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**Perla Sassón-Henry,**  
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**Abstract:** In her paper "Chaos Theory, Hypertext, and Reading Borges and Moulthrop," Perla Sassón-Henry presents a multidisciplinary perspective to the study of Jorge Luis Borges's and Stuart Moulthrop's works. Sassón-Henry argues that there exists a tripartite relationship among Borges's texts, Moulthrop's *Victory Garden*, and chaos theory. The dialogue among these texts via chaos theory, bifurcation theory, and noise is what separates this analysis from former studies. Sassón-Henry concludes that by underscoring the reciprocal interconnectedness among Borges's stories, *Victory Garden*, scientific theory, and new media technology we also acknowledge the intricate connections among print literature, digital literature, and science, and thus move towards a new interpretation of Borges's oeuvre, one that reaffirms Borges significant role in Latin American literature and culture while acknowledging its projection into the digital age.

## Perla SASSÓN-HENRY

### Chaos Theory, Hypertext, and Reading Borges and Moulthrop

Since 1975, advances in chaos theory and a proliferation of technology have influenced literature as well as the study of literature thus challenging writers, readers, and scholars to expand their modes of expression and interpretation (on the coinage of the term "chaos," see Li and Yorke 1985). The impact of chaos theory in literary study in the US parallels the development of "empirical" and "contextual" approaches to the study of culture and literature such as the journal in which the present paper is published, *CLCWeb: Comparative Literature and Culture* <<http://clcwebjournal.lib.purdue.edu>> and the monograph series Books in Comparative Cultural Studies, both published by Purdue University Press (see Aims & Scope of *CLCWeb: Comparative Literature and Culture* <<http://clcwebjournal.lib.purdue.edu/aims.html>>; The Purdue Series of Books in Comparative Cultural Studies <<http://clcwebjournal.lib.purdue.edu/ccs-purdue.html>>, <<http://www.thepress.purdue.edu/series/compstudies.asp>>; for a bibliography of the field see Tötösy, "A Selected Bibliography of Works in the Systemic and Empirical, Institution, and Field Approaches to Literature and Culture" <<http://clcwebjournal.lib.purdue.edu/library/sysbib97.html>>; see also the several bibliographies in the field in the *Library of CLCWeb: Comparative Literature and Culture* <<http://clcwebjournal.lib.purdue.edu/library.html>>. It is in this contextual approach that I examine Jorge Luis Borges's "The Garden of Forking Paths" (1941) and "The Library of Babel" (1941), thus not from a Saussurean bipartite assumption but from the perspective of a tripartite relationship among these texts, chaos theory, and Stuart Moulthrop's hypertext *Victory Garden* (1999; in the following, I cite *Victory Garden* by stating the title of the node to which I refer). I seek to underscore the role played by chaos theory, bifurcation theory, dissipative structures, complex systems, and noise as points of convergence in these works. The dialogue among these texts separates this analysis from former studies. The modeling of this new perspective in the study of "Forking Paths," "The Library of Babel," and *Victory Garden* opens up a space for exploring Borges's work with reference to the constant evolution and points of contact among literature, science, and digital narratives.

Among others, Ana María Barrenechea, Michael Capobianco, Pineda Cachero, Thomas Weissert, Gabriel Schriber, Roberto Umansky, Stuart Moulthrop, and Jay Bolter have articulated the bipartite relationship between Borges's work and chaos or the relationship between Borges's texts and hypertext. Their critique lays the foundation for the exploration of the tripartite relationship among literature, science, and technology as presented in this analysis. María Barrenechea's *Borges: The Labyrinth Maker* (1965) marked the beginning of a new approach to Borges's work. In her chapter "Chaos and the Cosmos," Barrenechea acknowledges Borges's preoccupation with the concept of chaos and his unique ways of representing it. In Barrenechea's words, "Borges presents the concept of a chaotic and illusory world by means of a few lucid details and a narrative structure that is well planned and coherent. Disorder, on the other hand, takes root in the occurrences to which he refers, in certain coined symbols, and in a sector of his vocabulary" (51). After Barrenechea, a growing body of scholarship has examined Borges's "The Garden of Forking Paths" in reference to chaos theory and complex systems. In his article "Quantum Theory, Spacetime and Borges's Bifurcations," Michael F. Capobianco observes that "The Garden of Forking Paths" presents the space-time diagram from modern physics as an element of the internal structure of the short story (27). Thomas Weissert, by contrast, claims that "The Garden of Forking Paths" belongs to a historical period of transition from a post-Newtonian to a post-modernist understanding of the universe. To illustrate his point, Weissert examines the levels of reality in "The Garden of Forking Paths" and the levels of reality in dynamics. By way of "correlating these levels of reality for a specific case," Weissert shows "how science and literature work as consensual constructions" (225). Four decades after the publication of *Borges: The Labyrinth Maker*, the subject of chaos and complexity in "The Garden of Forking Paths" continues to fascinate critics and scholars. Several have developed the topic as a metaphorical bifurcation of

