Writing complexity: the American novel and systems realism

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Abstract

Although the relationship between literature and science has been a major focus of research in the last few decades, the influence of complex systems science on recent American fiction has not yet been comprehensively documented. I argue that a significant body of that fiction is systems-aware and thus represents the world as a network of complex systems. In the first section of the thesis, I claim that the origin of systems fiction can be found in the nineteenth-century social novel, which displayed significant knowledge of system function. Despite the narrative challenges posed by the complex, nonlinear structure of systems, contemporary authors somewhat surprisingly turn to a broadly traditional form of realism rather than experimental literary techniques. Motivated by the desire for social engagement, systems realism conceptualises systems as fundamentally ordered and thus narratable, though it acknowledges that this order is frequently inaccessible. In the second section, I engage in a close reading of systems-aware fiction and explore the extent to which novels incorporate the principles and discourse of systems science. I suggest that these novels seek to understand social concerns through analogy and the creation of fictional models which foreground structural homologies between systems. In the third and final section, I argue that systems-awareness is vital to an understanding of recent 'post-postmodern' paradigms, and I demonstrate this through an exploration of emerging trends in fiction which are shaped by systems thinking. In particular, I focus upon the emergence of environmental concerns in recent American writing. To explore the extent to which authors have perceived reality as systemic and have engaged with the representational challenges presented by complex systems provides us with new ways of thinking about the novel as a form. For these reasons I suggest that systems realism is central to the contemporary history of the novel.

Contents

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Introduction

In the last few decades the world has become increasingly defined by the language of systems, and we have come to realise that in a biological, social and economic sense we are all interdependent, with each individual forming part of a "complex unity".[12] Terms such as 'ecosystem', 'immune system', 'education system' and 'operating system' now frequently appear in the news and other current affairs media, along with adjectives such as 'complex', 'emergent' and 'interdependent'. The prevalence of systems discourse in our everyday lives has arisen as a result of the culture-wide perception that life, particularly in the developed world, is becoming more complex (by which I mean more interconnected and interdependent than ever before). Since the arrival of the internet, advances in computer technology – including the recent growth of online social networks – have facilitated a significant change in the way that people think and act: we are now increasingly likely to 'think globally', in both our personal and professional lives. New forms of technology are not the only factors influencing this new systemic worldview. Developments in climate science have taught us that the energy consumption of a single individual contributes towards a change in climate which negatively affects many other people, and species, across the world. We are also increasingly aware of the influence of globalization upon manufacturing: the products we buy are shipped to us from producers in far-off countries, and resources, including labour, from a number of different countries may contribute to a single product. Furthermore, as genetics and neuroscience tell us

[1] The *OED* defines *system, n.* as "an organised or connected group of objects" (Def. 1), and "a set or assemblage of things connected, associated, or interdependent, so as to form a complex unity" (Def. 1.a). Attempts made in recent decades to visualize the totality of life on earth in explicitly systems terms can be partially attributed to the influence of James Lovelock's *Gaia: A New Look at Life on Earth* (1979). While much of the science behind Lovelock's original hypothesis has since been discredited, his assertion that the globe is a single, self-regulating "complex system" has gained credibility in recent years (vii). For an account of the relationship between the Gaia hypothesis and the science of complex systems, see Lewin 106-119.

[2] Citations in this thesis were compiled using the *MLA Handbook for Writers of Research Papers,* 7th Ed.

more about the elements which interact to produce a single consciousness, we are now more likely conceive of individual people as collections of multiple, interacting parts.

As a result of these changes in cultural perception, contemporary novelists are beginning to use concepts and language drawn from systems science (of which, more shortly). In the following chapters I refer to novels which are influenced by systems and systems discourse as examples of 'systems-aware' fiction. By this I mean that they express a heightened awareness of the systemic nature of reality. It is possible to argue that all novels are inescapably about systems, since brains, cities, economies and environments can all be defined as such, and because novels have typically taken such entities as their subject matter. However, I argue that some novels are more aware than others of the systemic nature of the contemporary world and as such place more emphasis upon system function and interaction. These texts focus upon interconnected wholes rather than isolated parts, and address the ways in which part and whole interact. In the following chapters I explore the fictional representation of complex systems. Most of the systems out there in the world are 'complex', as opposed to chaotic or mechanised, and this is an issue that I explore more fully in Chapters 1 and 2. In the following part of the introduction I explain in detail how complex systems are defined within systems science, and thus, in addition, how they are structured in recent fiction.

First, all complex systems are composed of many parts called 'agents' and are also referred to as 'agent-based structures'. Each system is "a network of many 'agents' acting in parallel" and each agent is "constantly acting and reacting to what the other agents are doing" (Waldrop 145). A complex system also "has many levels of organization, with agents at one level serving as the building blocks for agents at a higher level" (145). So, for instance, an individual human being is a complex system in his or her own right, but can also be viewed as an individual agent in larger economic and social systems. Agents can be "molecules or neurons or species or consumers or even corporations" (88). But whatever their physical form they are all engaged in similar

relationships, “constantly organizing and reorganizing themselves into larger structures through the clash of mutual accommodation and mutual rivalry” (88). Through these relationships, larger structures are formed: “molecules […] form cells, neurons […] form brains, species […] form ecosystems, consumers and corporations […] form economies”, and so on (88).

Secondly, all complex systems exhibit ‘emergence’. What makes a system complex rather than merely complicated is that the whole of a system is greater than the sum of its parts. Emergence refers to the macro-level properties of a system that ‘emerge’ from the interaction of agents at lower levels (Holland 1-15). The term ‘emergence’ reflects the coming into view of patterned order from low-level chaos. Much is still unknown about the nonlinear processes by means of which emergent behaviour occurs. As agents organize themselves into larger and more complex structures, new system properties ‘emerge’, and these require new laws and concepts to describe them. For example, liquidity is an emergent property of water that cannot be explained with reference to the properties of the component gases oxygen and hydrogen (Waldrop 82). There is also a possibility that one day consciousness may be explained as “an emergent phenomenon from a complex adaptive system” (Lewin 155).

The third feature common to all complex systems is that the connections between agents are nonlinear. M. Mitchell Waldrop writes that “virtually everyone and everything in the world is caught up in a vast, nonlinear web of incentives and constraints and connections […] the slightest change in one place causes tremors somewhere else” (65). This is the area in which complexity theory and chaos theory overlap: both areas take into account the fact that nonlinearity leads to unpredictability: “everything is connected, and often with incredible sensitivity. Tiny perturbations won’t always remain tiny. Under the right circumstances, the slightest uncertainty can grow until the entire system’s future becomes utterly unpredictable – or, in a word, chaotic” (66). Complex systems are not chaotic systems; they are relatively ordered systems poised at the “edge of chaos”,

meaning that the components “never quite lock into place, and yet never quite dissolve into turbulence, either” (12).[3]

Lastly, complex systems are self-organizing. Order within a complex system emerges “without anyone being in charge or consciously planning it” (Waldrop 11). Coherent behaviour at the level of the system as a whole has to “arise from competition and cooperation among the agents themselves” (145). There is no centralized control mechanism and no single agent or group of agents controls the behaviour of the entire system. Paul Cilliers writes that “each element in the system is ignorant of the behaviour of the system as a whole” and “responds only to information that is available to it locally” (5). Complex behaviour exhibited by the system as a whole emerges as a result of the totality of these local interactions. Examples of complex systems include the immune system, an ant colony, the brain, cities, economies, ecosystems and the internet. All of these systems are self-organizing and can respond to feedback from their environment in order to adapt their strategies for survival and growth (Mitchell 3-13).

As knowledge of systems science permeates the wider culture and as our lives become increasingly defined in terms of large-scale systems, authors are, as I have suggested, frequently writing systems-aware fiction. In subsequent chapters I suggest that authors writing this kind of fiction are turning to a traditional form of literary realism in order to communicate their ideas, and I use the term ‘systems realism’ to describe this formal strategy. I argue that systems realism echoes nineteenth-century literary realism, since it involves a return to the kind of detailed documentation of social and industrial processes which we associate with social problem novels in the mid- to late nineteenth century. However, the new form of realism is not identical with the old: though systems realism shares some nineteenth-century concerns it is distinctively twenty-first century in outlook.

[3] The term *edge of chaos* was first coined in the mid-1980s by computer scientist, Chris Langton. See Langton 41-92 and Waldrop 230.

Influenced by recent scientific theory, the new body of fiction I have termed systems realism introduces new paradigms. In the eighteenth and nineteenth centuries, texts influenced by mechanist thinking or organicist philosophies frequently compared society to a machine or a biological organism. For example, in Charles Dickens' *Hard Times* (1854), Thomas Gradgrind's utilitarianism – his rigid adherence to rationalism and empiricism, to head over heart – must be seen, more broadly, as a critique of what might be called a mechanical paradigm, a way of viewing the world which derived from industrialization but came to encompass social relationships in their entirety. Joseph W. Childers suggests that "for Dickens, industrial culture threatens to turn all of society into a large factory" (87). Twentieth and twenty-first century systems realism also encourages us to think of society as a whole made up of interconnected parts, but its explanatory model is now 'the complex system', rather than the machine. For example, recent systems-aware novels by authors such as Richard Powers, Barbara Kingsolver and E. O. Wilson compare societies to ant colonies, the human brain, and computer networks, since all of these entities are examples of complex systems.

Broadly speaking, the type of narrative strategies used by contemporary authors mirror those of the nineteenth-century realists; they reveal the connections between "macro and micro worlds", employ omniscient narration, and model the world through analogy and correspondence.[4] For instance, where a nineteenth-century text might adopt an omniscient narrative position from which to survey the parallel lives of the rich and poor, the systems-realist might adopt a similarly elevated point of view to show, for example, the impact of deforestation or rising ocean levels. Both texts, in this instance, would be using omniscient narrative to present a high-level view of an entire system,

[4] LeClair suggests that the systems novel employs "the methods of 'earlier times'", including the use of "macro and micro worlds" (*Loop* 11). Like the nineteenth-century social novel, contemporary systems-aware fiction explores the relationship between the activity of individuals (the micro-level of the system) and that of the collective (the macro-level perspective of the whole). In recent years, the scale of the 'macro' has expanded to include the processes of twenty-first century globalization, while the 'micro' has reduced in size, down to the level of interacting cells, genes and neurons.

whether that system takes the form of an industrial city in 1850 or a continental ecosystem in 2010. Though systems-aware authors are predominantly committed to realism as a means of connecting with the world and the reader, I also consider the possibility that there are moments in systems-aware texts when the conventions of narrative realism are not able to provide an accurate presentation of complex systems. In future chapters I address the ways in which authors are forced to adapt their formal strategies to meet the demands of a vastly distributed and nonlinear subject matter. I also consider moments of tension or rupture when it seems that system processes are, in fact, unnarratable.

Texts which deploy systems realism show the manner in which the individual and the collective are interconnected and mutually constitutive. Through descriptions of life at the micro and macro-level, they show the processes by which systems like cities, economies and ecosystems self-organize, with large-scale behaviours emerging as a result of the unpredictable actions of their constituent parts. Systems realism addresses a variety of issues, such as how societies function; what the proper relation is between the individual and the rest of society, or between humanity and other species; how the internet impacts upon our lives; and how our lives impact upon the wider biosphere. Explaining in greater detail what is meant by the term ‘systems realism’ and why it is of such importance for the future of the novel as a literary form is the project which informs this thesis as a whole.

