Distributed Cognition at/in Work

Strickland, Lawson Jaramillo, and Ryan's *slippingglimpse*[*]

N. Katherine Hayles

> *From where, then, does our feeling of beauty come? From the idea that the work of art is not arbitrary, and from the fact that, although unpredictable, it appears to us to have been directed by some organizing centre of large codimension, far from the normal structures of ordinary thought, but still in resonance with the main emotional or genetic structures underlying our conscious thought.*
>
> - René Thom -

A significant body of work in the late twentieth and twenty-first centuries has focused on the distributed nature of cognition. Neurophysiologists, for example Antonio Damasio, have emphasized that cognition includes emotions and feelings, extending beyond the neocortex and indeed beyond the central nervous system to the viscera and other areas of the body. Anthropologist Edwin Hutchins and neurophilosopher Andy Clark have pointed to the ways in which cognition is enhanced and extended beyond body boundaries by everyday artefacts – from pencils to computers – that interact with bodily capacities to create extended cognitive systems. In analyzing how these extended cognitive systems work, researchers frequently draw on the cybernetic paradigm of recursive feedback loops, uniting components into a dynamic and enactive system that includes both human and non-human components.

Applied to literary works, this approach encounters two troubling problems. First is the traditional association of feedback loops with a disembodied and decontextualized idea of information, a legacy from the early days of cybernetics when Claude Shannon declared

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that information has nothing to do with meaning. Second is a long tradition of associating literature with the decoding of words, as if it were solely a linguistic artefact without connections to the body beyond conscious thought. Neither of these tendencies, of course, is absolute. Donald MacKay and Edwin Fredkin, among others, have argued for an embodied and contextualized theory of information (Hayles); and many literary critics have emphasized reading as a whole-body activity that involves breathing rhythms, kinaesthesia, proprioception, and other unconscious or non-conscious cognitive activities. Still, the tendency persists to regard literature as an imaginative enterprise that begins with the conscious association of sound with mark (although certainly it does not end there).

The transition from print to electronic literature has rendered these problems acute, for electronic literature, with its diverse multimodal interfaces, challenges traditional ways of understanding how, where, and with what capacities we read. In digital media, reading partakes irreducibly of synaesthesia, as sound, vision, haptic responses, kinaesthesia and proprioception work together to create complex sensory/cognitive experiences. Moreover, these experiences occur through the mediation of intelligent machines, resulting in the further in-mixing of human and non-human cognitions. We are only beginning to devise theories adequate to cope with these complexities. Fortunately, those of us interested in crafting theoretical frameworks for electronic literature have an increasingly deep and varied corpus of works to guide and instruct us.

Complex Dynamics and Recursive Reading

> *The difference between the Newtonian world and the world of communication is simply this: that the Newtonian world ascribes reality to objects and achieves its simplicity by excluding the context of the context – indeed excluding all meta-relationships –* a fortiori *excluding an infinite regress of such relations. In contrast, the theorist of communication insists upon examining the meta-relationships while achieving its simplicity by excluding all objects.*
>
> - Gregory Bateson -

Communication, Gregory Bateson believed, was inherently a nonlinear, non-Newtonian system. To focus on communication is to focus on the ways in which cognition occurs not only in the mind but as part of a complex system that includes whole-body responses as well as feedback loops with the environment. My tutor text to engage a vision of distributed cognition as a complex system is a contemporary work of electronic literature, *slippingglimpse*. *Slippingglimpse* is a digital kinetic verbal-visual collaboration between prize-winning poet Stephanie Strickland, programmer Cynthia Lawson Jaramillo, and videographer Paul Ryan. *Slippingglimpse* unfolds through ten sections, each consisting of one of Ryan's videos of moving water, which are incorporated using Flash video format within the work's Flash files. The videos are dynamically associated with a poem text in each of three possible views: high resolution, full screen, and scroll text view. In the first two views, the words and phrases from the poem text appear in the image.