previous critical work. Antonio Pineda Cachero's essay is an excellent example of this trend: he describes "The Garden of Forking Paths" as a neofantastic story which embeds Ilya Prigogine's concept of the irreversibility of time as described in *Las leyes del caos*; Pineda Cachero explores the intricate connection between the genre that he defines as neofantastic and the place occupied by Borges in a new postulation of reality where art, culture and science overlap (see Pineda Cachero <<http://www.cica.es/aliens/gittcus/700pineda.html>>). In their essay "Bifurcation, Chaos, and Fractal Objects in Borges' 'Garden of Forking Paths' and Other Writings," Gabriel Schreiber and Roberto Umansky discuss further the connection between bifurcations and "The Garden of Forking Paths." The authors flesh out the idea that in this story, "Borges prefers to deal with bifurcations, chaotic aspects involving time, rather than with fractal geometry involving space" (65).

With the emergence of digital writing, this image of bifurcations has become particularly appealing to hypertext authors and critics who see hyperfiction as an ideal tool to describe Borges's scientific and metaphysical concerns. "The Garden of Forking Paths" has inspired many hyperfiction writers and critics, many of whom have found in Borges's works metaphysical and scientific ideas that relate to the emerging paradigms of hyperfiction. Stuart Moulthrop's article "Reading from the Map: Metonymy and Metaphor in the Fiction of Forking Paths," is one of the first to focus on Borges's work through the lenses of hypermedia (1991, 118). In this groundbreaking essay, Moulthrop notes that the literary affiliations of hypertextual fiction can be traced to contemporary experimentalists, theorists, modernists or even to an older tradition of narrative eccentricity. However, he notes that "none goes as far toward defining the issues at stake in narrative hypertext as does a sequence of short stories that appeared in the early forties: Jorge Luis Borges' 'Garden of Forking Paths'" ("Reading from the Map" 118). He goes on to assert that "In a hypertextual version of 'The Garden of Forking Paths,' Yu Tsun's vision of alternate selves would be no illusion" (123). In consequence, Moulthrop's claim is informed by his reflections upon Borgesian thought, hypertext, and literary theory. These overlapping fields are also apparent in Moulthrop's pieces "forking paths" (1987), *Victory Garden* (1991), *hegirscope: a hypertext fiction* (1995-97 <<http://iat.ubalt.edu/moulthrop/hypertexts/hgs>>), and *Reagan Library* (1999 <<http://iat.ubalt.edu/moulthrop/hypertexts/rl>>). Jay Bolter has also noted that in "The Garden of Forking Paths," the garden "suggests a luxuriant growth of textual possibilities" (139). Bolter also acknowledges that Borges's prefiguring of the possibility of multiple temporalities belongs "in another writing space altogether" (139). This space is the digital environment where literature and science interact providing new ways of representation and interpretation. Bolter's claim is justified by Borges's characters as Stephen Albert, the famous Sinologist who explains the concept of bifurcating times, states: "Time is forever dividing itself towards innumerable futures and in one of them I am your enemy" (*Ficciones* 100).

Borges's labyrinthine fictional pieces take the reader beyond the perfect plot to a new realm where storytelling, philosophy, and science converge. Fantasy and reality seem to blur, and the reader is left to her/his own devices to figure out the author's subliminal metaphysical postulates such as the possibility of simultaneous times. For example in "The Garden of Forking Paths" reality and fantasy overlap as Yu Tsun ponders upon the ideas implied in his ancestor's novel: "Once again I sensed the pullulation of which I have already spoken. It seemed to me that the dew-damp garden surrounding the house was infinitely saturated with invisible people. All were Albert and myself, secretive, busy and multiform in other dimensions of time. I lifted my eyes and the short nightmare disappeared" (*Ficciones* 101). Borges relies on a succinct narrative frame to encrypt his philosophical interests. Michael Holquist refers to "The Garden of Forking Paths" as a "metaphysical detective story" whose plot raises questions from the lexical and narrative levels (93). The novel of Yu Tsun's ancestor provides the clues for a new interpretation of time and the world, as expressed by Stephen Albert: "The Garden of Forking Paths" is an enormous guessing game, or parable, in which the subject is time. The rules of the game forbid the use of the word itself. To eliminate a word completely, to refer to it by means of inept phrases and obvious phrases, is perhaps the best way of drawing attention to it" (*Ficciones* 99-100). In "The Garden of Forking Paths" and "The Library of Babel," Borges uses scientific tropes to express philosophical concepts, and thus anticipates scientific views that were to become the focus of

