QUANTUM POETICS: SIX THOUGHTS

INTRODUCTION

In a world of electronic, photonic, and bionic technologies, what and how does poetry speak, write, sound: what qualities emerge as it threads network flows, protein synthesis, random generators, algorithmic visual tools, sound engines, and other instruments that do not aim to (re)produce notes, or words, or pigments, but rather their own mesh of variable pattern?

For more than a century poetry has risen from the printed page, (re)locating itself in the corporal voice, in the life of the community, on the walls of cities, as part of performance. Now, by means of new technologies, poetry lives in new multi-dimensional environments. The position of the reader/auditor/viewer, who is sometimes a possible collaborator, has shifted—one more shift in a long history of shifts in reading mapped in the anthology *A Book of the Book.*[1] We don't know the "future of reading," though a recent Xerox Parc installation, *XFR: Experiments in the Future of Reading,* prototypes some exciting possibilities. Digital art makes us think of other directions. In the electronic arts, on which I will focus, (inter)convertibility of all previous media and energetic forms to one digital bitstream is a key capability and constraint.

The six major interests for me, as maker and receiver of these works, are: 1) the discovery or refinement of new time dimensions, from macroscopic "worldlines" to engagements at the periphery of attention to "curled-up" hidden possibilities; 2) privileging what I call a stenographic paradigm for interaction: "moving through me as I move"[2]; 3) cultivation of an oscillatory or flickering kind of attention, directed not only to different components but also to different emergent levels as we have learned to understand these in dynamic systems; 4) thinking beyond oscillation to superposition; 5) remolding our sensorium, our neuro-cognitive capabilities, through these new works; and finally, 6) a sense of the importance of the practice of translation, understood as encompassing acts of transduction, transposition, transliteration,[3] transcription, transclusion,[4] and the transformation we call morphing.

ONE: TIME DIMENSIONS[5]

What is engaging about poetic works in new media? A way of entering time, unmatched by our other experiences. We are taken, not by the site or the map, but by the ongoing journey; not by the view or the

path, but by the changing of the view, the diverging of the path; not by the archive or database, but by the ever re-contextualized act of retrieval; it is, then, not stasis, not velocity, but a new sort of time connection: what speeds me up, what slows me down, what hangs—

For almost a century, Einsteinian physics has taught that the universe has no master clock, no space pervaded by absolute time. We are intellectually convinced, but we have no "feeling for," no intuitive sense of what it is to travel on a worldline in an irreducibly compound spacetime. We do not understand kinesthetically that a worldline never ends or begins, that it can time-reverse without violating laws of physics. Could we simulate the experience of such travel in the unconstrained dimensionality of cyberspace?

Designers in educational multimedia have produced tools such as *Mathematica* and *ODE Architect* to provide an interactive sensory grasp of highly abstract structures, but electronic poetic art has only begun to harness similar strategies and has not given itself the task of rendering temporal abstraction. One wants to grasp *temporal* abstraction because the critical changes from sub-atomic levels through biological macromolecules, cells, organs, individuals, societies, on through ecologies, are decisive *time-based* events. These changes are jumps between levels that reveal emergent properties. Such properties are unpredictable by, and unanalyzable in terms of, properties of the prior level, *even though* there is an unbroken line of inheritance from bottom to top, and even though there is always a part/whole relation between the levels. In the transition from any one of these levels to the next, not only is the whole greater than the sum of the parts, but the emerging qualities feed back on the parts and give them qualities they couldn't have if isolated.

How do we measure time, then? Metronomes of considerable historical importance include the solar and lunar cycles, the rhythms of the tide, the heart, the menstrual cycle, and now, vibrations of a cesium atom. Most importantly, we ourselves are proper clocks, measuring one kind of time, because a proper clock, in Einsteinian physics, is a clock affixed to a moving object.

In this age of preeminently bio-science, we re-understand the body, have in fact translated the body through cloning, through digitized anatomy, through medical body-scan devices. We newly understand that the human timekeeper, the heart, is not the kind of clock that measures unvarying flow, but is rather a fractal tempo tracker that runs concurrently to the beat of several highly variable drummers. When it runs to no beat, or if it collapses to one stereotypic periodic behavior, losing some of the long-range correlations that tie it to events thousands of beats into the future, then it is about to die. Is the Internet also a fractal tempo tracker?

The tracing of a heartbeat over a period of milliseconds, then seconds, minutes, hours, days, exhibits a pattern that remains the same. The concept of fractal shifts here from self-similar structure in space to self-similar dynamics in time. Thus, though you can't tell what time-scale you are looking at simply by seeing, or hearing, these patterns, the pattern's persistence does become a means to travel *between* time-scales. And although it is true that an average regularity, a pulse, can be established, this is not the most interesting pattern—as a measure, it smoothes and destroys the huge amount of information hidden in the micro-measures, in the fluctuations, the interbeat intervals.

How can we use these dynamic measures, these hidden dimensions, for poetic works? By using large networks as our instruments, as arguably Net artists Mez (Mary-Anne Breeze) and Netochka Nezvanova[6] both do, creating and exploring multiply connected spaces in which different regions of space and time are spliced together, but more than spliced; in which histories are alterable, always different, manifesting in many media, driven to immaterial spaces by the assaults of technology—or are they released by technology, escaping both identity and identification, in search of some new present that they are leaning into? As Talan Memmott says, "Adentity is another manner."[7]

One poetic work that thinks time dimensions in new media is *1:1*, a time series image of the Internet, created by Lisa Jevbratt.[8] In this piece softbots, or agents, continuously scan servers doing an interlaced search of all possible IP addresses, expressed as four octets, and then expressing the results in terms of five different visualization algorithms. The search zooms in repeatedly on different samplings, each of which constitutes not a slice, but a snapshot, of the Web, which increases in resolution as the scans move toward sampling all the octets, after which they recommence. The title *1:1* refers to a scale of 1:1, suggesting that this map has the same size as its referent. In fact, the interface here has become not only the map but the environment, implying all of the logical problems Lewis Carroll addressed in 1893, in his book *Sylvie and Bruno Concluded*, and raising, as well, the issue of map as time tunnel, map-meaning dependent on date.