Section 1 documents the theoretical background to my approach. In Chapter 1, I examine why realism rather than more experimental narrative techniques is best suited to an exploration of complex systems. The recent resurgence of literary realism indicates a renewed confidence in our ability to use language to comprehend and communicate truths about the world. The task of the contemporary realist is made problematic, however, by the form or structure of those systems that he or she would seek to represent. As I mentioned previously, complex systems are large, diffuse, nonlinear entities which do not always sit comfortably within the confines of a realist text. The potential conflict of novel

form and content is explored in this chapter. Chapter 2 examines the rise of systems theory in the late twentieth century and the influence which this field of science has had upon contemporary fiction and literary theory. I consider the various ways in which systems theory can be applied to the study of literature, and explain why looking at the systemic content of recent texts is a useful way to trace larger cultural changes. In Chapter 3, I trace similarities between contemporary complex systems science and organicism in the nineteenth century, suggesting that nineteenth and twenty-first century novels share a similar view of systems, in part because of corresponding similarities in scientific paradigms of the time.

Section 2 takes the form of three paired case studies; in Chapters 4-6 I juxtapose texts from the period 1890-1920 with texts written in the period 1995-2001. I argue that today's systems-aware texts display similar features to those found in nineteenth-century literature: a concern with the interdependence of part and whole, a preoccupation with the opposition between freewill and determinism, and some technical knowledge of contemporary scientific theories. Chapter 4 compares and contrasts William Dean Howells' *A Hazard of New Fortunes* (1890) and Richard Ford's *Independence Day* (1995), based upon their shared subject matter: the representation of the real-estate industry and the individual's connection to the wider social system. In Chapter 5, I compare Frank Norris' *The Octopus* (1901) to Richard Powers' *Gain* (1998), looking at their representation of corporate and economic systems, and in particular, the comparisons drawn between those systems and biological organisms. In Chapter 6, I compare Edith Wharton's novels *The Custom of the Country* (1913) and *The Age of Innocence* (1920) to Jonathan Franzen's *The Corrections* (2001), addressing their shared representation of a complex private or domestic sphere, explored both in terms of individual consciousness and of interdependent familial relationships.

Section 3 suggests possible future directions for the systems-aware novel and addresses its connection to the recent rise of environmental fiction. In Chapter 7, I look at

bird migratory systems as a trope used to highlight a number of environmental issues including climate change and habitat depletion. The novels featured in this chapter are Richard Powers' *The Echo Maker* (2006), Jonathan Franzen's *Freedom* (2010) and Teju Cole's *Open City* (2011). Chapter 8 investigates swarm systems, particularly insect swarms, and how they are used in recent fiction to highlight the agent-based and emergent nature of systems in the natural and human world. Swarms are also used to represent environmental problems in the wider biosphere, notably climate change. The texts featured in this chapter are E.O. Wilson's *Anthill* (2010) and Barbara Kingsolver's *Flight Behaviour* (2012). In Chapter 9 I look at novels which consider what the world would look like without complex systems. I question whether novels which focus upon the destruction rather than the emergence of complexity can still properly be termed systems-aware novels. The texts featured are Cormac McCarthy's *The Road* (2006), Tom LeClair's *The Liquidators* (2006) and David Vann's *Caribou Island* (2011).

The history of the novel as a form has been influenced, in ways that haven't yet been documented, by various system concepts. For example, while the nineteenth-century novel's treatment of the city has been the subject of extensive research, few, if any, have noted that authors at that time frequently thought of cities in systems terms and that this outlook influenced the way in which they wrote about modernity, urbanization, immigration, and so on. The influence of systems theory upon a number of mid-twentieth-century novels was pursued by Tom LeClair in 1987, and I will examine this work in more detail in Chapter 1. However, my aim in the chapters that follow is to expand our understanding of the systems novel in both its nineteenth and twenty-first century versions, and to revise and update LeClair's formulation in order to demonstrate that systems-awareness and the science which underlies it have changed significantly since the 1980s. In this thesis I argue that both literary realism and the conceptual paradigm of the system are not only essential to understanding the nineteenth century novel, but are

also central to 'post-postmodernism' as an emerging genre.[5] I suggest in Section 3 that systems-awareness in the twenty-first century is part of a larger ecological turn which has gained significant momentum in the last thirty years. All systems-aware fiction, but particularly that produced in this period, has a social and environmental purpose: to reorient the perception of the reader from the individual to the collective, and thus encourage them to think contextually about their position within the biosphere.

[5] For perspectives on the diversity of 'post-postmodern' literature and the varied interpretations of the term, see Hoberek and McLaughlin. In *Jonathan Franzen at the End of Postmodernism*, Burn gives a detailed account of the term's origins and evolution: from an early ironic usage in the mid-1970s, denoting the "fashion-driven need for new terminology" (17), through to its more serious acceptance as a critical term in the 1990s (18). Outside the field of literary criticism, first usage of the term *post-postmodern* is generally attributed to architect, Tom Turner, and his work, *City as Landscape: A Post-Postmodern View of Design and Planning* (1996).

Section 1: Complexity and Narrative

Chapter 1: The Return of Literary Realism

In his introduction to *The New Journalism* (1973), Tom Wolfe predicts that the future of the novel will be characterised by a highly detailed realism based on reportage. He restates this claim in "The Billion-Footed Beast" (1989), arguing that the new realism will be "more thorough than any currently being attempted" and will "portray the individual in intimate and inextricable relation to the society around him" (50). The project of the 'social novel' is usually considered to be a nineteenth-century endeavour.[6] However, in this later essay, subtitled "A Manifesto for the New Social Novel", Wolfe claims that detailed social realism is also the novel's future. What he calls for, and what he claims that America has lacked since the advent of postmodernism, is a contemporary Dickens or Zola who will demonstrate through fiction "the influence of society on even the most personal aspects of the life of the individual" (51). His suggestion here is, in effect, that the future of fiction involves a return to nineteenth-century literary techniques (mimetic realism and detailed social reportage) and corresponding thematic concerns (the relationship between the individual and society as illustrated in the social novel). The novel must be a form of social explication and critique, and that, for Wolfe, can only be conducted within the form of the social novel and by means of the techniques of mimetic realism. Wolfe claims that though "the status structure of society has changed" since the nineteenth century, "it has not disappeared", and that as a result of its continuing influence upon character, the techniques used by writers such as Thackeray, Dickens and Zola have "never been more essential in portraying the innermost life of the individual" (51).

The systems-aware novel bears a close resemblance to the nineteenth-century social novel in that both forms are concerned with the influence of society upon the individual and seek to document the complex processes by which they shape each other.

[6] The first use of the term *social novel* is generally attributed to Louis Cazamian in *Le Roman social en Angleterre* (1903), translated into English as *The Social Novel in England, 1830-1850*. See also the chapter on "Industrial Novels" in Raymond Williams' *Culture and Society 1780-1950*.

In this chapter I set out my case for systems realism as a significant post-postmodern paradigm which eschews the overt experimentalism typically associated with postmodernism and asserts continuity with nineteenth-century realism and naturalism.[7] Like the social novel, or 'social problem novel', systems-aware texts are motivated by social and environmental concern and seek to inform and shape the opinions of their readers. After addressing the issue of periodization, I move on in the second part of this chapter to an assessment of the difficulties involved in any realist portrayal of systems. First, I suggest that there are problems caused by the increasing complexity of globalized society, which, along with advances in science and technology, has begun to change our perception of what constitutes 'the real'. Secondly, I contend that there are a number of potential areas of conflict between system structure and the form of a written narrative. I conclude the chapter by suggesting how authors might begin to resolve these tensions.

Wolfe's claim that no "big realist novels" were written about important social issues of the 1960s and 70s may be overstated. In the latter half of the twentieth century there was, however, as Wolfe suggests, a tendency for some postmodern novelists to retreat to the "timelessness" of myth, and for characters "named H or V or K or T or P" to conduct their business within some "nameless, elemental terrain – the desert, the woods, the open sea, the snowy wastes" (49). The few decades since 1989, however, have seen a resurgence of realism(s), leading Patrick O'Donnell in *The American Novel Now* (2010) to state with confidence that "literary realism […] is alive and well in the turn from the late

[7] While in *The Art of Excess* (1989), Tom LeClair refers to systems novelists as "our new, scientifically and aesthetically sophisticated naturalists" (17), he more frequently alludes to them as "re-moderns" (17) or "inheritors of modernism" (*Loop* 10), in order to stress similarities of theme (process, simultaneity, uncertainty) and form (stream of consciousness) between systems novels and modernist works. However, my definition of what constitutes systems-aware fiction differs significantly from LeClair's, and, as such, while noting that the comparison has been made, I do not propose to explore the connection with modernism at this time. Briefly, I would suggest that modernism's response to disorienting and overwhelming changes in complexity was to turn inward towards an exploration of individual consciousness. Contemporary novelists, however, stress the importance of continued, though necessarily contingent, social engagement. While modernism stresses alienation, fragmentation and post-war scepticism about the existence of a coherent global pattern of order, post-postmodern systems fiction is broadly optimistic about our ability to access, comprehend and narrate the complex structure of the real.

twentieth century to the twenty-first" (36). Recent criticism suggests that naturalism is also a resurgent force within contemporary fiction. Keith Newlin begins his introduction to *The Oxford Handbook of American Literary Naturalism* (2011), by stating that "the continuing presence of naturalism" can be seen in the fiction of Don DeLillo and Cormac McCarthy, authors whose work I discuss in later chapters as examples of systems realism (3). In *The Cambridge Companion to Cormac McCathy* (2013), Eric Carl Link also refers to McCarthy as a "prime example" of "new or contemporary literary naturalism" (154). Defining naturalism as "a set of preoccupations that persist – albeit in ever changing ways – to this very moment", Link suggests that a number of features or conventions associated with naturalism may be found in McCarthy's fiction, including a sustained exploration of the relationship between individual agency and determining economic, social and biological environments (154). While such criticism suggests that contemporary authors such as McCarthy and DeLillo are writing in the naturalist tradition, in the following chapters I suggest that these novelists should properly be termed systems realists: 'realists' to suggest, in part, their continuity with or return to nineteenth-century themes and techniques, and 'systems' realists to identify the influence of contemporary systems science upon that realism.

Talk of postmodernism's "waning influence" or "decline" has become commonplace in recent years, though as yet there is no consensus on what has or will supersede it as a dominant literary movement (Hoberek 237). As Andrew Hoberek points out, "postmodern techniques – even if they no longer play quite the dominant role they once did – have hardly disappeared from contemporary fiction" (256). There is, however, a sense in which the self-reflexive play associated with high postmodernism "no longer provides a self-evident organising principle for recent writing" (237). As authors turn to social documentation, they are also retreating from some of the more challenging metafictional aspects of postmodernism. While some contemporary authors continue to experiment with narrative form, a significant trend within what we might term 'post-

postmodernism' is the re-emergence of a kind of 'straightforward' realist representation within which we also find the renewed expression of social, political and environmental concerns, and the increased use of specialist (often scientific) discourse.[8]

Positing a post-postmodern return to realism is, however, complicated by the fact that realism never really went away. Though Wolfe claims that "by the 1970s there was a headlong rush to get rid of not only realism but everything to do with it", Hoberek suggests that in the period from 1950 to1980, "postmodernism – and in particular the form of postmodernism defined around self-conscious literary experimentalism – was not the only or even always the dominant player on the literary field" (236). Instead, literary fiction was "characterized by the coexistence and frequent commingling of high postmodernist experimentalism, traditional realism, and an autobiographical strain related to both women's writing and the memoir" (236).