debate in the late 1950s. In his essay "Borges's Garden of Chaos Dynamics," Weissert declares that in "'The Garden of Forking Paths' Borges discovered the essence of Bifurcation Theory thirty years before chaos scientists mathematically formalized it" (223). Throughout this Kafkaian metaphysical detective story, Borges not only conveys the possibility of multiple times but also foreshadows the many-worlds interpretation which was first proposed in 1957 by Hugh Everett II (for Borges's definition of a "Kafkaian fiction," see Sarlo <<http://www.uiowa.edu/borges/bsol/bsi5.shtml> >). Stephen Albert's voice once again expresses Borges's fantastic, innovative yet disturbing picture of the world: "The Garden of Forking Paths is a picture, incomplete yet not false, of the universe as Ts'ui Pên conceived it to be. Differing from Newton and Schopenhauer, your ancestor did not think of time as absolute and uniform. He believed in an infinite series of times, in a dizzily growing ever spreading network of diverging and converging and parallel times" (*Ficciones* 100).

Another hypothesis that Borges introduces in "The Garden of Forking Paths" is the idea of "order out of chaos" as elaborated by Ilya Prigogine and Isabelle Stengers in *Order Out of Chaos la Nouvelle Alliance* (1979). To illustrate the idea of "orderly chaos," Borges immerses the reader in fantastic worlds where perfection and chaos coexist. Donald Leslie Shaw has demonstrated that in "The Garden of Forking Paths" the labyrinths stand for "man made realities that though bafflingly chaotic, have an appearance of regularity and order" and that the same concept is "visible in the order, containing chaos, of the Library of Babel" (42). It is through these short stories that Borges ponders the turbulent changes that took place in Argentina throughout the late 1930 and 1940s, a time marked by an eighteen-month military coup which "was the opening shot in what was to become a new, chaotic, completely unresolved Argentina -- the one we know today" (Bell-Villada 21). José Felix Uriburu's military coup awakened strong nationalistic and oligarchic feelings while dissolving the legislature and turning the dictator into an almost mythological figure. As a result of these events, Borges abandons his nationalistic perspective and adopts a more universal, cosmopolitan, and philosophical approach in his writing. Thereafter, he uses his narrative "as another strategy for establishing an order in a society where old orders, precisely, were vanishing" (Sarlo <<http://www.uiowa.edu/borges/bsol/bsi5.shtml> >) and deploys his new strategy in the "The Garden of Forking Paths" and in "The Library of Babel." Whereas the former refers to the events of the First World War and the interpretation of a chaotic manuscript, the latter alludes to a symmetrical library whose dwellers engage in a frantic quest for meaning as they try to understand the chaotic nature of its artifacts. To highlight the contrast between a structured environment and inhabitants frustrated in their search for meaning and identity, Borges states: "It is now four centuries since men have been wearing these hexagons" (*Ficciones* 84).

Although "The Garden of Forking Paths," "The Library of Babel," and *Victory Garden* were written at different times and in different media, a reading of each text through the lenses of chaos theory and technology illuminates the other. These literary artifacts share a number of traits that the avid Borges reader cannot overlook and finds among them theme, structure, and references to chaos theory and bifurcation theory. Whereas "The Garden of Forking Paths" and *Victory Garden* incorporate confusion and chaos of a time of war, "The Library of Babel" with its symmetrical, almost infinite structure and its unintelligible artifacts dares the reader to make sense of an orderly chaotic environment which incorporates confusion to underscore man's frantic search for his own destiny. Borges and Moulthrop rely on discourses that mask their common interests in humanity's destiny and in scientific and technological developments. For example, the first paragraph of "The Garden of Forking Paths" introduces readers to events of the First World War in which the British artillery defensive attack against the Germans "scheduled for July 24th, 1916" was postponed (*Ficciones* 89). As the plot develops, Yu Tsun, the main character, faces a double objective. On the one hand, he must relay a secret to the British artillery; on the other hand, he feels compelled to understand his ancestor's legacy: a labyrinth and a chaotic novel. As he reflects on his ancestor's labyrinth, Yu Tsun thinks of "a maze of mazes, of a sinuous, ever growing maze which would take in both past and future" (*Ficciones* 94). Borges's war narrative echoes in *Victory Garden*: "I am trying to get some reading done (story of my life) but the world keeps intruding. It is 7:05 p.m. on the 16th of January, 1991. Something dark and terrible is

