and adapters.
3. Configuration of the electronic interface:

**Hardware**
- Microtouch Unmouse touch interface
- Microtouch 5 voit external power supply.
- 12 voit light source and power supply.
- Appropriate grounded power and data cables, connectors, and adapters, including 50’ serial cable.

**Software**
- Microtouch Unmouse driver running in absolute mode.
- A written introduction to the use of the touch interface. This document was included in invitations and was posted near the entry way to the in

4. Configuration of the IBM PC XT computer which produced the sound structures:

**Hardware**
- IBM PC XT.
- Intel Inboard 386 XT accelerator.
- Intel 386DX processor running at 16Mhz.
- 1M RAM; 640K DOS, 256K RAM drive.
- 360K FD, 10M HD.
- VGA display adapter with 256K.
- Switch for sharing NEC Multisync monitor.
- Roland MPU-401 MIDI interface card.
- 84 key XT keyboard.
- Microsoft compatible serial mouse.
- 1 Serial, 1 Parallel I/O ports.
- Appropriate grounded power and data cables, connectors, and adapters.

**Software**
- MS-DOS Ver 3.3.
- Microsoft mouse driver Ver 8.2.
- Microsoft Ramdrive.
- KMM software, John Dunn programmer; an algorithmic composition and real-time MIDI control system.

5. Configuration of the sound synthesis, amplification, and projection system:

**Hardware**
- Proteus/1 16 bit Multi-timbral digital sound module.
- Hafler DH-200 stereo power amplifier.
- DCM Time Windows stereo speaker system.
- Appropriate grounded power and interconnection cables, connectors, and adapters.
6. Configuration of the IBM PC AT compatible computer which produced the visual imagery:

Hardware
- Comtrade IBM PC AT compatible clone.
- Intel 486DX processor running at 33Mhz.
- 16MB RAM; 640K DOS, 16M disk cache.
- 1.2M FD, 1.44M FD, 210M HD.
- ET4000 based local bus VGA display adapter with 1M.
- NEC Multisync monitor.
- Music Quest PC MIDI MPU-401 compatible interface.
- 84 key AT keyboard.
- Microsoft bus mouse.
- 2 Serial, 1 Parallel I/O ports.
- Appropriate grounded power and data cables, connectors, and adapters.

Software
- MS-DOS Ver 6.0.
- Microsoft mouse driver Ver 8.2.
- Microsoft Smartdrive disk cache.
- Vango software, John Dunn programmer; an ASCII character-mode hypertext and animation program.

7. Configuration of the conceptual structure:

- See Figure 7: The Conceptual Structure of Random Access Memories, Page 41.