Readers of *1:1* can select locations via the Hierarchical, Random, Petri, Excursion, or Every interface. The latter is a densely striated coat of many colors, a clickable image map linking to every top level website associated with an IP address. The specific color of each square is generated by using the second, third, and fourth octets to specify RGB numbers. The Petri interface resembles a star-map of live sites, each of which brightens the more it is clicked, demonstrating the self-fulfilling-prophecy aspect of collaborative filtering. The Excursion interface permits a recursive choice from a search-progress graphic that opens nested windows; Hierarchical allows consecutive choice of each octet; and Random requests a randomly generated choice. When using these database interfaces, readers experience predominantly undeveloped sites and inaccessible information, at best a few hits among the myriad error messages that announce vacant or forbidden sites. Without a probabilistic sampling scheme, without recursive searches, without a time series interface, this particular view of one of our most important public environments would not be available.

This interface/visualization only transiently yields to a gestalt. It must be reconstituted continuously with computer processing time and human cognizing time, a kind of temporal knowledge that we learn to feel with and that digital artists are exploring in unpredictable ways.

TWO: THE STENOGRAPHIC PARADIGM[9]

If we think of oral performance as mapping time into time, an insertion of the invisible into the invisible, smoke in air; if we then think of script as mapping time onto space, the time-uttered word now held on vellum, stuck there, ink-spattered, or the time-uttered word now chisel-chipped on stone, we will think, the letter kills, but the spirit (-voice) gives life.

And then, if we think of print as mapping time onto a grid, the justified page stamped by type set in rigid frames, always the same, no difference one copy to the next, under the control of the Learned Latin line, a line that has excluded childhood and linguistic play, that has excluded those prohibited from learning by reason of their birth, we will wonder where the human voice has hidden itself—and notice that the Romantics and Mary Shelley, for different reasons, aligned themselves with technology dreams.

And if we ask, finally, in this line, what does the electronic word do, will we say that it maps time into a medium that defeats geometry, that is profoundly anti-spatial, not a place to hold and to own, but a place to login, full of transitions, timely views, snapshots of malleable non-placed space? Will we say that many co-present, fleeting, refugial, but reappearing, glances and glimpses can begin to assemble themselves across many levels of reference and embeddedness, across many types of text, and will this act of recombination or reconfiguration have a shared public structure, the structure of a quest? A quest, we must ask, of whose unconscious.

What anthropologists call polychronic time, software engineers call multitasking: doing many things at once. Both multitasking and microprocessing, as Sadie Plant points out in *Zeroes + Ones*, are activities associated with the work of women in many societies and eras. This interruptible ability to do many "little" things at once is contrasted with monochronic male time, a time in which only one task is addressed, no matter its mental, physical, or ritual character. In a digital age, all are interruptible, and digital art often takes on the "never done," always renewable quality of so-called "women's work."

Rosmarie Waldrop, in her prose poem, "Accelerating Frame,"[10] describes this mode of reading: "I badly wanted a story of my own, as if there were proof in spelling. But what if my experiences were the kind of snow that does not accumulate? A piling of instants that did not amount to a dimension?"

Vannevar Bush[11] wanted his Memex to intercept and capture the neural circuits of the stenographer who could reduce his words to a phonetic code on the fly, whose encoding practice was encompassed by her body. I want to do the same thing, not from the position of Bush, outside the device, but from the position of the stenographer, attached to it. In her body, words moved through her as she moved, a fluent circuit of meaning that she hosted, instigated, permitted, understood, explored, and enjoyed. Her somatic practice deflects not only the threat of analytic dispersal, into "simplified language…nascent form…intelligible only to the initiated," as Bush characterizes her code, but also the threat of obsessive recombination and confusion, the multiple overlapping streams of speech she is asked to transcribe.

The notion of "moving through me as I move," as a paradigm for interaction, intends to install the stenographer, and not her employer, as the crucial creative/receptive presence in digital art. Hers is an egalitarian position that can be stated of, and by, each element in a dynamic network. "Move through me as I move" is as much the "voice" of a hypertext as it is of the writer/encoder. It is also the voice of the network addressing all those hosting it and served by it. In the case of work open to multiple authoring, or to synchronous reading and performance, the command 'move through me as I move' represents the utterance of each of the performers and participants speaking to all the others.

The stenographer, however, is more than a writer/reader/monitor; she is also the operator of an appliance. This position is described by Talan Memmott, here explicating his theory/fiction hybrid, *Lexia to Perplexia,* winner of the 2000 trAce/altx New Media Writing competition:

> With a document that is acted upon, unfolded, revealed, opened rather than read, full of holes to elsewhere, hiding secret inScriptions, filled with links like mines and traps and triggers—we are no longer talking page or screen, but appliance. Navigating the Lexia of *Lexia to Perplexia* is…like getting a new device and trying to figure out how…it works…."[12]

The stenographer moves within an unforeseeable context. Communicating by "strokes" in an energized yet languid atmosphere, she is absorbed, alert, and somehow also free to gaze about the room—the aspect that most disquieted Bush. She participates in a form of dancing in which the lead changes many times a minute, her moments of apprehending/encoding activity giving way to deep moments of passive reception in a regular alternation or oscillation.