unfolding in Baghdad, Iraq. Something dark and terrible took place in Staffordshire, England during the month of July, 1916. ... At the moment, none of these events seem real" ("Story of My Life"). Moulthrop's hypertext takes up the war theme by narrating events of the Gulf War within an environment that underscores late twentieth-century technology to present a Borgesian text and ideas from a new perspective. In one of the lexias Moulthrop states: "Maybe history is different for us. Perhaps hypermediated and postmodernized, we now live in a universe that looks suspiciously like a Garden of Forking Paths. Or perhaps the old ways of understanding our lives -- struggle, question, commitment, love, loss, mourning -- can't really be pushed aside. I did not set out to resolve that issue. I set out to put some stories in motion, hoping they'd take me somewhere. Here's where they led" ("The Place of the Big Wind").

In "The Library of Babel," the reader, like a detective in a time of war, must decipher the secret message encoded in the narrative. The librarians' search for meaning stands for the quest for his own destiny in a library which is described by some as "the febrile Library, whose hazardous volumes run the constant risk of being changed into others and in which everything is affirmed, denied, and confused by a divinity in delirium" (*Ficciones* 86). Borges's frantic and unstable library speaks to and illuminates the unpredictable, chaotic and warlike scenarios in "The Garden of Forking Paths" and *Victory Garden*, where an unexpected event could determine a new outcome in the story. Consequently, the ludic appeal in "The Garden of Forking Paths," "The Library of Babel," and *Victory Garden* lies in their ability to yield new ideas and challenge readers to focus on the reading process as they generate new interpretations and figure out what these two stories stand for. Borges's texts and Moulthrop's stories are works that "yield": a phrase that I coin and that refers back to Michael Joyce's definition of 'words that yield' (on Michael Joyce's definition of 'words that yield,' see <<http://www.sigweb.org/conferences/ht-conferences-archive/ht04/hypertexts/larsen/noflash/joyce/afternoon.htm>>). Thus, taking up Joyce's interpretation of a lexia as an anchor that generates more text and therefore more understanding of a hypertext, I see these three literary works as generating a new understanding of literature. By traversing and assembling these texts, the reader moves beyond the plot to come to terms with the metaphorical implications of the texts that are signaled by metaphysical, scientific and technological references. Each of these literary texts as well as the relationships that can be established among them allow us to see them as complex artifacts portraying the complexities of a world as defined by chaos theory and complex systems. Thus, "The Garden of Forking Paths," "The Library of Babel," and *Victory Garden* are amenable to an analysis based on chaos theory. With respect to chaos theory, Katherine Hayles notes: "At the center of chaos theory is the discovery that hidden within the unpredictability of chaotic systems are deep structures of order. 'Chaos,' in this usage, denotes not true randomness, but the disorder characteristic of these systems" (*Chaos and Order* 1). "The Garden of Forking Paths" and *Victory Garden* illustrate Hayles's claim because these two highly structured narratives display chaotic environments. For example, in "The Garden of Forking Paths," a spy-detective story, Dr. Yu Tsun, great-grandson of Ts'ui Pên, finds himself trapped in a Borgesian labyrinth as he tries to decipher his ancestor's incomprehensible manuscript. While trying to convey a secret coded message in a time of war, Yu Tsun faces the challenge of comprehending his ancestor's likewise secret coded text. The concept of meaning out of chaos becomes tangible when Stephen Albert explains to Yu Tsun that the labyrinth and the novel that his ancestor created are not distinct objects but one and the same: "At one time, Ts'ui Pên must have said; 'I am going into seclusion to write a book,' and at another, 'I am retiring to construct a maze.' Everyone assumed these were separate activities. No one realized that the book and the labyrinth were one and the same" (*Ficciones* 96). The reader is left to apply "chaotic" reasoning to extract meaning from Yu Tsun's apparently erratic murder of Stephen Albert, and from the short story "The Garden of Forking Paths" which they inhabit. The act of reading becomes an act of spying, of playing detective, and of making meaning in a multilayered maze.

In *Victory Garden*, on the other hand, the author has set -- by means of a computer program with cascading binaries -- certain restrictions or paths that the reader can explore. Although *Victory Garden* provides the reader with some predetermined narrative possibilities, this hyperfiction encourages her/him to form new connections among the different narrative threads.