Figure 1: Full screen with high resolution. *Consult full-color for the full effect.*

In the scroll text view, the poem text, in addition to appearing in the image, also appears in its entirety below the image, where the reader can choose to scroll or stop it. *Slippingglimpse* exemplifies how a work of electronic literature may respond to the two problems noted above. It is located within philosophical, technical, and aesthetic contexts that create a richer sense of information than the disembodied version

that emerged from early cybernetics. Moreover, it both requires and meditates upon multimodal reading as a whole body activity. To see how the work explores what reading might mean in digital media, we can approach it along three major axes of interpretation: structure, dynamics, and modes of interaction.

The basic structure *slippingglimpse* enacts is a threefold recursive cycle between human and non-human cognizers. We can begin our analysis of its dynamics with the moving images of water, recorded by Ryan off the coast of Maine. Ryan's inspiration for his video images comes in part from René Thom's analysis of chaotic systems in *Structural Stability and Morphogenesis*. Whenever turbulent flow occurs – in crashing waves, bubbling streams, waterfalls, white water rivers – certain patterns are likely to appear amidst the continuing changes. This kind of chaotic behaviour can be modelled as a trajectory in phase space, a graphical and mathematical representation in which every system parameter is associated with an axis in multidimensional space.

A swinging pendulum, for example, may be represented by a two-dimensional phase space showing position and momentum, with the phase space consisting of all possible values of these variables. If the pendulum is not driven (think of a swing that is pushed once and then not pushed again, so that it eventually comes to rest), the phase space diagram will show a half-spiral looping in to the centre where the swing comes to rest. This simple pendulum is typically a linear (i.e., Newtonian) system. Add a motor so it is driven, and fasten another swinging pendulum to the bottom of the first, and the interactions (in certain energy ranges) between the positions and momenta of the double pendulums now make the motion of the two together so complex that it becomes impossible to predict. Nevertheless, the pattern the double pendulum traces will remain within a constrained area of phase space, creating endless variations within this pattern so that no two trajectories exactly coincide. The combination of seemingly chaotic motion that nevertheless reveals embedded patterns when represented in phase space has earned the name 'strange attractor' for these kinds of systems. One of the most famous is the butterfly-wing shape of the Lorenz attractor, first discovered by Edward Lorenz when he was analyzing weather patterns.

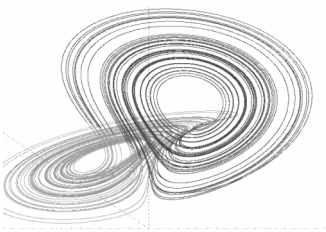

Figure 2: Lorenz attractor in phase space. *The strange attractor's trajectories in phase space are unpredictable but show an overall pattern, here of the famous 'butterfly-wings.'*

René Thom, whose work in catastrophe and chaos theory made him an early researcher in complex systems, described the recurring patterns by the term 'chreod,' a word his friend and associate, C.H. Waddington, coined from Greek roots meaning 'necessary path.' In his videography, Ryan sought out chreods and enhanced them through a variety of techniques; including timing, reverse direction, repetition, and the negative art of inverting colour and brightness. The videos incorporated in *slippingglimpse* show the chreods in dynamic interaction with unpredictable flows, giving an impression of constant change that nevertheless is not merely random. Rather, the interactions manifest a complex order that can be grasped intuitively if one watches the moving images long enough.

As the user quickly becomes aware, she is not the only cognizer reading the water. Also at work is an algorithm that looks for colour changes within the moving images; when the colour change extends over a number of pixels, that location is tagged and randomly matched with a word or phrase drawn from the accompanying poem text. The chosen phrase is then generated within the image, where it grows or shrinks and also rotates along the plane of the screen, further enhancing the impression of ordered but unpredictable changes. The poem texts themselves are in part found language, selected and fashioned from interviews of photographers and programmers about their work. The concatenation of the poem text, video images, and algorithmically generated words in the images comprises a recursive system of three interacting feedback cycles. In Strickland's notes on the piece, she comments that "the water reads the poem text, the poem text reads image/capture technologies, and, completing the loop, image capture videography reads the water – in particular, reading for chreods" (Strickland: Emails April 29 and July 22).