Partnering the machine—and then the network, always in touch as well with the social networks in which the digital networks are embedded, people often need to change their patterns, or moves, to deploy or receive effectively. The more one becomes attached, the more one wants a fluid form of action/understanding. "I want to be as able as a spider, sitting astride thousands of webs she has spun, to sense each soft ripple or bursting hail of electrons coming toward me and, of course, those pouring back—from my fingers, my mouth, perhaps even my glance."[13]

Figuring this back-and-forth motion, I wrote a poem about Sand (silicon-based e-media) and Soot (carbon-based life) called *The Ballad of Sand and Harry Soot.*[14] It hosts a seeming disjunction of image and text on each of its 33 pages. Images from Jean-Pierre Hébert's *Sisyphus*—a device shown at Siggraph 1999 that inscribes algorithmic patterns in sand with a steel ball—are the ones most prevalent in the *Ballad.* Other images suggestive of digital or mathematical culture, such as a Metro card, Webcam photos, a core dump, or an animated fractal, accompany the text of a love poem, a ballad of love gone wrong or at least not entirely right, between Sand and Soot. At one level, the disjunction of image and text mirrors the difficulties of this pair; however, the particular discordance, or non-reference, that seems to exist *between* image and text will, at some point, spring into resonant oscillation for the reader who either sees, or reads, an avatar of carbon-based chemistry in Harry Soot and one of silicon life in Sand.

Though this poem was written to probe differences between Sand and Soot, I came to identify, not only with Harry Soot, despite gender and temperamental differences, but also with Sand. A sensuous willingness to be pulled in, or to pull in, is part of what I feel about her. And certainly the intent of the *Sisyphus* device in actual operation is to create a meditative environment, which occurs as you watch it draw and also as you contemplate what it has drawn, a transient silicon image, equally present in the sand being traced and in the tracing program.

This early hypertext does not use programming to fluidly adjust to each reader, but it does provide a world responsive to many approaches. There are no privileged nodes, no highlighted links—the links must be found by caressing the text with the cursor in an attentive stenographic manner. Three navigation methods are explicitly described, each explicitly recommended, and their combination in any fashion also explicitly catered for. Beyond the multiple, but un-urged, choices on any page, there are "tendencies and flows" for the reader who seeks direction; for instance, there is a persistent but not rigid tendency for links to be found in both the Soot and Sand portions of the text at each node.

Four key images in the *Ballad* were created by Alex Heilner and shown at the 6th Annual Digital Salon. On his contributor page within the *Ballad,* Heilner explains: "This series of 'microbe' images…seeks to invert traditional understanding of our internal and external environments. Large, orthogonal, built objects…have been re-imagined here to represent the most basic organic living beings…." Thus, a DNA molecule is figured from transmission towers, helicoptors appear as mosquitoes, and the island of Manhattan is hidden as a collection of floating microbes.

Scale is elided on the Web, as it is in the stenographer's practice, where events in the conference room, in her brain, in her hand, and on her code-filled writing machine are nearly simultaneous. Many different scales can be present to the same screen, as if they belonged together, as if they cohered there as "naturally" as they do in the stenographer's body. But a change in scale is a change of context: the view/read cusp will

shift differently for zoomed text than it will for text that is panned. In fact, this kind of zoom or scale-changing cusp may be a particularly important one in a world where we are asked to process simultaneously scales from the nano to the cosmic.

Sand as meta-medium, the digital medium into which everything else can be poured—sound, image, touch, data—has its own Protean or Circean character, a hyper-environment, a cave, in which any world can present itself and be lived. There is a process of interpenetration, or perhaps learning, that goes on between Sand and Soot, moving through each other as they move, yet they are strongly contrasted to the end. The stenographer at her stenotype was an early pioneer in this environment. Her continual active choice to attend or to blur her focus, to remain poised or to flow within the moving stream, is a task we take up. We will not all take it up the same way. We bring many biophysical and cultural heritages to the task.

THREE: OSCILLATION AND RESONANCE[15]

Alan Sondheim and other digital e-media hyperpoets speak about taking a long time to "tune" their works, and I think this verb will ring true for most e-artists, truer than editing, cutting, retouching, painting over, or rehearsing, for instance.

An oscillating, or flickering, pattern has often been invoked with regard to electronic art. Katherine Hayles has said, "We have only begun to construct a semiotics that takes into account the different functions signifiers perform when they cease to be flat marks and become instead layers of code correlated through correspondence rules."[16] In recognition of the layered dynamic interactions between text and code, she proposed the term "flickering signifiers" for text onscreen. Both Richard Lanham in *The Electronic Word* and Bolter and Grusin in *Remediation* have remarked the importance of an oscillation between the viewer positions of "looking at" and "looking through"; that is, between experiencing works primarily as heavily mediated and "windowed," in the software sense, or primarily immediate and immersive, as in looking through transparent glass. I would like to propose a third kind of flickering or oscillation, the oscillation that occurs between the processing of alphabetic text and the processing of image in works that use both. A digital writer who uses image and text is in fact writing a score for their shifting interrelation.