As the reader processes different readings, initial chaos and disorder become simultaneously important elements for understanding each individual narrative. Thus, the reading process resembles one of assemblage, whereby the reader tries to piece together how the different narrative threads and/or lexias supplement each other. This concept is illustrated by two consecutive lexias from *Victory Garden*, one of which presents a reflection on a television broadcast while the other reveals a character's opinion on the Gulf War: "Thursday night, January 16, 1991. Here is what the war looks like so far: Blowtorch flares from F-15 Strikes Eagles burning above a 'large airbase somewhere in Saudi Arabia.' ... Street maps of downtown Baghdad with an ID shot of Holliman, Amett or Shaw stuck on ... Peter Jennings automaton avunculus, looking like he could use a few more minutes on the nod, which makes him almost human" ("Images"). "You have to believe, you've gotta have faith," Thea pointed out. "This isn't going to be any television war, sister. It's not what you see that matters, but what you don't see. Press restrictions, pool coverage, censorship" ("Unseen"). By combining data from the different narrations, different readers are likely to reach varying degrees of closure and a better understanding of this body of text and its metaphysical implications. This strategy is announced in one of the lexias of *Victory Garden* which resembles a news broadcast. The reader is informed: "It's a familiar feast, all fragments and repetition stuck together with a paste of groundless spec. And of course it's what we do not see that counts" ("Images"). Readers are therefore reminded to pay attention to what is not being said in each "story." In "The Garden of Forking Paths," Ts'ui Pên's writing strategy relies on an identical strategy: "I know that of all problems, none disquieted him more, and none concerned him more than the profound one of time. Now, then, this is the only problem that does not figure in the pages of *The Garden*" (*Ficciones* 99). In Borges's and Moulthrop's texts reality exists as an absence, as a voice that is silent and waits to be found among the surrounding chaos. In "The Garden of Forking Paths" and in *Victory Garden*, Borges and Moulthrop predetermine the possibility or even the necessity of finding meaning in their stories; stories that illustrate the concept of orderly disorder (see Williamsen 31). The reader is provided with basic structural and linguistic elements that allow her to create and/or recreate the stories in varying levels depending still on motivation and circumstances. This approach embraces literature as a complex system in a constant state of transformation influenced by the active reader and her environment.

"The Garden of Forking Paths," "The Library of Babel," and *Victory Garden* illustrate bifurcation theory and dissipative structures. These concepts refer to multiple chronologies and create narratives that challenge the characters as they strive to survive and make sense of the complex and chaotic systems in which they (and the reader) are immersed. In the foreword to Prigogine and Stengers's *Order Out of Chaos: Man's Dialogue with Nature*, Alvin Toffler states: "In Prigoginian terms, all systems contain subsystems which are continually 'fluctuating.' At times, a single fluctuation or a combination of them may become so powerful, as a result of positive feedback, that it shatters the pre-existing organization. At this revolutionary moment -- the authors call it a 'singular moment' or a 'bifurcation point' -- it is inherently impossible to determine in advance which direction change will take: whether the system will disintegrate into 'chaos' or leap to a new, more differentiated, higher level of 'order' or organization they call a 'dissipative structure'" (xv). These stabilizing forces -- called dissipative structures -- result therefore from a quest for organization and equilibrium within a system. They are markers of transformative points at which the narrative changes to yield a more coherent, harmonious and meaningful environment within the system. In effect, the system/narrative branches off, creating a number of possibilities and solutions which emerge not only from the interactions within the system but also from its unique prior development. The concept of "dissipative structures" provides a new interpretation of the world that is based on a constant process of being and becoming. Throughout this transformation and evolution, systems evolve from a disorderly state into a reorganized environment. In his essay "Literature as Dissipative Structure," David Porush explains that Prigogine's work provides us with "the tools to understand and justify features of the literary discourse that are otherwise hard to explain from a scientific perspective" (283). Among the features Porush mentions in his paper are the complexity of literary discourse, or "its unique ability to excite the imagination, its sense of nondeterministic, unpredictable complexity and organization

as well as its narrative of the unruly and chaotic as the grounds for higher insights" (283). "The Library of Babel," "The Garden of Forking Paths," and *Victory Garden* embody the concept of dissipative structures by allowing readers to go beyond a bipartite Saussurean interpretation of the texts and making possible the emergence of multiple plots that evolve as the reader gains a better understanding of complex texts and the relationships among them. One interesting approach to bifurcation theory is outlined by John Briggs and David Peat in *Turbulent Mirror*, where they discuss the applicability of bifurcation theory to the creative process. In their words, "'we enter the border between chaos and order' when we experience nuance. Whereas many of us either fail to recognize such nuances or purposefully deny them for they 'threaten our customary thinking,' those with a creative bent focus precisely on these disturbing elements" (195) (qtd. in Williamsen 28). According to Briggs and Peat, this process allows "thoughts to 'bifurcate to new planes of reference, and to form feedback loops among different planes in a process which self-organizes a form to embody the nuance'" (qtd. in Williamsen 28).