That there are three major components in these feedback cycles is not accidental. Ryan, inspired by ideas articulated by cyberneticist Gregory Bateson and the phenomenology of C.S. Peirce, has done extensive research into what he calls 'threeing.' The basic idea is that whenever three people get together, there is a strong tendency for two of them to form a dyad and exclude the third person. Bateson believed that this exclusionary tendency was a formidable obstacle to expanding creative collaboration beyond the dyad. Ryan accordingly devised a system for training people to interact productively in groups of three or more; the core technique is to have them rotate between the three positions of initiator, respondent, and mediator (terms that have much in common with Peirce's 'firstness,' 'secondness,' and 'thirdness') so that the dyadic symmetry is broken and all three positions are validated. In one version, he shows how a single person can occupy in turn each of the three roles through a video feedback system. The three components of *slippingglimpse* instantiate a similar system through, firstly, recursive feedback loops between the algorithm selecting words to be displayed in the moving images of the water, secondly, the text which can also move when in scrolling mode, and thirdly, the image capture technology of Ryan's videography showing water in motion.

That these recursive feedback loops are interpreted as 'reading' raises significant questions about the act of reading, including what cognitions may count as reading and what relationships obtain between reading and language. Here structure and dynamics interact, for part of Thom's methodology in *Structural Stability and Morphogenesis* involves mapping chaotic motion onto a topology representing a two-dimensional slice through the phase space of the strange attractor. Motions through space are thus transformed into spatial surfaces. Thom further suggests that this topological method can be used to study language. In this view, syntax represents the speaker's motion through a linear stream of language; syntactical relationships can then be represented as topological surfaces. Through this approach, Thom suggests, one can compare verbal language with other forms of communication, for example gesture, because both can be translated into the common denominator of topological form. Verbal discourse represents one possible dimension of language, but many other dimensions are possible as well.

The great advantage of topology over, say, traditional grammar as an analytical method is that it can be used to represent even high-

dimensional forms, or what Thom calls multidimensional languages. Reading in this view extends beyond decoding written symbols to any theoretical method capable of generating topological surfaces. In this context, it is not merely a metaphor to say that the videography 'reads' the water, for the videography, including the initial image capture as well as the techniques Ryan used to enhance the visual perception of chreods, amounts to an analysis of complex surfaces by representing them as video images. Similarly, when the algorithm analyzes colour changes within the image, this too amounts to a form of topological 'reading,' which is then correlated with the selection and positioning of words from the poem text in the image, where they become available for a form of reading by the user. Since the words are in motion, however, this recuperation back into verbal language can never be simply a decoding of written symbols, for the user necessarily perceives the motion of the words as they rotate, grow, and shrink, tracing through their movements another topology overlaid onto the topologies created by the images of moving water surfaces.

Immanence of Mind and the Sign of Reading

> *Similarly, we may say that 'mind' is immanent in those circuits of the brain which are complete within the brain. Or that mind is immanent in circuits which are complete within the system, brain plus body. Or, finally, that mind is immanent in the larger system – man plus environment.*
>
> - Gregory Bateson -

Having seen how the feedback loops between structure and dynamics operate, we can now turn to consider the modes of interaction that the work offers to the user, as well as the kinds of interactions that occur between human cognitions and the non-human cognitions of intelligent machines (leaving aside for the moment the question whether intelligent machines can cognize). Here we can engage in something that approaches traditional literary criticism, for surely an important part of the user's response to the work will derive from her understanding of the poem texts.