Flickering or oscillating poems differ from pure sound and pure image work in the following respect: whereas sound layered on sound creates new sound, and image on image makes new image, alphabetic text, superimposed on alphabetic text *or* on image, does not reliably yield legible text. In the poems that explore this truth, one flickers between seeing the viewable and reading the legible. Jim Rosenberg and Mez are poets who approach this movement very differently. Rosenberg[17] overlays his texts in a dense blur of self-interfering micro-information, a tangle literally drawn apart by hand into legible text. But no sooner do

words come into focus than the slightest mouse movement dissolves them back into blur. These texts thus move through the reader, as she moves, at *exactly* the pace her hand/brain browses—and superimposed on that oscillation, one experiences a constant trembling across the view/read cusp. Mez, on the other hand, in a practice she calls "M[ez]ang.elle.ing,"[18] leads us to confront the legible with strategies ordinarily reserved for the viewable, giving us text that rewards a scanning multi-directional view that is not restricted to movement in lines.

My own e-poems investigate oscillation between image, text, sound, and animation, both within and between hypertextually-linked units. In this way, several states of oscillation, a set of cross-rhythms, come into being.

In 1995, I "translated" my book-length poem *True North,*[19] featuring language-revolutionaries Emily Dickinson and Willard Gibbs, to a digital poem created with Storyspace software. The *True North* themes of navigation and embeddedness moved from being print concepts, refracted in language, to being the steering mechanism and constitutive structure of a hypertext. For this textually-driven work about navigation, I designed the two most important orienting elements to be visual. The first of these is a set of mouse-drawn Storyspace maps, emblematic shapes with their legends of node names. As sitemaps *and* as pattern poems, they give a very fair idea or sampling of *True North.* They provide a mode of understanding that may supplement, *or* substitute for, following links and reading text. Such a displacement of text by image, that also functions recursively as a guide to text, is itself a distinct mode of oscillation—one which co-exists with the familiar reference oscillation between a map and what it maps. The second orienting device was the coloring of a few words on each page. Since Storyspace does not use color to signify text-links, instead permitting the reader to press a key to reveal boxes around link words, each color operates visually to suggest a connection between similarly colored words: each color *is* an embedded link, but one traceable only by human memory, not by software.

A different kind and rate of oscillation occurs in *To Be Here as Stone Is,*[20] an early digital poem (properly viewable on Netscape 4) written collaboratively with M.D. Coverley. This poem is composed of two very different sorts of screens: six highly visual ones with sound that use Anfy Java applets and thirteen primarily textual ones where lines of verse are overlaid on a visual background, itself layered with a text ribbon. The links between these promote a rapid exchange between two kinds of attention, between primary viewing/listening and primary reading/searching, for the links must be sought for, by cursor scanning, on the textual pages. The experience of strongly discernible shift resonates with the text of this poem which shifts the reader from photons to cosmos and back.

In the Flash poem, *Errand Upon Which We Came*,[21] Coverley and I choreographed animation for the alphabetic text as well as for accompanying images and sound. The reader/operator of this text may press

the silver butterfly to the screen if she wishes to read with complete accuracy, but she may prefer to oscillate between sampled reading and periods of viewing. The words of *Errand* address the reader, speak to her of fragmented mobile text; speak to her, in fact, of the very act of reading she has undertaken: in response, she may actively intervene in the poem to read or redirect it, or she may attend to it as a movie.

One *Errand* stanza begins with the question "space?" floating down from the top of the screen, followed by a second question about knowledge-mining. A flock of butterflies flies in from upper right and circles around toward screen center. A third and fourth question, about "go(o)ds" refusing to go to market, appear onscreen. They imitate the butterflies' circling motion. At the end of the Flash movie we see two dimnesses in the central far distance, one, the almost out-of-sight V of butterflies; the other, the lines of the last two questions, now collapsed to one extremely faint line poised at the butterflies like a lance. The question is *visually* posed as to whether the image and text must attack each other, or may perhaps exist in oscillating accommodation.

The range of oscillation and its timings are extended in my next project, *V,* a poem distributed *across* media. *V* exists, in part, as an invertible two-in-one print text, *V: WaveSon.nets/Losing L'una* (Penguin, 2002). No matter where one begins it, upon arriving midway at the URL, http://vniverse.com, a reader must choose: either invert the physical book and continue from the other "end," or go to the Web address to find the poem's digital embodiment, *V: Vniverse,* a Director project made in collaboration with Cynthia Lawson. *V* exists in the virtual space of oscillating attention *between* book(s) and screen, each of which are interpreting the poem in its own material way.

V analogizes the role of nomadic peoples of the Ice Age to nomadic peoples of the Information Age. Acts of migration are key to both. The *Vniverse* interface, like the night sky read by Ice Age nomads, is a continuous present of varying forms in which readers trace their own path. As with the night sky, highly abstract diagrammatic images are produced by tracking. Sweeping a mouse across the *Vniverse* screen full of "stars" causes fleeting forms to appear that disappear back into the darkness. These are spontaneously read as constellations, though most of them (the Broom, the Dragonfly, the Embryo, etc.) are invented. Rolling-over a star releases its constellation, its keyword, and the spelling-out text of a numbered tercet. Clicking stabilizes the constellation, making it temporarily permanent, able to be read if it is traced *without* clicking. A second click (or any double-click) releases the text of a WaveSon.net, assembled not sequentially, not the top-down of print, but in relation to that chosen tercet, which displays in color while the other lines display in white. Clicking yet again oscillates the form between a Son.net and a set of triplets, creating a kind of doubled reading. Toggling between these provides a spatial micro-texture unavailable in print, an interplay between a pattern and its activation—not only the patterns of the alphabetic text, but their relation to the diagrammed constellation which is being read visually at the same time.