Just as traditional realism extended into the postmodern period, we might say that postmodernism was anticipated within an earlier predominantly realist or pre-postmodern period. There are eighteenth- and nineteenth-century texts – Laurence Sterne's *The Life and Opinions of Tristram Shandy, Gentleman* (1759) is the most obvious example – which engage in the kind of self-reflexive play associated with postmodernism. Any references made to a neat sequence of discrete periods, therefore, must necessarily be partial and subject to exceptions, as is noted by Fredric Jameson in *Postmodernism, or, the Cultural Logic of Late Capitalism* (1991). Jameson writes that: "the various preconditions for a new 'structure of feeling' also pre-exist their moment of combination and crystallization into a relatively hegemonic style everyone acknowledges" (xix). Thus we might argue that any and all features of postmodernism "can be detected, full-blown, in this or that preceding

[8] Others have characterised post-postmodernism in terms of a return to or restatement of literary realism. Rebein sees post-postmodernism as a "revitalization of realism" (7). McLaughlin notes that contemporary authors are attempting to "reconnect language to the social sphere" ("Post-postmodern Discontent," 103). Kelly sees a "new sincerity" in recent fiction (54).

modernism" (4).[9] In "Re-Writing Modernity", Lyotard similarly claims that "neither modernity nor […] so-called postmodernity can be identified and defined as clear-cut historical entities" and that the "postmodern attitude is […] implied in the modern" (3). Literary periodization is clearly problematic; nevertheless, literary forms do change over time and generalizations about such shifts are to some extent inevitable. The debate over the nature of 'Romanticism' or 'the Renaissance' suggests that periodizing terms continue to be useful, and this is equally true of terms such as 'realism', 'naturalism', 'modernism', 'postmodernism' and, perhaps, of course, 'post-postmodernism'.

Those critics trying to define the post-postmodern have frequently noted that social concerns are becoming increasingly evident in recent fiction. In a section of *From Modernism to Postmodernism* dedicated to defining the post-postmodern, Gerhard Hoffmann suggests that "the scenario of the typical contemporary American novel (if there is such a thing) is defined by the recovery of [...] the social environment and often the reintroduction of social criticism" (844). This return to realism is partly prompted by a renewed desire for social engagement. As global issues of terrorism, war, economic crisis and climate change have entered the American collective consciousness in the last few decades, many authors have been inspired to re-engage with social, environmental and political events. For example, in their introduction to *Literature After 9/11* (2008), Ann Keniston and Jeanne Follansbee Quinn reflect upon the "highly varied and ever-growing range of literary responses" to '9/11' as both a set of historical events and as a symbol (2). This "new body of literature", which includes novels by Don DeLillo, Philip Roth, Claire Messud and John Updike, attempts to represent, interpret and respond to the events which occurred in New York City on September 11th, 2001 (3). Keniston and Quinn argue that initial feelings of shock and bewilderment following the day's events "generated a culture-wide need for explanatory narratives […] prompting [literary] attempts to place

[9] For Jameson, however, modernism and postmodernism remain distinct modes because of "the very different positioning of postmodernism in the economic system of late capital" (5).

9/11 into an historical framework" (3). The recent global financial crisis has also been the inspiration for a number of recent novels, including Jonathan Dee's *The Privileges* (2010), Adam Haslett's *Union Atlantic* (2010), John Lanchester's *Capital* (2012) and Alex Preston's *This Bleeding City* (2010).[10]

This movement towards social engagement is seen by some, including Robert L. McLaughlin, as a response to the declining influence of postmodernism. McLaughlin suggests in "Post-postmodern Discontent", that "many of the fiction writers who have come on the scene since the late 1980s seem to be responding to the perceived dead end of postmodernism, a dead end that has been reached because of postmodernism's detachment from the social world and immersion in a world of nonreferential language" (103). He writes that the "aesthetic sea change" of post-postmodernism is "inspired by a desire to reconnect language to the social sphere or […] to reenergize literature's social mission" (103). Despite this accusation that postmodernism lacked social engagement, many postmodern texts from the 1960s, 70s and 80s were influenced in some way by the conflict in Vietnam, the civil rights movement, or escalating Cold War tensions. For example, Joseph Heller's *Catch-22* (1961), Kurt Vonnegut's *Slaughterhouse-Five* (1969) and Thomas Pynchon's *Gravity's Rainbow* (1973) use pastiche, self-reflexivity and the absurd to satirise and critique twentieth-century warfare. The response of experimental postmodern texts to these stimuli was different from that of the realists which preceded them. McLaughlin acknowledges that postmodernism did not rule out the possibility of social engagement, but that it instead attempted to reconceptualise the manner in which we saw our ability to access and define the real. He writes that "postmodernism made the process of representation problematic; it foregrounded literature pointing to itself trying to point to the world, but it did not give up the attempt to point to the world" (115). The change involved in the move towards post-postmodernism, therefore, is for McLaughlin a

[10] See Alger, also Mason. The recent wave of financial crisis fiction reflects concerns also expressed in late nineteenth century fiction. See Zimmerman for an account of financial crises in American fiction from 1890-1910.

question of “emphasis”. Post-postmodern writers are said to be less concerned with metafictional techniques and more concerned with “representing the world we all more or less share” (115). For McLaughlin, therefore, this change of emphasis implies increased faith on the part of novelists in the ability of language to accurately represent the world, even though that world is increasing in complexity. This belief is necessarily tempered by the legacy of the postmodern period, since “this fiction nevertheless has to show that it is a world that we know through language and layers of representation” (115). Authors cannot simply return to the mimetic realism which characterised much nineteenth-century fiction; having now lived through the postmodern period we cannot forget the challenge which it made to notions of absolute truth and authenticity. There is, however, a renewed belief in the power of realism as a method of representation.

Fiction has always responded to large-scale social changes and to the events that precipitated those changes. The nineteenth century in particular saw a surge in social problem fiction such as Dickens’ *Hard Times* (1854), Elizabeth Gaskell’s *North and South* (1855) and George Eliot’s *Felix Holt* (1866) which explored the rise of industrial capitalism and the harmful effects which these economic and social changes had upon the individual. However, due to processes of globalization the world today is more fast-paced and interconnected than ever before, and this enhanced complexity presents increased challenges for the social novelist. Brian Castellani claims that western society is becoming increasingly ‘complex’, by which he means “more interdependent and inter-reliant, much faster and chaotic […] much more quickly impacted globally by localized change, and […] more difficult to manage as a system” (23).The recent arrival of the internet, social media and twenty-four-hour news broadcasts, for instance, mean that events and the way in which we experience them are being shaped by global networks in a way that is without precedent.

New information and communication systems are not the only systems influencing fiction today. While globalization has changed the way in which we perceive ourselves as

individuals, other changes in perception have been brought about by recent developments in the sciences. The transition from psychological to neurological explanations of brain activity witnessed in the latter half of the twentieth century has given rise to the 'neuronovel', at the heart of which is a neurological realism which sees mind or consciousness as an emergent property arising from the chemical interaction of a multitude of neurons.[11] In "Rise of the Neuronovel", Marco Roth critiques Ian McEwan's portrayal of neurological realism for its alleged return to or restatement of "Zola-esque naturalism". Roth argues that in producing a purely physical explanation of 'mind', so-called 'neuronovels' reduce free will to "stark biological determinism". However, while neurology provides a physical explanation of consciousness, it still perceives the self to be a product of nurture as well as nature. Environmental influences combine with genetics to make the individual 'more than the sum of its parts'.

Recent developments in climate science are also frequently represented and explored in recent fiction. With the responsibility for climate change placed increasingly upon humanity, we are now encouraged to see ourselves as part of larger, interconnected ecosystems in which the carbon emissions created on a small scale at a local level may have a terrible collective effect upon other people and other species. Though contemporary fiction's return to realism is inspired by the need to engage with real life events, our perception of what constitutes 'the real' and therefore what constitutes 'realism' has changed. Increasingly, we see ourselves as systems involved in complicated relationships with other systems, and as such, realist representation becomes measured against the scientific account of systems which has diffused into the wider culture. The contemporary reading public is more scientifically aware than ever before, and this places a new burden of responsibility upon the fiction writer who seeks to communicate some truth about reality. Contemporary novelists are more frequently creating a scientifically-informed realism which bridges the gap between C.P. Snow's 'two cultures', a realism

[11] For a fuller discussion of the 'neuronovel' or 'cognitive fiction', see Roth, Lustig and Peacock, and Tabbi.

which is based upon a vision of systems as ordered, yet complex and difficult to represent.[12] Reality is becoming more overtly systemic, and the nonlinear structure of these systems, as well as the extensive ways in which they have altered our lives, makes the task of today's social novelist especially difficult.

I engage with the specific representational challenges posed by the nonlinear structure of systems shortly; however, before a detailed discussion of form, I turn now to an exploration of how perceptions of reality as systemic have influenced writers in making those formal choices. The increasing complexity of society has resulted in fears that narrative will not be able to keep pace with social developments. In his essay "Why Bother?" (2002), Jonathan Franzen laments the inability of recent literature fully to engage with the complexity of contemporary society. Franzen's suggestion is that reality, now characterised by vast and rapid social change, has outpaced the contemporary social novel. He argues that the task of social documentation now belongs to the faster, more vivid and immediate televised media, and that "the big, obvious reason for the decline of the social novel is that modern technologies do a much better job of social instruction" (65). His fear is that the novel of social reportage has been rendered obsolete, with only a constantly evolving televised and online journalism now standing any chance of matching the accelerating and disorienting pace of social change. In spite of the challenges facing contemporary novelists, however, novels continue to be produced. Writers may occasionally despair about the scale and complexity of the challenges facing them, but all the evidence suggests that they continue to grapple with those challenges. Franzen himself went on to write *Freedom* (2010), which reviewers have defined as a large social novel in the style of the nineteenth century. I discuss this novel in some detail in Chapter 7.