Complicating the linearity of syntax and poetic line is a bold vertical stroke running down the middle of the text (indicated here as double vertical lines ||). Although sometimes sense requires that the stroke be treated as a divider, often syntax requires reading across it as well. The language has been shaped (by selection, lineation, and spacing) so that suggestive juxtapositions occur within and across the poem texts. One strand weaving through the poems is that of the image maker riding what we might call the cusp of control, pushing equipment to and beyond its limits, making use of accidents, searching for the aleatory juxtaposed with firm artistic control. In one text, for example, we read on one side of the stroke "huge failure rate," and on the other:

> physical presence luminosity
> wanting to touch
>
> *please don't touch*
> almost any
> photographic paper will
> fingerprint if you touch[1]

In the same poem text, scrolling down reveals this thought: "I can work/with some accident/but I still have a great many disasters/usually through pushing something/too far." In another poem text, the voice refers to "the heaviest-duty black industrial/enamel I could find/toxic colloidal gunk/," "sludge from the bottom of the brush jar/" || "created this very lyrical and delicate/image landscape on the surface."[2] "Is it self-organizing?" the voice asks, answering ambiguously "totally/well" where "well" can be understood either as a completion of the previous thought or as an indicator of a reflective pause drawing back from conclusive certainty. After a long space (denoting an equally long pause by the speaker), the speaker says "eighty-five percent--/which I liked," presumably aiming for a more exact qualification than the "totally/well" implied. Like the chreods appearing amidst turbulent flow, here patterns are revealed through all that the artist does not

1 <http://www.slippingglimpse.org/pages/scroll_6_lettuce.html>.
2 <http://www.slippingglimpse.org/pages/scroll_3_green.html>.

control and yet seeks out (or at least accepts) for their contributions to the overall effect.

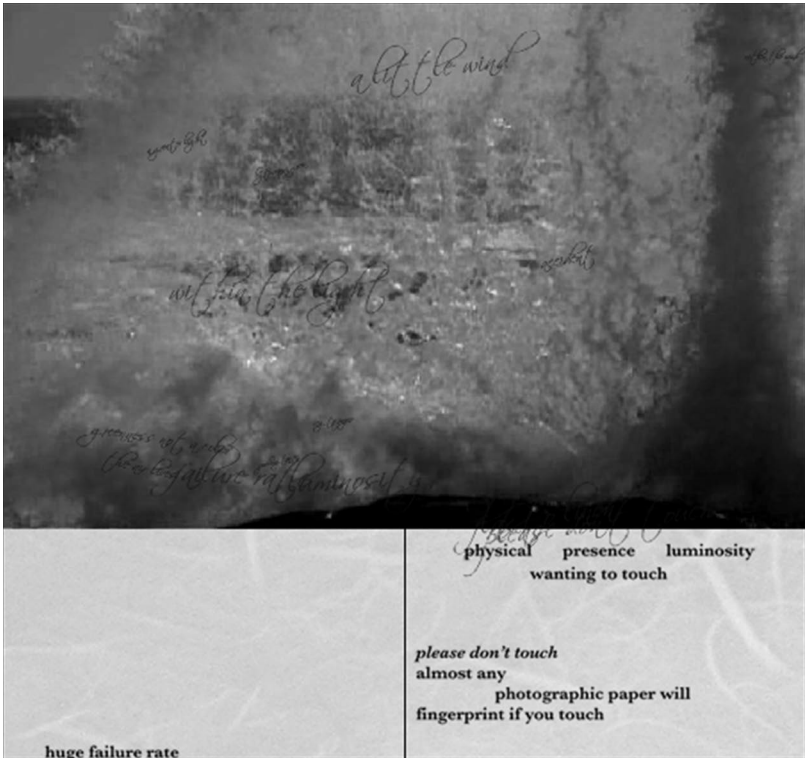

Figure 3: Scroll view with text stopped. *The dynamic flow has words generated in image.*