Clicking the darkness makes everything disappear, whereas pressing a "next" activates many implicit time-scales. A text-decay process takes place that leaves many states of the poem co-present onscreen. The time of break-up, the time of emergence, and the time of cross-layer existence *between* dissolving and emerging text co-exist with the time of reading forward in the same constellation. Many foci compete for attention even though the overall environment is highly textual and subdued. A reader who continues to swing her hand across the screen, as she reads, brings forward at her own pace, moving as she moves, the time of overlying keywords, the almost auditory time of the spelling-out tercet, and her own hand's rhythm. This play-read process is an iterative one. The iterative process of return overwhelms individual differences in sampling, just as years of sky observation yielded recognizable repetitions or significant conjunctions. Extinction, as much as production, is to be read.

For people of the Ice Age, their sky became an Oracle, a constructed relation to the natural world probed by counting. The *Vniverse'*s Sibylline space can also be probed directly by number, by entering any star's number in the small circular dial in the upper right of the "sky." The *Vniverse* not only creates a fragile, infinitely interruptible location, but there is a special smoothness to its space that comes from the way it was programmed in Director. This highly recursive piece never leaves its original frame which helps give the illusion of words moving directly in and out of the sky. In this space, time never advances—so far as the Director timeline is concerned—but it is highly active. All of the time resources go toward responsiveness and the production of language, rather than visual display. All the stars are waiting—each one a standpoint and a center—and they are more active than the constellations, though the visual impression is the reverse. Here, space has been fashioned to amplify the sense of resonance that internal timings create.

Simone Weil distinguished different ages in the history of science according to the values they embodied. She claimed that Greek science was motivated by ideals of "balance" and "beauty." The Greeks, she said, saw a moving waterline on a hull as an image of balance; whereas Newton, in the next age of science, one that valued energy and work, saw a loaded-down ship; he saw force and displacement.

Willard Gibbs, in the 19th century, devised visualizing methods which redefined the meaning of space. Instead of being a static Cartesian grid, his phase space could represent every possible lifeline of a system, any system, any number of coexisting systems. Gibbs's method, criticized by some as *merely* visualizing, was grasped at once by James Clerk Maxwell—the man whose equations define electronic reality—as both profound and productive. The very shapes of graphs and models yielded truths about energetics of the system—the relation of transitions to degrees of freedom and free energy; phase transition itself, as from ice to water, being a change of identity toward which the whole system was attracted.

Simone Weil died in England in 1943. What word might she have chosen, had she lived, to name value for our age, as "balance" and "beauty" named value for the Greeks? I would propose her Greek term μεταξύ translated as "betweenness" or "resonant communication." Resonance entails response, interaction, co-creation, a space between.

Quantum reality, the reality of electronic computers, works by resonance.

FOUR: SUPERPOSITION

To recognize threads in the cloth, then patterns in the weave, and then to understand every thread, every pattern, as co-present, superimposed on each other in a multi-dimensional space, a superposition space: all "there" until "then, when" only one is observed, one trailing and entailing long-range correlations.

Quantum mechanics is an engineering science used for building electronic devices. The equations "work," as well-tested as any, but the language describing what they do is either entirely mathematical or verbally extremely counter-intuitive. To explain all the *observed* effects, one must acknowledge that "the particle" is in more than one place, is in fact "everywhere at once."

It takes a very long time to compute atomic angles in a molecule, using quantum mechanics, yet the forming molecule figures it out instantly. It seems to store superpositions, many states at once, or to do many calculations simultaneously. In a quantum system when two particles interact, their fates are entangled, interdependent, remarkably correlated, beyond any such interdependence in the classical world. To measure one is to affect the state of the other, no matter where that other is. Quantum mechanics suggest every possible separate configuration and a profound entanglement, that can yet be undone, can decohere. What it does not suggest: intermediate states, fused combinate states, *Gesamtkunstwerke.*

The physics of neuron and transistor depend on quantum mechanics, but neural processing appears to take place at the classical, Newtonian level. I offer no suggestion of quantum mechanism, here, with regard to digital art, but rather a set of metaphors for understanding that draws on the struggle between mathematical abstractions and words in coming to terms with quantum mechanical effects. I suggest that we may need and expect a new level of emergence, a new form of gesture, of notation, perhaps notating processes rather than images or outcomes—even as the Feynman diagrams permitted a rethinking of quantum mechanics—to grasp the situation that has emerged in the ever-filling space of interconnected digital structures, to understand the effects of network connectivity on the synchronization of biological oscillation.

FIVE: NEURO-COGNITIVE SHIFTS: SEEING THE WAVE THROUGH THE PARTICLE[22]

The flow of waves and of particles, the scan constantly sweeping down over the screen/over the eye, cutting it off, setting a rhythm of passes, shifts us toward an older information-processing pattern, holistic pattern-recognition, away from our newer accomplishment, sequential analysis. Sequential analysis had allowed us to become adroit at anticipation, not be trapped the same way twice, and now sequential analysis is relocated to the writing and execution of code. These two types of thinking, pattern recognition and sequential thinking, are highly associated with visual and auditory processing. Visual processing is almost entirely static pattern recognition—with one exception, when we react instantly to the image of a rapidly approaching object, a response not handled by the brain but hardwired in the retina. Auditory perception is, however, inherently sequential, because sound is received not as a broad field of information but in a stream.

How might we grasp several levels of information at once? How do we combine different types of processing? Two non-electronic examples are autostereograms and calligraphic inversions.

Autostereograms are computer-generated random dot "Magic Eye" pictures, used to entertain but also for vision training. Embedded 3-d images are discovered, perceived, in what appears to be a plane of flat repeating patterns, when fused by the brain's active seeing. Each eye is addressed separately and neither eye alone can perceive the hidden form. The perception is not instantaneous, because the brain has to take time to create the perception. One must look *through* the plane image, and not focus on it, in order for the perception to occur.