If post-postmodern texts are aiming for a highly detailed realism which portrays

[12] For an account of the supposed "gulf of mutual incomprehension" between the sciences and the humanities see Snow 4.

with scientific accuracy the action and interaction of various systems, the kind of literary techniques employed will depend to some extent on whether we believe those systems to be ordered or chaotic. Though I have so far contended that a return to realism involves a movement away from metafictional techniques, not everyone agrees that high postmodernism failed to engage with the real: Terry Eagleton has suggested an opposing perspective, that postmodern writing could itself be termed realistic, perhaps more so than novels with clearly defined plots and well-rounded characters, "in the sense of being faithful to a surreal world of surfaces, schizoid objects and random sensations" (10). The appearance of a text which aims to engage with real-world systems will depend on whether the author believes that complex systems like cities or brains have a hidden pattern of order that can a) be perceived, and b) represented within narrative, or whether instead such systems are surreal, schizoid and random. Broadly speaking we might say that authors who turn towards traditional realism believe that the world possesses a hidden structure of order, meaning and value, which, though inaccessible to the individual, is available at the macro-level perspective of the whole, and is thus ultimately narratable and communicable. Those who turn to highly experimental narrative techniques, however, tend more towards a perception of reality as being fundamentally chaotic; exhibiting activity which is random, wholly unpredictable and thus without meaning in any traditional sense. In my view, therefore, novels which display systems-aware realism suggest that social reality is complex, but not necessarily random or chaotic. Wolfe, writing in 1989, stated that:

> American society today is no more or less chaotic, random, discontinuous, or absurd than Russian society or French society or British society a hundred years ago, no matter how convenient it might be for a writer to think so. It is merely more varied and complicated and harder to define. (51)

Contemporary realist authors who adopt a systems perspective also take this view of

reality as complicated, but not chaotic. As a collection of complex living systems, society is poised at the border region known as the 'edge of chaos' which divides fixed, closed systems (which are highly ordered and predictable) from chaotic systems (displaying no visible order). No individual can possess total knowledge of the complex social system within which they exist, and this may give rise to the perception that reality is chaotic, yet the system does possess an ordered structure, albeit an adaptive one which is never in stasis. In addition, change within such systems is often unpredictable. All of this creates obvious problems for realist representation. Society might not be any more random or chaotic than a hundred years ago but its increased complexity (the interconnections between different systems) makes it, in Wolfe's terms, more "complicated" to represent in fictional terms, and also "harder to define" (51).

Experimental postmodern fiction captures something important about our feelings of bafflement and disorientation in the face of large, globalized systems. However, contemporary authors are now turning to realism, informed and shaped by the influence of complex systems science and advancing computer technology, to convey a cautious optimism about our ability to comprehend and represent real world systems. In his entry on post-postmodernism in *The Routledge Companion to Experimental Literature*, Robert L. McLaughlin notes that post-postmodern authors, having learned the lessons of postmodernism – that "truth is contingent" and "representation is self-referential" – nevertheless continue to attempt representation of the real (222). Rather than despairing in the face of partial knowledge of the world, these authors advocate positive engagement and are committed to "an ethical and productive knowledge" (222). McLaughlin writes that for post-postmodern writers, the key issue is how to respond constructively to the disorientation produced by the experience of complexity:

> Where postmodernism embraced the uncertainty within totalizing systems' claim to truth, post-postmodernism takes the uncertainty of epistemological systems for

> granted and explores instead what to do with it, how to live in the world with incomplete systems of knowledge, how various systems of knowledge can be linked together or embedded within one another to create a contingent but useful structure. (221)

In Section 3 I suggest that the issue of "how to live in the world with incomplete systems of knowledge" is a specific concern of recent environmental systems-fiction, which takes as its subject the issue of how we can begin to combat global climate change when we cannot fully understand the process or its multiple causes.

As I promised, I now return to the specific formal challenges involved in narrating complex systems. In the first half of this chapter I suggested that, partly as a result of globalization, social, information and economic systems are becoming more complex, since they are frequently larger, more widely distributed in space, more densely interconnected and unpredictable than ever before. I also argued that the way in which we perceive both ourselves and our connection to the environment is becoming more systemic in nature. My overall argument is that literary realism is still the most appropriate method for twenty-first century social engagement; however, it is apparent that our systems world poses significant challenges for realist representation, and in the following section I address this tension in more detail.

As the foregoing discussion has begun to make evident, the organizational structure of systems (as revealed by complex systems science) makes them difficult to represent comprehensively. Novelists must grapple with the issue of how a narrative read in a linear sequence which conforms to generally agreed laws of cause and effect can ever hope to represent the simultaneous and nonlinear activity of complex systems. They must also discover how best to reconcile a novel form that typically focuses upon one or few central protagonists with systems that contain billions of agents, especially when each of these agents may be of equal importance to system function. How best to represent the

'real' within fiction becomes increasingly problematic as the level of social complexity increases, along with our scientific knowledge of how that complexity is generated. These issues force us to question the logic of choosing a traditional realist form to represent nonlinear complexity. Taking up Eagleton's suggestion and playing devil's advocate for a moment, I pose the following question: would it not make more sense for contemporary authors to continue using the experimental narrative techniques of high postmodernism in order to achieve a 'true' systems-aware realism? After all, postmodern literary texts have for decades experimented with chronology, narrative viewpoint and formal structure, thus suggesting alternative ways to begin narrating the complex. Gerhard Hoffmann argues that postmodernism aspires towards both nonlinearity and the presentation of simultaneity: features which I would suggest are important for a realistic depiction of systems (280, 304). Rather than trying to identify a 'post-postmodern realism', therefore, should we instead see postmodernism itself as the answer to the accurate portrayal of systems? I would suggest not, for reasons which I will now explain.

Within the last thirty years there has been a shift in the scientific community away from 'chaos' as a paradigm and towards the related paradigm of 'complexity'. Waldrop writes that the "peculiar dynamism" of complex systems is "a far cry from the weirdly unpredictable gyrations known as chaos" (12). While chaos is one example of emergent complexity, very few complex systems exhibit chaotic dynamics, being instead poised at the 'edge of chaos'. The movement towards complexity as a paradigm is characterised by an increased focus upon the emergence of large-scale order. While fractals or patterns of turbulence are "extraordinarily intricate", Waldrop writes that chaos theory alone cannot "explain the structure, the coherence, the self-organizing cohesiveness of complex systems" (12). Experimental metafictional texts frequently display all of the unpredictability and randomness associated with turbulence, but I would suggest that in order to engage with the large-scale cohesiveness of complex systems we need a realist novel that asserts the existence of a communicable (albeit complex) narrative order. The paradigm

shift in fiction from postmodernism to a post-postmodern realism mirrors this transition from chaos to complexity within the scientific community. Moving away from the concern with entropy and disorder found in high postmodern texts, complexity theory and systems realism are distinct in their focus upon open and adaptive living systems which locally reverse the second law of thermodynamics (displaying increasing rather than decreasing order).

If I am to justify my assertion that realism is just as capable, if not more capable, than postmodernism in engaging with the complexity of living systems, I must first address in more detail the potential conflict between narrative form and system function which authors must somehow overcome. Terry Eagleton has written that the novel is “an ironic, self-undoing genre” whose “form seems at odds with its content” (14). Drawing attention to a potentially problematic disjunction between the content of novels and their narrative form, he suggests that “in the modern age in particular […] human life seems less and less to have an inherent design to it”, thus rendering the formal designs imposed by fiction “implausibly artificial” (14). Another writer who acknowledges this disparity is the historian Hayden White, who suggests that “narrative becomes a problem […] when we wish to give real events the form of a story”, since the world does not “present itself to perception in the form of well-made stories, with central subjects, proper beginnings, middles and ends” (23). Instead, reality may appear “either as mere sequence without beginning or end or as sequences of beginnings that only terminate and never conclude” (23). White suggests that the dominance of narrative form in the recording of historical content “arises out of a desire to have real events display the coherence, integrity, fullness and closure of an image of life that is and can only be imaginary” (23). It is at least logically possible, then, that the structure of today’s complex reality may be incompatible with any form of narrative. Yet, nevertheless, we feel drawn to the kind of order that narrative offers us, and the novel as a form continues to have an enduring appeal to authors seeking some form of social engagement.

Frank Kermode suggests that "in making sense of the world we still feel a need, harder than ever to satisfy because of an accumulated scepticism, to experience that concordance of beginning, middle and end which is the essence of our explanatory fictions" (35). Though the linear progression of beginning, middle and end would seem to render a literary text in some respect incompatible with a scientifically 'realistic' portrayal of complex systems, to remove this sequence would rob readers of the mental anchors necessary to navigate them through the text. As Kermode suggests, to people who more than ever feel that they are born, live and die 'in medias res', such stories provide a sense of connection to something larger than the individual self. Judie Newman makes a similar point in *Fictions of America*, when she writes that "in the globalized world the human need for stability becomes more acute, and narrative becomes more essential as a means to tune worldly discourse into a coherent resonance, to help make sense of the world" (2).[13] Despite the formal difficulties involved in narrating the complex, post-postmodern authors are beginning to move beyond the self-reflexivity of metafiction towards a more outward-tending engagement with large-scale social wholes. Systems realism is generally less sceptical than postmodern writing about the ability of language to communicate truths about ourselves and the world; however, as I will now discuss, there are still a number of areas in which this ability is contested or disrupted.

If one looks in some detail at the different structures of systems and narratives, one area which immediately stands out as a potential source of tension is linearity and nonlinearity. Interactions in a complex system are nonlinear, both in spatial terms (the typical dynamic involves simultaneity and circularity rather than linear sequences) and with regard to causality. What nonlinear causality means in practice, as M. Mitchell Waldrop explains, is that within any complex system "under the right circumstances, the slightest uncertainty can grow until the system's future becomes utterly unpredictable" (Waldrop 66). This unpredictability is known within chaos theory as "sensitive dependence

[13] For more discussion of "resonance" in the context of globalization, see Harris.

on initial conditions" or, more colloquially, as "the Butterfly Effect" (Gleick 8).[14] Waldrop explains the effect of 'the butterfly effect' upon scientific research as follows: "researchers realised that the flap of a butterfly's wings in Texas could change the direction of a hurricane in Haiti a week later [...] or that a flap of that butterfly's wings a millimetre to the left might have deflected the hurricane in a totally different direction" (66). What this insight offered to complexity scientists was the realization that very simple agents and basic forms of interaction could, with the addition of nonlinearity, generate astonishingly complex behaviour. Causality in complex systems is also often circular, meaning that the "economic climate can feed back to shape the very buying conditions that produced it" (65). Attributing a direct linear chain of cause and effect is frequently impossible due to the highly interconnected and nonlinear nature of the system.

Most narratives, however, employ a linear form of causality and seem to be built on the assumption that effect follows cause in a proportionate and predictable sequence. Mieke Bal suggests that it is possible to attribute to the novel a "double linearity: that of the text, the series of sentences, and that of the fabula, the series of events" (81). In *Narratology*, he explains that the terms 'fabula' (designating an order of events) and 'sjužet' (the order in which events are narrated) originate with the Russian Formalists.[15] Though a text may disrupt the linearity of the sjužet, perhaps through the use of flashbacks or stream-of-consciousness techniques, we can normally still infer the existence of a linear fabula: "a series of logically and chronologically related events that are caused or experienced by actors" (Bal 5). Terry Eagleton also draws attention to this issue when he suggests that "narrative involves a kind of necessity, as cause and effect, action and reaction, are logically linked to each other" (16).

[14] Edward Lorenz was the first to identify chaotic dynamics in weather systems. He coined the term *butterfly effect* in the 1972 essay, "Predictability: Does the Flap of a Butterfly's Wings in Brazil Set off a Tornado in Texas?". For more on Lorenz and sensitive dependence, see Gleick.

[15] For an early discussion of 'fabula' and 'sjužet', see Propp.