"The Garden of Forking Paths," "The Library of Babel," and *Victory Garden* force the reader to search for meaning out of chaos by carefully engaging in nontraditional readings to seek clues that will help her understand the ideas veiled behind these texts. For example in "The Library of Babel," the reader is challenged to see the library in at least three ways: as a metaphor for the universe, as a reference to Argentina's dictatorial political structure and its chaotic social environment, and as the place where man tirelessly searches for his destiny. These multiple interpretations oblige the reader to constantly recreate the text and to engage in thinking that, taking up on Briggs's and Peat's position, "bifurcate[s] to new planes of reference" (qtd. in Williamsen 28). Bifurcation theory is particularly productive to establish points of convergence and divergence between "The Garden of Forking Paths," "The Library of Babel," and *Victory Garden* as parts of a single complex system within which the three works engage in an intertextual dialogue: each text illuminates the other and strengthens the message each of them conveys. As in a bifurcation point, the three works converge in a thematic point -- the existence of a fundamental orderly structure under a narrative that at first glance disorients the reader. Moulthrop's digital work materializes this concept in a carefully planned structure embedded with Borgesian references. At the same time, Borges's works speak to Moulthrop's text as inspirational pieces whose metaphorical themes are taken to the digital realm. Nevertheless, each of the texts diverges in a new direction, conveying its message in a unique fashion. "The Library of Babel" illustrates the quest to find some equilibrium in the search for destiny and situates the narrator in a remote time and unspecified location, adding universality to the story. "The Garden of Forking Paths" and *Victory Garden* immerse the reader in two wars where characters and readers alike try to make sense of a chaotic environment.

Writing about "The Garden of Forking Paths," Weissert claims that an "essential characteristic of bifurcations in nonlinear physical systems is that, at the splitting, chance determines which path the system will take" (234). Borges anticipates Briggs and Peat by acknowledging the role of chance and choice: "Sometimes the pathways of this labyrinth converge. For example, you come to this house, but in other possible pasts you are my enemy, in others my friend" (*Ficciones* 98). Another metaphorical reference to bifurcations embedded in the story's dual narratives, which branch off in two different directions: a detective story and a philosophical exploration that in itself anticipates bifurcation theory. Stephen Albert's words illustrate this point: "Naturally, my attention was caught by the sentence, 'I leave to various future times, but not to all, my garden of forking paths.' I had no sooner read this, that I understood, The Garden of Forking Paths was the chaotic novel itself. The phrase 'to various times, but not all,' suggested the image of bifurcating in time, not in space" (*Ficciones* 97-98). Similarly, Moulthrop takes up Borges's strategy in his *Victory Garden*, where he conveys bifurcations by allowing the reader to select the lexias and reading paths she wants to traverse. In the introduction to *Victory Garden*, Moulthrop informs the reader: "At most moments you can also double-click certain words ('words that yield') which will take you to a different story line. Though yield-words often create discontinuities, they also map connections" ("Welcome").

Moulthrop recreates Borges's multiple pasts, presents and futures and adds another layer of complexity by restructuring the linear narrative with technology. In *Victory Garden*, the bifurcations of modern chaos theory and the metaphor of multiple times are presented through a set of binary constraints (on the types of choices a reader has while reading a hyperfiction text created with Storyspace, see Rettberg, <<http://www.electronicbookreview.com/action/Search?kw=Victory+Garden> > ). According to Moulthrop "the reading paths do change according to a set of binary constraints (often multiple, cascading binaries), and this effect makes it unlikely that a second reading will resemble a first reading. As well, there are mechanisms that are meant to seduce the reader into establishing a different set of initial conditions and thus discovering new paths through the text" (personal communication). This bifurcating structure and its language engage intentionally the reader into creating multiple worlds. The choices the reader makes during the reading lead to bifurcating points at which the storyline shifts in time and in place. One of the multiple readings of *Victory Garden* starts with a class in progress, discussing Borges's ideas, followed by what seems an almost unrelated passage where Professor Dorothea Agnew and a young student named Veronica acknowledge the relevance and reality of the Gulf War. To Veronica the war feels unimaginable. "For the second time tonight the same thought seized her. 'It can't be real. This is the end of the 20th century. War is something you study in history classes'" ("Unreal"). As the reader continues, the story bifurcates to a description of Dr. Urquhart's experiment related to dreams and the unconscious to be followed by quotations concerning literary theory and technology from critics such as Roland Barthes, Donna Haraway and Gregory Ulmer. Ulmer's words reflect the impact of media in our daily lives: "Everything now, in its own way, wants to be television--Greg Ulmer, Teletheory" ("Wannabe"). All these segments are followed by a lexia that takes the reader to the scene where Emily Runbird, Veronica's sister and Professor Agnew's student, has been deployed to the war as a combat postal clerk and is now in a very real, frightening, and chaotic battlefield. This highly wrought structure of *Victory Garden* makes tangible the underlying concepts of bifurcation and chaos theory because it illustrates multiple plots and it relies on creating meaning out of apparent chaos. Each bifurcation generates a new narrative thread causing the perpetually evolving system to be reorganized as with the emergence of a dissipative structure. Although *Victory Garden* has many intertwined levels or stories, these are not hierarchical layers but narrative threads that supplement each other and contribute to the reader's understanding. By interpolating references to developments in chaos theory and technology in his narrative, Moulthrop signals a new interpretation of the world and of literature: "There are no patterns here, no true correspondences. The world cannot be understood in terms of providence, fate, tragedy, spatial form. The world is only a complex problem in nonlinear dynamics, the ultimate chaos experiment" ("Anonymous"). Hence, *Victory Garden* invites the reader to see the literary work of Borges from a new perspective that engages the reader in a new interpretation as if it were a natural bifurcation of Moulthrop's digital work.