Inversions, from the book so named by Scott Kim, are calligraphic words that read the same upsidedown and/or in the mirror and/or across other symmetry operations. As Douglas Hofstadter, remarking on similar games he and his friends played, says: "We were not very good at it, for we never came across the key insight that [Kim] has learned to exploit, namely, that letter *parts* can be regrouped so that what is one letter going one way may be two letters or half a letter when read the other way."[23] Here we see that the letter is no longer the combinatorial primitive, but that the human sensorium is used as a guide to create new, more granular, "primitives."

How do we make or recognize patterns, with our visual and auditory cognitive systems, both employed at their different time-processing scales, both passing through that mill of scans that supervenes on our gaze as the screens repaint themselves, leaving us to glean from gaps in the glow what we can or will. Something has been "carried across," from one energy form to another, from one "language" to another. Is it an algorithm indifferent to its manifestations? Is it a melody, a font-design, that survives all texts in it, all

arrangements of it? What gets carried over does not remain unchanged, not in either or any of its locations. The appellations source and target exchange places at a high-frequency rate, both in the process of translation and in its generated forms. There is no seamless information environment, only increasingly extended forms of attention and inter-attention, crossmodes of attention, muscular, neural, endocrinologic, visual, acoustic, kinesthetic, and proprioceptive. New forms of learning, as with the Magic Eye pictures and Kim Inversions, are called for to integrate environments partially digital, partially photonic, partially biotechnical.

In relation to space/mapping, roadbuilders, travelers, and wanderers maintain different body/map relationships; but from a time/processing awareness the pathway to the present is created *by* the "travel" (signal) which has built a transient road. To arrive, to be, at the present, by wandering or by intention are not fully distinguishable in a world where which choice gets made depends on interactions between internal rules and completely unpredictable gradients in the external environment *at that time.* Frozen accidents create history and are the means by which we reveal it.

Can digital art change neuro-cognitive timespace? We know that the number of neurons firing in the adult brain of a person who has played a musical instrument since childhood is appreciably greater than the number in a person who has not played an instrument.[24] We know that timespace perceptions change in our dreams, those powerful wetware virtual reality machines. When we dream, we don't need to discriminate between what originates in perception and what in fantasy, because physiology protects animal bodies from dreams by decoupling them from the possibility of action: during dreams motor commands are inhibited before they reach the body's muscles. But with digital simulations such source-monitoring becomes a pressing issue, because we have no comparable mechanism for decoupling representation and reality in public simulations, the sort of digital work that dominates adventure-games, television, the Web—or the larger-scale work apparent in blockbuster movies and theme park thrill rides. One can easily imagine public spaces, like a subway system, transformed by such simulations. What would be the consequence of an art that affected our time-sense as dreams do, but without dream safeguards and without any public source-monitoring standards or conventions in effect?

Guitarist Davey Williams, a performer of freely improvised music since the mid-70s, says: "Improvising, for me, is almost a state of unconsciousness. You kind of lose your awareness because you're leaning into the present, you might say. It's like a dream, the way you don't realize you're dreaming until you wake up."

When "leaning into the present," a very awake state of intense focus and a deeply asleep state of dream seem to co-occur. Timespace perceptions are observed to change when people are particularly awake, focused, and concentrated in a task. An example from Tracy Kidder's *The Soul of a New Machine* describes

a computer engineer who is so focused on his task that his sense of duration has been affected: he is able to respond to nanoseconds. Since the time it takes to snap your fingers is 500,000,000 nanoseconds, these are presumably below the threshold of human temporal consciousness, yet

> "It's funny," [the engineer says,] "I feel very comfortable talking in nanoseconds. I sit at one of these analyzers and nanoseconds are *wide*. I mean, you can see them go by. 'Jesus,' I say, 'that signal takes twelve nanoseconds to get from there to there.'"[25]

What about the neurophysiology of time perception? From the edge of awareness through to speech: one-thousandth of a second for neural firing, one-hundredth of a second for neuronal pattern formation, one-tenth of a second for vocal articulation or action, and more than 3 seconds for narrative description. Tools from dynamic systems help us understand how we might develop time concepts from this physiology, particularly the retrospective and prospective horizons involved with our sense of being in a "now." The basic event or fusion interval specifies the minimum time between events such that they *can* be perceived as distinct and not simultaneous. This time is different for each sensory modality. The modalities also interact with each other, and a lot of Web art explores these interactions through the use of micro-manipulated streaming sonic and cinematic effects.

The neuronal level relates to brain operation. Any mental act involves the concurrent participation of separated regions of the brain. The time needed to relate and integrate signals from these separate regions is called the relaxation or holding time, during which perceptual flashes are spread and organized by cell assemblies to create the synchronized firing we need in order to act, to move our mouse for instance. From a mathematically intractable number of possibilities, from many competing cell-assemblies, the interaction of external gradient and internal rules yields one particular "now," without the assistance of either an internal or external clock—synchronization occurring rather by resonance.

From this point on in the cognizing process, on the scale of seconds forward, language does finally enter, and with it, all that descriptive assessment entails. Thus the e-artist is tapping many scales, fine-tuning neuro-cognitive and muscular response both to fluctuations in the signal propagation structure of the Net and to the emerging nuances of the way, on another level, Web traffic communicates a social environment. Web literature and art also exploit different aspects of the time-based human perception process, playing with the fusion interval limits, and—because they require a large number of actions from their readers, clicks, mouseovers, drags and drops, shifts of a joystick, scans, zooms, probes of all kinds, maneuvers to be made within a certain time frame in some literary and all game environments—playing also with the synchronized neuronal patterns that must be mobilized for action. A number of works also explicitly address questions of time, history, and memory, often using dynamic means, Web-streaming or telepresence, in order to do it. They contribute to enlarging the window of "now," both by the new calisthenics they offer our perception system and by the fact that they bring into consciousness many more

of the microfluctuations and/or fractal patterns that had been smoothed over, averaged over, hidden by the older perception and knowledge systems.