The obvious exception to this kind of narrative linearity occurs in experimental postmodern fiction, which frequently disturbs not only the chronology of the narration, but also the idea that there is a logical sequence of events behind the story which we can uncover as part of the reading process. Hoffmann writes that "in the same way that postmodern writers shun depth, they also attempt to avoid linearity" since within linearity "lurk[s] unavoidable causal relations and the danger of closure" (283). Postmodern texts often disrupt causation, confound rational logic and dispense with plot, frequently displaying reaction out of all proportion to initial action and effects produced without first causes. Not everyone, however, agrees that realist texts are necessarily linear (and thus less able to engage with nonlinear complexity). In *Cognitive Fictions*, Joseph Tabbi contests the supposed linearity of both print texts and the reading process, arguing for a more complex understanding of their relationship. He suggests that:

> The celebrated nonlinearity of hypertext is in large part a literalization [...] of mental connections that readers learn to make, one way or another, when reading fiction or poetry in print. Through a kind of flickering or oscillating attention, such connections can easily take place across many pages, or within the space of a single phrase; they enable a poem or narrative to take shape in the mind of the reader, and this mental picture [...] is rarely congruent with the progressive continuity of lines following lines and pages stacked on pages through the course of a book. (121)

It certainly seems reasonable to suggest that all novels possess 'features' which do not accord with a linear plot progression. In *Narrative,* Paul Cobley suggests that "the progress of a narrative must necessarily be impeded […] must entail some kind of delay or even diversions, detours and digressions" (17). In addition, as Tabbi suggests, whatever the nature of the text itself, once the reading process has begun the novel becomes part of the reader's mind which is itself a nonlinear complex system (121). Thus, while experimental narratives may initially appear to reflect system structure more

accurately than a realist text, I suggest that realist novels, too, have strategies by which they can engage with nonlinearity.

While the joining together of a linear written text with nonlinear subject matter may provide a site of tension or disjunction, there are additional conflicts which present even greater challenges to the systems-aware novelist. H. Porter Abbott argues that systems cannot accurately be represented in narrative due to their particular agent-based structure. In “Narrative and Emergent Behaviour”, he suggests that the behaviour manifested by complex social systems is a “form of action […] without any discernible sequence of events, that is, without a story” (233). As stated previously, in any novel, but especially in a realist text, cause and effect, action and reaction, tend to follow each other in a logical sequence and proceed in a linear fashion through time. Abbott, however, argues that systemic action is lacking in sequential defined events. Additionally, in a novel, there will usually be a character or small group of characters who are the main focus of our attention from beginning to end. Their lives are essential to the plot: individually they cause events to happen, driving the narrative’s internal conflict, and without them there would be no story to tell. As Abbott suggests, however, complex systems are characterised by “a massive distribution of cause among agents, all of which interact in some degree by chance, and each of which lacks any preeminent role in the emergent behaviour of which it is a part” (233). Though agents indirectly or collectively ‘cause’ the emergent behaviour to happen, it does not result directly from any individual intention. Agents interact primarily on a local level, often through chance collision, and generally speaking, there is no design or plan on the part of the individual to directly impact the whole (the obvious exception being individuals wielding political or ideological power within certain social systems, and even in this case system behaviour is unlikely directly to reflect the nature of the intention). For example, an ant colony’s ability to evade predation or flood is something which cannot be directly attributed to the action or intention of any particular ant: no individual ant alone ‘causes’ the colony to adapt to its

environment.

Abbott also sees a potential conflict between a system's agent-based structure and the role of characterization in the novel. Individual agents within a complex system have only a limited importance, because most agents can be replaced. A system can continue to exist long beyond the death and replacement of each and every one of its individual agents. John H. Holland illustrates this point when he writes that systems are constituted by "patterns of interaction that persist despite a continual turnover in the constituents of the patterns", the most striking example of this being the human body which "turns over all of its constituent atoms in less than two years" (Holland 7). A novel, however, rarely sees the total replacement of its cast of protagonists. In addition to a lack of sequential action and defined protagonists, Abbott's suggestion that complex systems are unnarratable also stems from his view that systems continually change their structure whilst narratives involve fixed forms. In Abbott's opinion, narratives are able to present static images of the different levels within a particular system, for instance a visual description of a crowd (macro-level) or a particular individual within a crowd (micro-level), but they cannot with any degree of realism represent the massively distributed and nonlinear process by which individual behaviours relate. As a result of this disparity between the way that systems and plots function, and the differing role of chance and agency in each, Abbott goes as far as to argue for the "incompatibility of emergent behaviour with narrative" (227); in his opinion "emergent behaviour is by definition unnarratable" (233).

Since most novels choose to focus on a few individuals, who constitute only a fractional number of the agents within a social system, the focus of the text is often restricted to the micro-level view of system function. If a novelist chooses to attempt the macro-level view, the focalization used must move beyond the consciousness of those characters and into a more disembodied, omniscient narrative perspective reminiscent of the kind used frequently in nineteenth-century texts. However, critics such as Ursula

Heise have criticised the use of all-knowing narrators in contemporary fiction, suggesting that their use is incompatible with realist representation since our knowledge of systems today can only ever be partial and incomplete. Richard Powers' novel *Gain,* a systems realist text, juxtaposes the growth of a corporate system, Clare International, against the growth of cancer in an individual, Laura Bodey. Powers attempts to narrate the growth of corporate selfhood in the form of a biography because his aim is to present corporations and people as analogous and interconnected complex systems. By drawing comparisons between biological and non-biological systems, Powers is able to examine the connections between individuals and the larger systems which structure their lives.

In an essay which reads *Gain* in the light of risk theory, Ursula Heise criticises the formal aspects of the text for not adequately matching what I would term the level of systems realism in the novel's content. Heise writes that: "the novel's formal accomplishment lags behind its conceptual formulation" since "while *Gain* portrays with astonishing conceptual sophistication individuals' inability to resist or even comprehend the worldwide networks that entangle them, its narrative structure does not in the end offer a persuasive formal correlative for this approach" (769). The source of Heise's dissatisfaction is that Laura Bodey's feelings of powerlessness and bewilderment in the face of both her cancer and its potential causes are not reflected in "the self-assurance of the [omniscient] narrator's command of the global" (773). Unlike Burroughs or Pynchon, who Heise claims "persistently refuse to reassure their readers that they, after all, can grasp this world with the help of omniscient narrators and realist narration", the challenges to system perception which Powers articulates are in her view "not translated into any disturbance in the reading process" (772). For Heise, realist narration equates to full knowledge and control of material, as well as a certain transparency and clarity of transmission, whereas reality (our real world perception of systems) is one of confusion, anxiety and lack of either full knowledge or control. What she is arguing here is that the macro-level view of the corporation and the micro-level view represented by Bodey's

experiences sit *too* comfortably together. In effect, what Heise wants is a representation not of complexity, but of our bewilderment in the face of complexity. As I stated previously, however, contemporary novelists such as Powers display a cautious optimism about the ability of realism to 'master' the representation of systems. Though complex systems frequently frustrate our attempts at understanding, systems realism is not inherently pessimistic about our ability to overcome the aforementioned representational challenges and thus accurately narrate system activity. While it is not always possible to represent systems at the level of realistic mimesis because of their nonlinear, distributed structures, systems realism asserts that it is nevertheless possible to model their behaviour in narrative using insights gained from analogy. I discuss the role of analogy and model construction in more detail in the following chapter. While models are not a direct reflection of reality as we perceive it, they serve a useful educational purpose, enabling us to understand that reality in greater detail.

While postmodern texts depict our disorientation in the face of systems, it is systems realism which most accurately represents our attempts to engage with them constructively. As I explain in the following chapter, complexity science, too, seeks to understand complex systems through analogy and model construction. In postmodern texts, disruption of narrative sequence can all too easily become fragmentation and systems too often close in upon themselves. Meaning is thus frequently not only problematized but lost entirely. Hoffmann suggests that since postmodern texts often exclude the "past and history as structuring forces of time", the reader is often left within a series of simultaneous present moments or possible worlds which "by abandoning [...] causality and finality" leads toward a disconcerting sense of "incompletion and limitlessness" (297). In contrast, systems theory retains the importance of history within analysis, since all complex (and thus adaptive) systems are influenced by their past states as well as current environmental inputs (Cilliers 3, 92,122). If characters become reduced to a series of simultaneous present moments then development becomes impossible; we

are left with the sense of a narrative which, confirming Abbott's suggestion, can convey fragments of the whole – static images of various system levels for example – without the ability to show how they integrate and co-evolve. But this, in my view, is precisely why we need realism. We need to be shown relationships between part and whole in order that we might begin to understand emergence and other aspects of system function. In *Gain*, Powers applies the format of a *Bildungsroman* to the story of a new kind of individual: the corporate system. This formal choice adds weight to Wolfe's assertion of the continuing relevance of nineteenth-century literary forms within contemporary fiction. Clare (the corporation) and Laura Bodey are presented not only as analogous individuals but also as analogous systems. In illustrating the extent to which Laura's identity is also corporate, the process of integration and co-evolution between individuals and corporations which has occurred over the last century is foregrounded. Parallel life stories are made to interweave into a single narrative system. Though it is not possible for a single individual to possess total knowledge of the systems that they live within, it is possible for the novel form, which encompasses and contains those systems, to provide the reader who is standing on the outside with increased knowledge and understanding of the whole.

The presentation of simultaneity is perhaps the most crucial strategy for any novel's engagement with complexity, since complex systems are networks of "many 'agents' acting in parallel" (Waldrop 145). Hoffmann highlights the fact that the "metafictional reflection" of postmodern texts "aims at and attains simultaneity by juxtaposing different discourses and by interrupting and slowing down the flow of time" (317). However, attesting to the relevance of nineteenth-century forms to the realistic depiction of complexity, the complex simultaneity of social systems is also represented particularly well within the form of the nineteenth-century social novel. Through the use of multiple protagonists or narrators, parallel and unconnected narrative lines, or simultaneous subplots which occasionally diverge before veering off on their own trajectories, novels such as George Eliot's *Middlemarch* (1871-2) show what might be

called a pre-systems awareness of the multiplicity and interconnectivity of complex social networks. Post-postmodernism's return to realism, therefore, frequently involves some kind of engagement with nineteenth-century forms.

The presentation of simultaneity is not only a useful technique for narrating the complex, it is also an indication of the way in which the realist novel is itself a complex form. The structure of those social novels which foreground simultaneity actually mirror in some sense the structure of complex social systems which they represent, since they both present emergent forms of community. I address the similarities between the structure of novels and systems in the following chapter and ask whether we are justified in viewing the novel itself as a form of complex system. If we look back at the history of the social novel, its extensive use of simultaneity led theorists to compare its structure to social systems such as the 'community', the 'city' or the 'nation'. The structural similarity between social systems and novel form is alluded to in *The Rise of the Novel,* in which Ian Watt suggests that "the world of the novel is essentially the world of the modern city" (192). Similarly, in *The Country and the City*, Raymond Williams suggests that "most novels are in some sense knowable communities" in that their characters are known through their relationships with one another (14). In *Imagined Communities*, Benedict Anderson suggests that the factor which links literary characters that are presented as existing simultaneously, yet unknowing of each other is that "they are embedded in 'societies'" (23). Societies are peopled with individuals whose concept of nationhood is based upon the imagined "steady, anonymous, simultaneous activity" of other individuals, and thus Anderson argues that the structure of the social novel (and the nation) can be summarized as "a complex gloss upon the word 'meanwhile'" (25).