As I introduced above, "The Garden of Forking Paths" and "The Library of Babel" contain elements that seem to obey laws similar to the ones observed by dissipative structures. For example, the characters in these stories engage in a search for meaning that goes beyond the binary signifier/signified interpretation of the text. To make sense of the situation in which they find themselves, Yu Tsun and those who inhabit Borges's library of Babel must understand the texts before them as "open rather than sterile and self referential systems of signs, reliant upon input from other sources to make [them] go and on a process of dissipating entropy (analogous to interpretation) to make [them] grow" (Porush 301). Similarly, the readers of the two stories must consider multiple and confusing levels of meaning -- referential, metaphoric, symbolic, and perhaps even historical references -- in order to achieve varying degrees of understanding and overlapping issues in both works. Whereas Borges's texts present some of the features of dissipative structures, they also trigger in their readers cognitive strategies that resemble some of the features of dissipative structures. Porush observes: "Even the moment of insight to which great texts bring us can be viewed as an explosively meaningful reorganization and addition of information in the reader's mind, much like the activity of a dissipative structure" (295-96). This is

evident in Borges's texts where readers and characters of these stories must invest a considerable amount of time and cognitive effort to reorganize their thinking to make sense of the complex and chaotic information presented to them. Characters and readers alike are challenged to deal with a subtle portrayal of metaphysical implications and scientific and cultural challenges. Similarly, as the narrative of *Victory Garden* unfolds, the reader encounters references to multiple times and realities. Key among these is the reference to Professor Urquhart, who is working on a research project related to virtual reality and who has included in his students' reading "The Garden of Forking Paths." There is no doubt that Urquhart's voice raises and reiterates the issue of multiple times and chronologies laid out by Borges in his story. Through a conversation between Thea Agnew, a university professor, and Urquhart, the reader finds out that Urquhart's desire for change in the world goes hand in hand with his interest as a scientist. A haphazard selection of links directs the reader to a somewhat surreal passage in which Professor Urquhart explains his experiment with interactive electronics and "Alternate Realities" ("Just Say No"). According to Urquhart, he and his team "are attempting to locate and stimulate the mental faculties that allow us to perceive the world not as a singular, linear unfolding, not a closed system or a line of necessity, but rather as a network of possibilities, an organicity of intersections, parallels and departures, infinite in its extension and vast possibilities of permutations" ("Vox-Pop"). Urquhart's research agenda echoes Porush's claim that "the notion that the human mind -- or at least its information processing capacities--is itself as a dissipative structure is not far fetched as it may sound" (305). Porush concludes that "very recent theories of neural action, and its integration into the general schema of biological development and human behavior, suggest that these activities operate according to 'central mathematical concepts of self-organization in non-equilibrium systems'" (305). Urquhart's "scientific" approach links *Victory Garden* back to Borges's fiction. Professor Urquhart's scientific experiment invites readers to consider bifurcation theory and the presence of dissipative structures as means to reexamine Borges's short stories. Moulthrop, like Borges, invites readers to reassess their traditional rules for interpretation of reality to generate meaning out of complex systems that abound with noise, redundancy and confusion.