Consider the work of Tom Brigham, the inventor, in 1982, of morphing. In a morph, as with individual frames on a reel of film, a series of discrete images moves across a screen so quickly as to give the impression of a transformation without discernible intermediate steps. Unlike with cinematic frames, however, morph technology allows for the separate interpolation of different attributes of the series, such as shape, color, texture, and motion.[26] Brigham's morph-making work shifts the emphasis in digital arts from rendering impressions to rendering *the process of forming* an impression.

The material of his work is the infinitely fine transition. He deploys frequencies detected by image-processing software at sites of rapid change in an image; these are, he says, sites of high "spatial frequency," that one comes to acquire a feeling for. The morph, as it enacts before our eyes, relocates our perception from routine to active recognition, the kind we bring to interpreting optical illusions, the kind which makes us experience seeing as an act of understanding and not as a receiving of the properties of objects. Brigham explains that "…in addition to controlling surface qualities, morphing allows control of an image's meaning, blurring the distinction between a physical object and a mental construct."[27] He links the experience of a morph to the psychological illusion of continuity, itself a second-order time-based motion. In a morph, Brigham explains, "an image smoothly transforms, morphing into another with a motion so slow as to be almost imperceptible. Yet, at precisely some specific increment, itself undetected, the content changes utterly and a different pictorial subject becomes comprehensible."[28] That is to say, an emergent level is experienced. According to Brigham, it is this *motion* that is read, not the underlying static images, so that "a slight change in materials results in a total reformation of content."[29]

Brigham's aims are high. He understands morph technology not merely functionally, as a way to extend cinematic techniques in a digital arena, but asking rather:

> Will it show us how to unsettle and evaporate complacent interpretations? Will it help us understand the constructs of our mind that overlay the world? … A transformation that hesitates and hovers between two identities engages the mind in a special way… What lies between one face and another? A variety of faces. But what lies between a face and a chair? A tougher question with more answers, and a more difficult morph.[30]

A work by Noah Wardrip-Fruin and collaborators, *Impermanence Agent*, expands the sense of "now" in yet a different way. It pushes at the edges of awareness by explicitly incorporating peripheral attention into the act of reading. *Impermanence Agent* is not a site to be visited or clicked through; rather, it runs in tandem with the reader's Net browsing. An active agent, it adds to, alters, and comments on the pages readers visit, as well as taking material from those pages to create the ever-scrolling content of its own divided window, meant to be kept open for about a week in the top corner of a reader's monitor. There its own story of grief

will be both told and lost as it permits elements of the reader's browsing to invade and transform it to the point of extinction.

A reader intent on browsing, who has enabled *Impermanence Agent*, will find her attention constantly solicited, but only peripherally, by the active image in the corner of her screen, and by invasions of unselected material into her focus. The "now" of her reading is both threatened and fertilized. Her content is mirrored back to her in such a way that she feels how it cumulates and overwhelms another's story; how a click made in a second, can, through the mechanism of selection, become amplified and feed into and feed back on the longer scale of narration, destabilizing the bounds of "now" and "here."

SIX: TRANSLATION RETHOUGHT

The concept of "conversion media," according to Sean Cubitt, construes differences between media as "*only* [emphasis added] a matter of the conversion of data streams into one form of output or another…[they] become a matter for the end user, just as fonts and default colors have become for Web users."[31] In such an environment, one is faced with creating translations and/or algorithms for translation that accommodate output over large numbers of forms, but over which in fact very little control exists. What the receiver views or hears or experiences is as controlled by his particular devices and his personalizing choices as by the poet's implementations. This challenge is perhaps not so different from that facing the print translator of hieroglyphic or Chinese or Linear B texts into 21st century English, the idiosyncratic "hardware," in this case, being the time-bound culture-imbued body of the unknown recipient.

John Felstiner, an acclaimed literary translator, has turned his attention on his own process in a book that has never been out of print since 1980, *Translating Neruda: The Way to Macchu Picchu*. Felstiner believes so strongly in the process of translation that he teaches Keats in German, Yeats in French, Eliot in Spanish, to his Stanford students. In a 1997 interview, Felstiner says,

> […] the poem is just as fine in the original as it ever was, no matter what happens to it in translation. But still, there's a sense in which the poem can remain static, or dormant maybe, or quiescent, or even overcrystallized, unless it is brought back into life. … I often liken the process to a stress electrocardiogram: you put the poem under a kind of alienating stress to see what's really going on in it, because you can't see that in the quiescent state. It seems to me that to translate a poem is in a sense to—I wouldn't want to say *re*vivify, because it doesn't need re-; it isn't dead—but to vivify it, especially in your native language….[32]

Later, he adds, "I feel that the translator enters some kind of trajectory, call it a re-arcing back, a sparking back, or call it a boomerang." To a reader in the digital arts this statement resonates strongly. The act of translation across natural languages and between cultures evokes justified resistance and claims that it can't

be done, yet in Felstiner this act finds a positive champion: he claims that it is a revealing and life-giving act.