Related to this dance between accident and design is the collision/conjunction of human and non-human cognition. "I learn my form my (subtractive) form/from computed information/like learning a piece of/music by heart or a choreographic/sequence."[3] The analogies point to action below the level of conscious thought, as when a dancer or musician knows the moves in her body better than in her mind. Moreover, the language suggests that these non-conscious parts of cognition can form a creative coupling with the non-conscious performance of the intelligent machine, with the implication that what is "subtracted" is

3 <http://www.slippingglimpse.org/pages/scroll_3_green.html>.

not only unnecessary superfluity but also the intervention of conscious thought. In another text, the voice invokes the capacity of artificial evolution for creative invention: "Genetic brushes/an evolutionary model where you could/breed two brushes together/they would make a whole new brush," and on the other side of the stroke, "||brush over the entire image algorithmically/no human/intervention other than setting/the basic parameters."[4]

The theme of the non-conscious agent forming a creative coupling with human consciousness reaches its most intense expression in the passion of the flax, a folk motif that compares the beating of flax plants to release the silvery fibres so they can be spun into threads and woven into linen with the suffering of Christ. This centuries-old story extends the conjunction of human and non-human cognizers into the distant past, suggesting the traditional nature of appropriating objects into extended cognitive systems (an idea developed by Merlin Donald, for example, in his discussion of cave paintings as external memory storage devices). Consider the following lines:

> buried blue-eyed flowering plucked root
> & branch retted soaked to partial rotting
> scorched over the fire bound battered dressed
> rippled with hackle combs and thorns
> drawn fiber spun thread woven *linen*
> bleached on grass pierced needles sewn
> shirt worn to rag rent drowned calendered
> dried to paper written on[5]

The flax plants, themselves innocent, give themselves over to be tortured, as if they had agreed (as agents capable of choice) to their fashioning into fabric and clothes. Finally they are torn into rags and recycled into paper that may, among other purposes, perchance be used to record their suffering.

In the remediation of the ancient story in this digital work, the recursive cycles widen beyond flax, linen, and paper to turbulent flow, intelligent machines, and algorithmic reading. The questions set into motion by the passion of the flax expand accordingly: if we are bound to

4 <http://www.slippingglimpse.org//pages/scroll_10_leaf.html>.
5 <http://www.slippingglimpse.org./pages/scroll_7_sideways.html>.

non-human cognizers through chaotic dynamics and multiple feedback loops, where does our responsibility to these non-human agents begin or end? The poem text entertains the question in the final passage of the section recounting the passion of the flax. Alluding to a harvest ritual called the Denial ceremony in which the harvesters denied their guilt for torturing the plants by disguising themselves in animal skins,[6] the voice ritualistically disclaims her responsibility for atrocities visited on the vegetable kingdom:

I have not tortured
the plants
nor have I shoveled them into the oven

It is another who did this
And brought them to me

I ate innocently

spoken to the loaf[7]

The logic of the work, however, argues against such pleading, for the feedback loops connecting us to the non-human world surely imply that we share responsibility for the interconnected fates of the animal and vegetable kingdoms, and indeed for the complex ecologies that constitute the world as a whole.

The positive side to this involvement is expressed in Paul Ryan's belief that "digital streams of aesthetic intelligence about our planet" can contribute to our survival by making us freshly aware of the environment's immense importance (Ryan 202). Following Gregory Bateson's argument that the unit of survival ought not to be seen as the reproductive individual or group but rather the species plus environment, Ryan further concurs with Bateson's view that a 'mind' is not only something that inheres in an individual but rather

6 The article on "The Passion of the Flax" was written by Robert Eisler, who died in 1949 before revisions could be completed that would make it suitable for publication in the journal *Folklore*. These revisions were completed by W. L. Hildburgh, and the article appeared posthumously in 1950.

7 <http://www.slippingglimpse.org/pages/scroll_7_sideways.html>.

is "any system with the circuit structure necessary for self-correction," including organisms in their environments (Ryan 202).