This concept of individuals connected synchronically in time could in Anderson's view "only arise historically when substantial groups of people were in a position to think of themselves as living lives parallel to those of other substantial groups of people" (188). Therefore, in this respect, the ability to narrate complex and nonlinear relationships

between individuals existing in simultaneity only came into being with the advent of the nineteenth century's complex (urban) social system. Gerhard Hoffmann makes a similar point in *From Modernism to Postmodernism,* when he writes that:

> The growing complexity of the world in the nineteenth century [...] brings about within the novel a multiplicity of persons, plots, places, and even times, a phenomenon that intensifies emphasis on parallelism and juxtaposition and leads therefore to [...] a foregrounding of simultaneity. (355)

In this chapter we have seen that systems realism offers one possible solution to the question of what comes after literary postmodernism. I have claimed that that in the future, the realist novel is likely to be characterised by increasing levels of systems-awareness as, motivated by social and environmental concern, authors attempt to reengage with representation of the world we all share. At the same time, this new form of post-postmodern realism involves a partial return to nineteenth-century forms and concerns. The similarities between the fictions of these two periods can be partially attributed to the occurrence of similar surges in social complexity which authors have then sought to address in fiction.

As we have seen, systems provide challenges as well as inspiration to writers; their structures are complex, nonlinear and recursive. What it means to represent them with any degree of accuracy is complicated by the fact that much about the way they function is still unknown. In the following chapter, I suggest that systems realism responds to the representational challenges associated with systems by the creation of fictional models. These models, comparable in their mode of function to the simulations created by systems scientists, use reciprocal analogy to communicate information about system function that is not directly available, either to our perception or to traditional mimetic realism. Systems science has had an influence both on the kind of fiction that is being produced today and the way in which we attempt to analyse that fiction. At the heart of

current research into complex systems is the Santa Fe Institute, whose history and research programmes serve as the basis of the next chapter. What they and other similar research institutes are discovering about social, biological and information systems will have a profound impact upon how we view fiction's project of realist engagement in the years to come. In the next chapter I accordingly address the growing influence of complex systems science in recent decades, both inside the scientific community and amongst the general public, and I explore how this concern is finding expression within contemporary literature, as well as documenting the recent critical response.

Chapter 2: Complexity Science and Literary Systems

In the previous chapter I suggested that our view of the world has become more overtly systems based in the last few decades, by which I mean that within a whole range of spheres, from science, politics and economics through to the arts, there is a growing emphasis upon concepts such as global wholes, connectivity and the interdependence of parts. While this emphasis upon systemic properties is not a new phenomenon – I address this issue in more detail in Chapter 3 – there are a range of factors which make the period from 1980 to the present day more receptive to systems thinking than the earlier part of the twentieth century. The rise of the internet, social networking and twenty-four-hour news broadcasting has altered the way that individuals perceive themselves and their relationships with others. We are clearly more 'connected' than ever before, and the general public more easily perceives that interactions between individuals, companies and nations involve global ties of interdependence. Beyond the influence of globalization on the contemporary world-view, recent scientific advances have also reoriented our perception of systems. Neurological readings of the brain have suggested that the self is the emergent product of a large number of interacting and interdependent physical parts, and climate science has stressed the connection between collective human activity and global temperature.[16]

The most significant factor involved in the rise of systems thinking (and systems fiction) in this period has been the establishment of complexity studies as a defined area of scientific research. In this chapter I have a number of objectives. I outline distinctions between two waves of systems science, and suggest the extent to which they have been influential in the development of systems realism. In particular, I focus upon the Santa Fe Institute as an influential centre of second-wave systems thought, and explain how it (and

[16] While the explanation of brain activity in terms of interacting neurons is not specific to the post-1980 period, such readings have been particularly influential during this time, especially within literature. See Lustig and Peacock, Roth and Tabbi.

its most famous resident, Cormac McCarthy) have been responsible for spreading knowledge of complexity to a non-scientific (and specifically literary) audience. I then move on to engage with criticisms of complexity science as a discipline, as this necessarily has some bearing upon the perceived explanatory power of systems fiction. In the final part of the chapter I situate my proposed genre of 'systems realist' fiction within wider literary and scientific contexts and thus show the various points of intersection between literary and scientific systems-thought in the post-postmodern period. I address how literary criticism has so far utilized system science as part of its inquiry, and the extent to which others have recognised that authors use system concepts in their fiction. I also look at alternative ways to analyse novels using systems theory. I suggest that, rather than looking at a novel's representation of systems (its content), it is also possible to take a higher level perspective and address the book, the genre or the language as a self-organizing and adaptive system. I look to Bakhtin's writing on discourse and the novel in order to provide an example of how, prior to the establishment of systems science, the novel was considered a system for the representation of other systems.

Though, as I explain in the next chapter, we can trace the history of systems thinking back to the nineteenth-century discourses of holism and organicism, systems science as a properly defined subject of inquiry began in the second half of the twentieth century. For the purpose of my discussion I divide the history of this science into two waves.[17] The first wave began in the 1940s and 1950s in the field of cybernetics and was initially concerned with creating and analysing man-made control and communication systems. The impetus for this research was primarily military: after the Second World War,

[17] The issue of periodization is a complicated one. For the sake of simplicity and clarity I distinguish between two waves of systems science; however, other interpretations of this history are available. LeClair refers only to 'general systems theory' (which I see as the first wave), but does suggest that some features of that theory, such as a concern with homeostasis, have been "modified by later systems thinkers" (*Loop* 4-5). Sawyer divides systems science into three waves, the first being cybernetics, the second comprising a combination of general systems theory and chaos theory, and the third being complex systems theory (10-26).

scientists at Los Alamos National Laboratory and elsewhere were attempting to design self-regulating missiles (Sawyer 12). Eventually this form of systems thinking spread into other areas of scientific and social thought, leading to the establishment, for instance, of research into artificial intelligence. Important texts within this first wave of systems theory included Norbert Wiener's *Cybernetics: or Control and Communication in the Animal and the Machine* (1948), Talcott Parsons' *The Social System* (1951) and Ludwig von Bertalanffy's *General Systems Theory* (1968). Von Bertalanffy's writing about systems provides a bridging point between the early system theorists and those who I term the second wave, whose discipline is referred to as 'complex systems science', 'complexity science' or the study of 'complex adaptive systems'. Bertalanffy distinguishes between systems which are closed (such as cybernetic systems) and those which are open to their environment (for instance, biological systems).[18] Von Bertalanffy proposes the term 'general system theory' as describing "a general science of 'wholeness'" whose subject matter is "the formulation and derivation of those principles which are valid for 'systems' in general" (36, 31). General systems theory resembles complexity science in that it proposes that we can observe isomorphisms between many different forms of open system. Yet it remains distinct from complexity science, which I see as the second wave, because it retains much of the influence of cybernetic theory. While complexity science is concerned with nonlinearity and distributed control, general systems theory focuses upon centralization and hierarchical order (25-27). Bertalanffy writes of systems in equilibrium and homeostasis, whereas complexity science is concerned with adaptation, growth, and evolution. He also conceptualises systems in terms of information flow, feedback and noise, rather than as agent-based structures exhibiting interdependence and emergence (40-44). Though general systems theory has some relevance to my discussion, particularly in Chapter 6 where I discuss the distinction between open and closed systems, it is primarily the second wave, begun principally at the Santa Fe Institute, which

[18] For a fuller discussion of the distinction between closed and open systems, see Chapter 6.

I refer to when I discuss the influence of systems thinking upon contemporary novelists. In these texts systems are generally described in second wave terms using concepts of agent interaction, micro and macro system levels and emergent behaviour.

The Santa Fe Institute was founded in 1984 by a number of eminent figures associated with Los Alamos National Laboratory, including George A. Cowan, a former director of research at Los Alamos, and the Nobel Prize winning physicist, Murray Gell-Mann. Their aim was to counter trends of reductionism and increasing departmental specialization in scientific research and establish a 'think-tank' where researchers could address speculative and large-scale ideas about nonlinear systems that "lay outside the purview of any one academic department" (Waldrop 67).This transition from departmental isolation to multidisciplinary collaboration resulted in an interdisciplinary ethos which has since spread complexity studies into a wide range of subject disciplines, including that of literary analysis. In *Emerging Syntheses in Science*, a collection of essays based upon the founding workshops of the Institute, Gell-Mann suggests that this new multidisciplinary research area aimed to "attack the interesting question of how complexity arises from the association of simple elements" (6). What arose from this shared inquiry was the awareness that 'wholes' in different disciplines can be seen to function in similar ways. These agent-based systems – brains, ecosystems and economies – which came to be called 'complex systems' or 'complex adaptive systems' by Institute members, had certain structural features and patterns of behaviour in common: from fairly simple lower-level interactions, complex higher-level behaviours would spontaneously arise. A research environment began to develop in which unusual cross-disciplinary connections were being made on the basis of these similarities. Researchers specialising in human biology were startled to find parallels between the functioning of the brain or the immune system and features of the global economy; connections were also drawn between ants and neurons and between the behaviour of birds and that of people in a crowd. Furthermore, it was felt that comparisons between these biological, social and economic entities were more than

superficial: they were evidence of deep-seated structural homologies between different types of system.

Since each complex system is agent-based, nonlinear, self-organizing and produces emergent behaviour, it makes sense to say that one system is 'like' another: structurally speaking, cities really are like brains and brains really are like ant colonies. Analogies based upon structural similarity are central to the complexity science project. In *Metaphors: Ladders of Innovation*, David Gray and Michele Macready suggest that "complexity science is premised on the assumption that seemingly disparate phenomena, both natural and social, evolved and constructed, can be understood using a common conceptual framework" (36). The language of complexity science (agent-based structures, self-organization, emergence, nonlinearity, distributed control, and so on), provides a set of features common to all complex systems, and this facilitates the formation of cross-disciplinary analogies or models which can be used to enhance our knowledge of system function. In *Metaphors and Models*, written just as systems theory was beginning to emerge as a discipline, Max Black describes "analogue models" as "some material object, system or process designed to reproduce as faithfully as possible in some new medium the structure or web of relationships in an original" (222). While complex systems are not 'designed' by an external source, the concept of an analogue model illustrates that it is possible for two different objects or systems to possess the same structure. In a sense, complexity science works by means of analogue models, with scientists arguing that one system (a city, for example), mirrors in a new medium the web of relationships found within another system (such as the human brain).

We also see this use of models in systems-aware fiction. In George Eliot's *Middlemarch*, for example, we see the model of the web to signify interconnection and interdependence; webs of social connection are compared to woven webs of fabric and the webbed network of tissue in a living organism.[19] In the following passage from Richard

[19] For a fuller discussion of *Middlemarch,* see Chapter 3.

Powers' *The Echo Maker,* two different systems are compared in terms of both their structure and function:

> Through the plane's plastic window, the lights of unknown cities blink beneath him, hundreds of millions of glowing cells linked together, swapping signals. Even here, the creature spreads countless species deep. Flying, burrowing, creeping things, every path sculpting all the others. A flashing electrical loom, street-sized synapses forming a brain with miles-wide thoughts too large to read. A web of signals spelling out a theory of living things. Cells by sun and rain and endless selection assembling into a mind the size of continents. (Powers 450)

While a city is in no way 'designed' to model a brain, a structural analogy is being drawn here between the two entities and therefore also between social and biological systems. A set of features attributed to a particular biological system – the interdependence of component agents – is being transferred to another system whose features are in need of further explanation. This extended metaphor is part of *The Echo Maker'*s suggestion that positive environmental change can only be initiated through collective action. Powers is exploring the possibility that a population could act with the intent and purpose of a single individual by drawing attention to their similarities as complex systems. We see the same comparison between cities and biological organisms in contemporary complexity research. Luis Bettencourt writes that:

> Cities as consumers of energy and resources and producers of artefacts, information, and waste have often been compared with biological entities, in both classical studies in urban sociology and in recent research concerned with urban ecosystems and sustainable development. Recent analogies include cities as 'living systems' or 'organisms' and notions of urban 'ecosystems' and urban 'metabolism'. (7302)

The use of structural analogy to create models which educate the reader about system function is an important part of the systems-aware novel. I address in more detail how these models are constructed and implemented in Section 3.