In digital translation each non-electronic art—visual, linguistic, vocalizing, written, sonic, musical, cinematic, animating, gestural, or other—enters a new timespace, under a new regime of attachment, to encounter newly trained sensoria. It is subject to the emergent behavior of networks and subject to a constraint of oscillatory resonance with its many new partners, each as convertible as the other into a bitstream. However harsh this process may appear, it can, as Felstiner suggests, reveal dimensions unseen (or unfelt, or ungrasped) in its former "quiescent" state. I find translation newly appropriate as a model: a process that involves transliteration,[33] transduction, transposition, transcription, transclusion,[34] and transformation. With regard to new media poetry written with new technologies, I would also suggest that print is a fully viable position within the many conversion sequences, as well as having a place in documented code and as one element at the presentation level of many e-works. It is not the source, nor the target, but neither is it displaced beyond the displacement of any other non-electronic modality, mathematical, visualizing, moving, sonic, or haptic.

Some questions are not easy. Why does DNA write RNA in order to write proteins? Why that much "translation"? Evidently, some aspect of the entire systemic environment makes this an optimal choice. I think of Salman Rushdie's sea of stories. The sea is not a storeroom—the sea is an ocean comprised of the streams of story, of poem, of poesis/making, held in fluid form. If, to that metaphor, we add the oceanographer's knowledge, gained only in the last 40 years, of how the oceans store and exchange energy through the movement of water masses from basin to basin and through the activity of eddies, which hold more than 90 percent of the ocean's energy, we can amplify the metaphor and see that to access energy and life the poems must move from basin to basin and swirl in the eddies, becoming new versions of themselves. I suggest that the dynamic electronic composition of various media streams supports exactly such movement. Beyond that, we understand that 90 percent of the "stories" are *in process of* "translation." The actual home of the poems is in the eddies, only occasionally arriving at the basins of contemplation.[35]

A work of digital art and telepresence that raises issues of translation is Eduardo Kac's *Time Capsule*.[36] It does not investigate the space "between" print and e-domains, but it does investigate and reside in the unspoken but experienced spaces between its various transversions. Kac, whose family arrived in Brazil from Eastern Europe and who now teaches at the Art Institute in Chicago, makes holographic poems that display time-reversibility and also makes work that combines robotics and telecommunications. The world of *Time Capsule* is a world where, for many, TV competes with, or even exceeds, face-to-face experience in providing the effect of being "live," and where this effect of "live" has become the effect of "truth": technology the transmitter become technology the warrant.

What is the *Time Capsule* Kac embeds in this world? It is a complex act. On November 11, 1997, in a room in São Paulo with parquet floors and ornate plaster ceiling, he created an inner room of movable white walls on one of which hang seven sepia-toned photographs his grandmother brought from Poland in 1939—the *actual* photographs, he says in a talk given a year later, though in the gallery they are not identified in any way. On the facing wall, as of the next day, he hung a diptych combining an x-ray of his ankle with an enlargement of the registration screen for a Web database used to track lost animals; for, on the prior day, broadcast live both to Brazilian TV and to the Web, Kac had injected his leg with a microchip implant that contained a programmed identification number and that, when scanned, emitted a radio signal. He then put his leg in the scanning device, and his ankle was Web-scanned from Chicago, the scanner button being pushed by a telerobotic finger. Kac then registered himself, as both animal and owner, in a North American pet database, the first human to do so.

Time Capsule takes place in Chicago, Brazil, Poland, the airwaves, the phone lines, around the world on the Web, and in Kac's flesh wherever he goes, yet is called site-specific. It takes place on November 11, 12, 13th, or now on his webpage devoted to it, or always, in his leg, or in the thirties in Poland. It is a body, a broadcast, a netcast, a database, an identification, a schedule, a sound byte, an implant, a webscan, an x-ray, a gallery show. In these respects it resembles the spatially distributed cell-assemblies that have to be synchronized temporally in a neuronal pattern for us to take action. The meaning of the image changes with the pathway. A man is marking his ankle with an identification number under the photographed eyes of his refugee family, a family in flight from a regime that wrote numbers on skin with needles. Without being bound to any machine he is now always readable by a machine, wearing an electronic anklet that monitors him as much as any prisoner. The temporal scales range from milliseconds to years, but where is memory, personal or collective, the kind of memory we believe ethically needs to persist? Is it "quiescent, or even overcrystallized"? Has Kac effectively relocated it in the microfluctuations, in multifractal patterns that persist beyond the persistence of any given sequence, even though we may consciously experience it as disconnected and diffuse, as both refugial and vivid?

In new media, our task is the measure of measure. To accomplish this we write less "with places" and more with "transitions." Space does open up, perhaps monstrously, to a world of currents and translations. We don't see these spaces full so much as feel them fill. We don't watch them perform; we perform them, in part, in connection with others, in processes of conjugal transfer that propagate themselves. Our probes help us draw the connections and form the perceptions needed to flow, to participate in and comprehend an increasingly complex patterning that enfolds us, from nano-techniques to cosmic extent through genetic alteration and the new world disorders.

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[4] In Ted Nelson's Xanadu and ZigZag programs, "transcluded" units of information are shared across a system of evolving versions in n-space. Each unit can simultaneously be part of many different dimensions; but, unlike units or cells in a spreadsheet, it is not required to have any particular set of connections.
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[34] In Ted Nelson's Xanadu and ZigZag programs, "transcluded" units of information are shared across a system of evolving versions in n-space. Each unit can simultaneously be part of many different dimensions; but, unlike units or cells in a spreadsheet, it is not required to have any particular set of connections.

[35] John Cayley's poem, *riverIsland*, as shown at TechnoPoetry Festival 2002 (Georgia Institute of Technology) could be seen as supporting this claim. My own poem, *V: WaveSon.nets/Losing L'una* (http://vniverse.com in collaboration with Cynthia Lawson), supports it in an entirely different manner.

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