With this claim the full scope of *slippingglimpse* as a work of digital art comes into focus. By establishing a 'circuit structure' of threeing, Strickland and Lawson Jaramillo create (or better, re-create) an environment of complex interactions in which the user can occupy various positions, all bound together by recursive feedback loops. At every level – computer algorithm, image technology, turbulent flow, human being – possibilities exist for 'mind' to emerge. At the widest scope, the kind of 'self-correction' the work implicitly gestures toward is re-connecting us to the environment by opening us to the realization that we cannot survive if we destroy it; we live or die together with our environments, which we can affect but never completely control or predict. In this context, the passion of the flax bespeaks not so much the sacrifice of plants as our responsibility toward the environment, which we are obliged to take seriously if only because our very survival depends upon it.

Reading Beyond the Boundaries of the Skin

> *There is no requirement of a clear boundary, like a surrounding envelope of skin or membrane, and you can recognize that this definition [of mind as immanent] includes only some of the characteristics we call "life." As a result it applies to a much wider range of those complex phenomena called "systems," including systems consisting of multiple organisms or systems in which some parts are living and some are not or even to systems in which there is no living parts.*
>
> - Gregory and Mary Catherine Bateson -

In conclusion, I want to return to the trope that Strickland and Lawson Jaramillo insist upon in their notes for *slippingglimpse*: that the relational circuits critical to our survival emerge and develop under the sign of reading. As we have seen, the claim that the water (via the computer algorithm) can read the poem text, or that image technologies can read the water, invests reading with a significance that goes far beyond

the decoding of words. By the same token, however, the claim also foregrounds the work's connection with the print tradition by insisting on retaining 'reading' (as distinct from, say, 'using,' 'playing,' or 'performing'). The result is a kind of balancing act in which the importance of inscribing and decoding verbal symbols is both glorified and delimited, disrupted and continued into the digital realm. Asked "what language do you write in," a voice in one of the poem texts answers "C++," a response that expands writing to include programming and, at the same time, delimits the inscription of verbal symbols so it shrinks to a subset of 'writing' in general.[8]

The ambiguity inherent in how reading is positioned echoes through the poem texts in views that at once invest perceptions of the environment with redemptive potential and simultaneously insist on the limitations of normative perceptions. One of the voices proclaims that "I finally learned to see/beyond the retinal/experience,"[9] while another suggests that "seeing is forgetting the name/of what you see."[10] Language inhibits and enables; seeing is essential and inadequate. The key to understanding how these ambiguities work within *slippingglimpse* is suggested by the title, which points toward the importance of connection in the way it conjoins two words without admitting a space between.

As long as seeing is understood as an individual experience limited by the boundaries of the skin, it is inadequate for grasping relational interconnectedness; as long as language is understood as verbal facility, it cannot open the doors of perception. Nothing works well when the focus narrows to the solitary individual considered in isolation; everything works when things are situated in relation to one another. Seeing is a concatenation of glimpses, no sooner experienced than slipping away to something else. At the same time, relationality cannot emerge except through a succession of glimpses, each inadequate in itself but fully realized when considered as part of a connected whole. Mind is not up to the urgent task of embracing the realm of slipping glimpses, but 'mind' – human and non-human, cerebral and visceral, individual and collective, focused and extensive – can engage in the multimodal, full-bodied, and recursive reading that is both required and performed by *slippingglimpse*.

8 <http://www.slippinglgimpse.org/pages/scroll_9_aquaGalaxy.html>.

9 <http://www.slippingglimpse.org/pages/scroll_3_green.html>.

10 <http://www.slippingglimpse.org/pages/scroll_2_blueFeather.html>.

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Summary
Slippingglimpse exemplifies how distributed cognition is being imagined and instantiated in contemporary electronic literature. The structure enacts a threefold recursive cycle between human and non-human cognizers in which the water 'reads' the poem text, the videography 'reads' the water, and the poem text 'reads' image capture technology. The work raises profound questions about the nature of 'reading' in the digital age, the collaborations possible between human and non-human agents, and the significance of the recursive loops that connect humans to the environment.

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