The term "noise," which is associated with interruption or poor quality of transmission, has its origins in early radio broadcasts which were often affected by atmospheric changes and gave way to jamming and distortion. Real noise is created not only by the presence of an external element that interferes with the transmission but also by the internal components of the system that affect the transmission of a code. I concur with William R. Paulson's claim that "under the right circumstances, noise -- from whatever source -- can create complexity, can augment the total information of a system" (73). One of the examples of noise cited by Paulson is Borges's library of Babel where the lack of codes for understanding random symbols "does not stop the librarians from pursuing their searches for the pockets of intelligibility that many believe must be there somewhere" (77). He goes on to explain that "the poetic text begins as an attempt to go beyond the usual system of a language -- in which the world is a conventional sign -- to a specifically artistic system, in which sounds, rhythms and positional relations between elements will signify in new ways" (85-86). Likewise, in "The Garden of Forking Paths" the spy-detective plot and the decipherment of Ts'ui Pên's manuscript are intertwined in such a manner as to obscure Yu Tsun's role as a spy for the Germans. Each narrative thread forces the reader to change focus as she gathers clues to understand the characters' true motivations and the very unexpected narratives. Yu Tsun's words illustrate the change of focus as he puts his war mission momentarily on hold to come to terms with his ancestor's writing: "I calculated that my pursuer, Richard Madden, could not arrive in less than an hour. My irrevocable decision could wait" (*Ficciones* 95). As the narrative progresses, the reader must identify and decode an abundant quantity of apparently incoherent data as clues to understand the story. Likewise, Yu Tsun chooses Stephen Albert for reasons unrelated to his ancestor, yet his murder victim surprisingly leads them to Ts'ui Pên's manuscript. Equivocal noisy clues, characterized by statements that provide a combination of real and metaphysical information, underscore the reader's fundamental role in transforming noise into message. The reader's relevance in translating noise into message also conforms to Jurij Lotman's application of the term "noise" to the arts. Paulson notes that "in

Lotman's view, the artistic text arises when its reader encounters elements for which the ordinary codes of language possessed by him are not adequate, elements, in other words, which are foreign to his reading process as determinism, as reception of signs according to rules already possessed" (89). Paulson elaborates on Yuriy Lotman's observation by noting two possible stances vis à vis noise and confusion. On the one hand, he refers to the unadaptive reader, one who is incapable of adapting and/or learning new codes. The unadaptive reader struggles with the code and what she/he considers noise disrupts the reading process. On the other hand, there is the adaptive reader, who is capable of deriving meaning and who "assumes the task of integrating elements that ordinary codes of reading do not account for" (90). This is the type of reader that Borges and Moulthrop have in mind for their texts. Such a reader who assumes as input not only the codes she understands but also the interpretation she has made of the disruptive elements of the text. Borges expresses a straightforward and unsettling challenge to the reader in "The Library of Babel:" "You who read me are you sure you understand my language?" (*Ficciones* 87). In a similar way, Moulthrop invites the reader to seek meaning through noise, in *Victory Garden* in a lexia entitled "Enigma:" "Like any maze or enigma, *Victory Garden* will bring you back to a place you've already been. Sometimes these familiar moments will be followed by something new. At other times you might find yourself in a loop, in which case, you might want to invoke a yield-word" ("Enigma"). It is this travelling back and forth in time through the different narratives that creates noise and confusion in the unravelling of the stories and their metaphorical implications. In *Victory Garden*, the reader has no other option but to consider noise and redundancy as a supplement necessary for the reading/decoding process. As she moves through the different layers of the story, she is compelled to perform what Paulson describes as: "[constructing] an autonomous explanation of how the lower level is integrated into the overall system" (110). *Victory Garden* engages readers in a challenging process of mapping whereby structure, narrative and meaning are intricately related. This understanding is crucial for comprehending the connection between *Victory Garden* and the Borgesian fiction with which it shares a close intertextual relationship.

In conclusion, I argue that it is advantageous to analyze the three texts at hand -- "The Garden of Forking Paths," "The Library of Babel," and *Victory Garden* -- as belonging to a complex system where each text speaks to the other via a common code embodied in the references to chaos theory, bifurcations, dissipative structures, and noise. Whereas "The Garden of Forking Paths" and "The Library of Babel" foreshadow metaphorically a narrative similar to the scientific model of chaos and bifurcation theories devised by scientists, *Victory Garden* materializes retrospectively Borges's ideas, mathematical and metaphysical concerns, thus bridging the gap between scientific and literary discourses. Above all, when considered as a system, these three texts of literature challenge the reader to experience them within a context of complex relationships and new meanings emerge from the interplay between Borges's work and Moulthrop's digital piece. Through the perspective of chaos and bifurcation theory, dissipative structures and noise, science illuminates Borges's works. The reciprocal interconnectedness among Borges's stories, *Victory Garden*, scientific theory and technology acknowledge the intricate connections among print literature, digital literature and science. Further, it suggests a first step toward a new interpretation of Borges's oeuvre: a perspective that reaffirms his significant role in Latin American letters while acknowledging its projection into the digital realm.

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