In 'structure mapping', the theory of analogy which was first formulated by Dedre Gentner, an analogy is said to focus upon shared aspects of "relational structure" between two things being compared (156). Significantly, the best analogies (those considered most fitting) convey "a system of connected knowledge, not a mere assortment of independent facts" (162). Structure mapping tells us that the process by which our brains construct analogies is weighted towards the use of interconnected descriptive attributes. Gentner proposes a "systematicity principle" for analogy, whereby some feature of an object is more likely to form part of a comparison if it belongs to a mappable system of "mutually interconnecting relationships" (163). This, I think, provides one explanation for analogy's prevalence in complexity science and systems-aware literature: those involved are primarily concerned with systems of relational structure, and these make for good analogies. In the sense that what we discover in science is in some part conditioned by what it is that we went looking for, complexity researchers are predisposed to finding comparisons between their objects of study.[20]

As I previously mentioned, thinking in terms of self-organizing systems and their analogous qualities was not a new idea at the time when the Santa Fe Institute was founded; scientists in the field of cybernetics had been working on the idea of self-organizing network structures since the 1940s, and Von Bertalanffy had proposed the existence of "isomorphisms" between systems (80-86). However, until the formation of dedicated research facilities into complex adaptive systems there was no vehicle for

[20] In *Metaphors We Live By*, George Lakoff suggests that we perceive the world in terms of conceptual metaphors. In more recent metaphor theory, a neurological account of language is being used to map metaphor to particular patterns of neuronal activity in the brain. See Lakoff's "The Neural Theory of Metaphor".

promoting cross-disciplinary awareness of systems theory and no structural model available to render these analogies concrete and measurable. Complexity science has enjoyed rapid growth and increasing prominence over the last two decades, partly due to the establishment of Santa Fe and further research centres dedicated to the interdisciplinary study of systems.[21] As a result of this growth in systems research and the popularity of associated publications, systems ideas are now working their way into mainstream science and culture. Melanie Mitchell states that "the importance of thinking in terms of nonlinearity, decentralised control, networks, hierarchies, distributed feedback […] and essential randomness is gradually being realised in both the scientific community and the general population" (300).

Of all the societies and institutes dedicated to complexity science, the Santa Fe Institute is the most widely known and culturally influential. Many of the references which I make to complexity science in subsequent chapters are therefore connected to it in some way. The scientists working at Santa Fe were the subject of two books published in the early 1990s: M. Mitchell Waldrop's *Complexity: the Emerging Science at the Edge of Order and Chaos* (1992), and Roger Lewin's *Complexity: Life at the Edge of Order and Chaos* (1992). I draw extensively from these texts in a number of chapters. Since the early 1990s a variety of texts about complexity science aimed at a non-specialist audience have been published, a number of them by Santa Fe faculty members such as Stuart Kauffman, John H. Holland and Melanie Mitchell. As well as giving rise to many scientific texts, the Santa Fe Institute has itself received mention in film and novels, most notably in Michael Crichton's *The Lost World* (1995), where the character of Dr. Ian Malcolm is said to be an Institute member. Novelist Cormac McCarthy is a long-term resident of the

[21] The International Institute for General Systems Studies (IIGSS), located in Pennsylvania, was founded in 1994, and The New England Complex Systems Institute (NECSI), located in Cambridge, Massachusetts, was founded in 1996. Since 1997, NECSI has hosted the 'International Conference on Complex Systems', an annual conference attracting researchers from all aspects of the physical and social sciences. A 'European Conference on Complex Systems' has taken place annually since 2004.

Institute, having occupied an office there for a number of years, and his continued presence emphasises the attraction of complexity science for contemporary writers.[22] I argue, particularly in my discussion of McCarthy in Chapter 9, that complexity science has significantly influenced his writing practice.

To what extent the environment at Santa Fe has influenced McCarthy's fiction is, however, the subject of some debate, since McCarthy himself insists that his presence at Santa Fe is independent of, and unrelated to, his career as a novelist. He states: "I'm here because I like science, and this is a fun place to spend time […] I'm not here because I'm a novelist. I just managed to sneak in" (Flood 2012). Officially listed as a member of the Institute's board of trustees and referenced in a number of articles as a "research fellow", McCarthy lives nearby and spends much of his time at Santa Fe writing and engaging in discussion with the scientists. In a 2007 article for *Rolling Stone* magazine which focuses entirely on McCarthy's relationship with Santa Fe, David Kushner argues that the environment at the Institute *has* had a definite influence on McCarthy's fiction. Kushner writes that "for McCarthy, the scientific life of the Institute plays a fundamental role in his life as a writer, sparking his imagination with "what if" scenarios while grounding his fiction in a greater reality". Kushner suggests that "the scientific interplay has forced him to improve his own work", and that a "sense of rigor is apparent in the increasingly taut work McCarthy has produced since moving to Santa Fe". I suggest in Chapter 9 that complexity science has influenced the content of McCarthy's latest novel, *The Road*, which addresses the loss of complexity which would result from a global environmental catastrophe.

In addition to the influence which complexity has had upon McCarthy's fiction, there is also evidence that he has provided scientists at the institute with assistance in

[22] In recent years, people with a background in the humanities have occasionally been brought to Santa Fe by the 'Miller Scholarship' programme, which offers non-scientists a short residence at the Institute (ranging from a few months to a year). Previous Miller Scholars include actor and playwright Sam Shepard, novelist Rebecca Goldstein and the philosopher and science writer, Daniel Dennett.

communicating their ideas. Articles in *The Guardian* and *The New York Times* have drawn attention to McCarthy's role as an occasional "copy editor" of scientific texts (Flood; Schuessler). Both fiction authors and scientists share reliance upon language and narrative conventions, particularly metaphor and imaginative models, in order to communicate their ideas. John H. Holland, for instance, claims in *Emergence*, that "in one sense, all of science is based on model construction" (12). Holland sees both science and literature as creative activities, with metaphors and models at the centre enabling researchers to see new connections and make intuitive leaps. He also speculates on the link between poetry and physics, suggesting that as disciplines they have "much in common" including a desire to get "beneath the surface of events" (219). Both the poet and the physicist work to master the particular "forms and constraints" provided by their respective disciplines, whilst innovation often means breaking those conventions, since "for both, broken symmetries and rhythmic shapes signal possibilities and opportunities" (219). Max Black had previously argued that metaphor has a positive cognitive value since the juxtapositions it creates allow the reader to "see new connections" or to "see a new subject matter in a new way" (237). Holland too, referencing Max Black explicitly, echoes this view that "models and metaphors allow us to see new connections", thus producing innovation in both the humanities and the sciences (210). Complexity theorists analyse systems through the creation of large-scale simulations, since much of the information which interests them lies in the pattern of interaction between multiple parts. Working upon similar principles, authors writing social novels look to replicate the social system in miniature, often focusing on the relationships between individuals and the ways that they are influenced by larger structures. Simulation is something that literature has been concerned with throughout its history; it is, in fact the basis of imaginative thought. From this, we might suggest that literature was doing the work of complexity science long before that discipline was created.

Having briefly described the role of the Santa Fe Institute I would now like to engage with criticisms of this new science of complexity since they necessarily have some bearing upon my choice of complexity as a useful interpretive paradigm. Since a large enough group of anything can be defined as a complex system provided that it satisfies the conditions of agent-based structure, self-organization, nonlinearity and emergence, there is a danger that complexity may be perceived as having little practical value or explanatory power. Because complexity science is a field which encompasses aspects of such varied disciplines as biology, neurology, economics, computer science and sociology, there are those who argue that its principles are too general and its remit too wide-ranging for it to properly be termed a 'science' (Horgan). Similar problems are encountered when we come to determine how to apply such a diverse theory to the study of literature. Since people, places, environments, other species and aspects of technology can all be defined as systems, it is possible to argue that all novels are about systems. If this is the case, and if authors cannot help but write about systems, then how can complexity as a paradigm have any explanatory power? In Sections 2 and 3 I explain more fully why I believe that reading texts in terms of their representation of systems *does* have real explanatory power, with particular reference to the four key features of complex systems which I outlined previously.

With the processes generating emergence still largely mysterious at this early stage of research, belief that the whole is greater than the sum of the parts can at times resemble either an ideological standpoint or religious doctrine. Roger Lewin discusses his own reservations about complexity science, pointing to "downright negative assessments of the Santa Fe Institute's venture", which suggest that the theory (or theories) are too "simplistic", too overreaching in their claims for multi-disciplinary universality, and subject to too much "unbounded hype" (184). He is sceptical of the occasionally quasi-religious tone of complexity scientists and suggests that the 'everything is connected' ethos at Santa Fe approaches "perilously close to mysticism" (188). Quoting Stuart Kauffmann,

who claims that his work on systems once provided him with a moment of epiphany that was almost "a religious experience", Lewin questions whether systems research can properly be called a science, or if it is instead more akin to a kind of religious quest. He suggests that perhaps, like sages rather than scientists, "the people at the Santa Fe Institute [...] were seeking the meaning of life" (186). Fittingly, from 1987 to 1994, the Institute was housed in a former convent. Waldrop describes the tour which economist W. Brian Arthur received on his first visit to the Institute in 1987, including "the former chapel, which now served as a conference room" and "on the far wall, where the altar had been, a blackboard full of equations and diagrams [...] washed by the ever-shifting light from stained glass windows" (100). Waldrop, too, notes the touch of mysticism which attaches itself to complexity research, writing that "to hear Kauffmann talk about order was to hear the language of mathematics, logic and science being used to express a kind of primal mysticism". Kauffmann is described as "a man in the grip of a vision" (102).[23]

If we assume for a moment a critical perspective, complexity science as a 'theory of everything' may resemble just the sort of totalising grand narrative that the postmodern period was so keen to undermine. It is not a theory which seeks to maintain or justify a particular power structure, but in its unwillingness to adopt a moral perspective (on social hierarchies, for example) it leaves itself open to such an accusation. And although it aims to achieve moral neutrality, I argue that within complexity science there is an implicit positive valuation of the complex over the simple or merely complicated. Said to be located in the region "between stagnation and anarchy", complex systems are "spontaneous, adaptive and alive" (Waldrop 12). Emergence is treated as a source of wonder, beauty and fascination, hence the perception of an almost religious reverence

[23] In "Mapping the Syndrome Novel", Burn identifies a "deep metaphysical ache […] at the heart of post-postmodern fiction (45). This ache is defined as "a yearning to achieve some transcendent spiritual meaning presumed to be absent from the postmodern world" (45). In the contemporary systems-aware novel, then, we might suggest that this longing for spirituality is transferred or projected on to science as a post-postmodern and secular source of wonder or a re-enchantment of the world. See also my discussion of globalization and 'the sublime' in Chapter 5.

discussed above, but systems can also be extremely destructive, particularly in their actions toward individual agents. In Sections 2 and 3 I engage with novels which present sometimes dark and dystopian readings of a systems-dominated world. Systems realism, however, is not inherently pessimistic. While acknowledging that systems can be frustrating and destructive, and that our knowledge of how they function is always incomplete, they advocate positive and constructive action, particularly with regard to environmental issues.

So far we have looked at some examples of the direct influence which Santa Fe and associated institutes have had upon recent fiction; however, I argue that the indirect influence is far more pervasive than this. In Section 2, I examine fiction produced by contemporary authors such as Richard Powers and Jonathan Franzen in order to show that some of the ideas associated with complexity science like emergence and agent-based structures are beginning to find expression within the arts. The dissemination of systems ideas within the culture as a whole has provided authors with a new set of templates with which to deal with real-world complexity: motifs that can profitably be used to categorise, compare and deconstruct the biological, social and information networks which surround us. Terms such as ‘system’, ‘self-organization’, ‘emergence’ and ‘complexity’ are also increasingly evident within contemporary fiction. Beyond the work of authors with scientific backgrounds like Powers, even contemporary authors who do not consciously appropriate the discourse of systems often describe elements of system function. In part this is due to the inescapable prevalence of systems discourse within western society. As I pointed out in my introduction, all novels are inevitably about complex systems, since all living things are systemic in nature. However, contemporary authors are more likely than their predecessors to be aware of this fact and to utilize some form of systems discourse in their fiction (describing the mind in neurological terms, for example). The interdisciplinary ethos of complexity science and the wider valuation of interdisciplinary research within the current scientific community as a whole have been

important factors in facilitating a recent narrowing of the divide between C.P. Snow's 'two cultures'. Complexity scientists, knowing the value of interdisciplinary research, are writing books accessible to a general audience. This diffusion of ideas in turn provides authors with the means to write scientifically informed fiction.

Having examined the explanatory power of system science I now move on to consider the extent to which system content in fiction has been the subject of recent criticism. The relationship between fiction and the related theories of chaos and complexity have been explored by a small number of critics in recent years. The first sustained application of systems theory to literary texts was conducted by Tom LeClair, who published two books on the subject in the late 1980s: *In the Loop: Don DeLillo and the Systems Novel* (1987), and *The Art of Excess: Mastery in Contemporary American Fiction* (1989). In these texts, LeClair coins the term 'systems novel' to describe large encyclopaedic works of fiction which both describe and imitate the functioning of large global systems of information, power and control (of which more shortly). Since 1989, the concept of the systems novel has been largely ignored in literary criticism; however the application of systems theory to literary analysis has continued to be a small though significant critical trend. Notable texts include the anthology edited by N. Katherine Hayles, *Chaos and Order: Complex Dynamics in Literature and Science* (1991), which is primarily an exploration of chaos theory; Joseph Tabbi's *Cognitive Fictions* (2002), whose account of system function is derived primarily from the German social theorist Niklas Luhmann; and Bruce Clarke's *Posthuman Metamorphosis: Narrative and Systems* (2008), which takes its cue from the field of cybernetics. In *Jonathan Franzen at the End of Postmodernism* (2008), Stephen J. Burn draws upon LeClair's account of the systems novel as part of his analysis of Franzen's second novel, *Strong Motion* (1998). In addition, the period since 1989 has seen a number of essays which apply the insights of systems science to fictional narratives, including Scott Hermanson's "Chaos and Complexity in Richard Powers's *The Gold Bug Variations*" (1996), Trey Strecker's "Self-Organization

and Selection in Richard Powers's *The Gold Bug Variations*" (2004), and H. Porter Abbott's "Narrative and Emergent Behaviour" (2008).

LeClair's 'systems novel' concept is of particular importance to this thesis since when I write about systems realism my aim is to revise LeClair's formulation in the light of more recent systems theory. In the Conclusion to this thesis, I summarise the key insights gained from my fictional case studies in order to provide a fuller definition of systems realism. As part of this task I explain in more detail how my interpretation of systems awareness differs from LeClair's notion of the systems novel. LeClair argues that certain novelists create texts which seek to both represent and formally "imitate" living systems (*Loop* 18). He writes that authors such as Robert Coover, Don DeLillo, William Gaddis and Thomas Pynchon have been influenced by systems theory in their creation of large "mastering" novels that attempt to engage with the whole of contemporary life (*Excess* 20). Written only a few years after the formation of the Santa Fe Institute in 1984, *In the Loop* (1987) is influenced by what I would term first wave sources such as Ludwig von Bertalanffy's *General System Theory* (1968) and Gregory Bateson's *Steps to an Ecology of Mind* (1972). As I explained previously, like complexity science, general systems theory made a distinction between open (nonlinear) and closed (linear) systems and sought to identify isomorphisms between different kinds of system. However, it made little or no mention of agents, emergence or adaptation. Influenced by cybernetics and network theory, the main focus of general systems theory was information processing, communication and feedback loops. Since LeClair's sources are derived from the first wave of systems theory, he is primarily concerned with information transfer and feedback mechanisms, whereas much of my analysis is based upon second wave concerns such as emergence, adaptation and evolution. Influenced by cybernetics, LeClair is concerned with large-scale political, technological and military systems which seek to control or master the individual, and while I engage with such dystopian readings of systems in subsequent case studies, I also look, particularly in Section 3, at biological systems which

are beneficial to human life. Influenced by the valuation of biological complexity seen at Santa Fe and elsewhere, recent ecologically informed systems fiction has a much more positive outlook upon complexity (even if it is sceptical about the ability of humanity to protect it from destruction). This differing focus has an impact upon which novels can be said to fall within the remit of the system novel genre. For LeClair, systems novels should be primarily dialogue based; characters must be merely conduits of information, passive "producers and consumers of messages" rather than fully-rounded individuals (18). However, recent complexity science suggests that as well as being agents within various large-scale systems, individual people can also be considered as complex systems in their own right. Therefore, a novel which is influenced by contemporary systems science may choose to focus upon the interior complexity of the human mind and the emergence of consciousness, something which does not feature in LeClair's formulation.

LeClair's concept of the systems novel has a number of features in common with the genre of 'encyclopedic narrative' defined by Edward Mendelson in "Encyclopedic Narrative: From Dante to Pynchon" (1976). One of the key features of LeClair's 'systems novel' is size: he suggests that these texts seek to "reflect formally the scale of their subjects [...] with quantities of pages and information deforming conventional expectations" (17). As a result of their vast scale, systems novels are said to "imitate living systems" by "giving the medium of the text the illusion of reciprocal simultaneity, growth to complexity, an ecosystemic plenitude" (18). Mendelson's 'encyclopedic narratives' (Herman Melville's *Moby-Dick* or Thomas Pynchon's *Gravity's Rainbow,* for example) similarly "attempt to render the full range of knowledge and beliefs of a national culture" (1269), including "a full account of technology or science" (1270). Mendelson suggests that the encyclopedic narrative is also "an encyclopedia *of* narrative, incorporating, but never limited to, the conventions of heroic epic, quest romance, symbolist poem, Bildungsroman, psychomachia, bourgeois novel, lyric interlude, drama, eclogue and catalogue" (1270). The idea of the novelist assembling a narrative encyclopaedia is

something which we see mirrored within *In the Loop*. LeClair writes that “the systems novelist establishes the illusion of being an intertextual collector, an arranger or editor of voices and information rather than a personal observer or creator” (20).

Confronting the vast scale of global systems is an important part of any exploration of the complexity of contemporary life, especially given the advances in information transfer and storage instigated by the developments in computer technology which have occurred in the last couple of decades. However, I would suggest that, contrary to LeClair’s assertion, size should not be a determining factor in deciding whether or not a novel successfully represents the experience of living within a systemic reality. The focus which LeClair places upon size, control and mastery makes his analysis seem rather phallocentric. In addition, complexity science foregrounds the fundamental unpredictability of complex systems and suggests that no individual agent can ever hope to gain total knowledge or ‘mastery’ of the wider system. These insights combine to make LeClair’s concerns seem a little outdated. LeClair continues to equate scale with complexity in a recent article, entitled “Going Up, Falling Down” (2011), a piece which laments the lack of a “Great New York Novel” since the publication of DeLillo’s *Underworld* in 1998. Here, he suggests that in order to adequately engage with the complexity of a city, novels must be themselves “cities of words”, such as “Karen Tei Yamashita's *I Hotel*, a 600-plus page novel comprised of ten novellas set in ten different years beginning in 1969” (sec. 4). However, when LeClair talks dismissively of novels focussing upon “personal problems and social relations one might find treated on *Seinfeld*”, he fails to address the fact that it is just such interpersonal relations between agents which give rise to a city’s emergent complexity (sec. 2). In this criticism he also compounds his phallocentric leanings by devaluing the complexity of the domestic or private sphere which has traditionally been the province of women.

In lamenting the lack of a “Great New York Novel”, LeClair unconsciously echoes Wolfe’s call for a “new social novel” with which I began my first chapter. In “Stalking the

Billion-Footed Beast", Wolfe writes of his desire to create a "big novel" about New York City. For Wolfe, in addition to realism and social documentation, writing a new social novel means "cramming as much of New York City between the covers as you could" (45). Both Wolfe and LeClair display a similar preoccupation with the size of the text, equating increased size with increased social complexity. In Sections 2 and 3 I set out an opposing view; referring to systems-aware novels which range in size from 259 to 436 pages long I suggest that an exploration of 'the whole' of a complex system does not depend upon formal correlation in size. I also address the complexity of both the public and the private sphere.

As I mentioned at the beginning of this chapter, the application of systems concepts to the content of novels is not the only, or by any means the main way in which complex systems theory is applied to literature. Alternative approaches address literature or language as large-scale systemic wholes, rather than addressing the content of the novels themselves. The quantity of analysis which has been conducted into the relationship between systems theory and the formal, generic and historical aspects of literary studies far outweighs the number of applications of systems theory to the actual content of novels. Here I will outline a number of these alternative approaches. In *Graphs, Maps, Trees: Abstract Models for a Literary History* (2005), Franco Moretti undertakes a quantitative analysis of the kinds of novels published in particular historical periods in order to trace the cultural evolution of "the system of novelistic genres" (91). A related field of research is that of citation mapping: using computer technology and network theory to identify what articles are being cited within various academic journals and how frequently. Using visualizations of this data, researchers hope to trace emergent patterns within humanities research such as global variations in the popularity of subject areas, patterns of influence between authors, multidisciplinary connections between subject areas, and so on (Howard 2011).

There are also a variety of research areas devoted to linguistic systems. In *Metaphor Networks: The Comparative Evolution of Figurative Language* (2007) and *Metaphor and the Historical Evolution of Conceptual Mapping* (2011), Richard Trim investigates the emergence of particular metaphors, how such metaphors relate to larger conceptual systems, and how such systems evolve (changing over time and as they encounter different nations and cultures). There is also a wealth of research available into the evolution of national languages, including the way in which human migration has influenced word usage and patterns of grammar (Zala 2012). The complexity of language is addressed in some detail by Paul Cilliers in *Complexity and Postmodernism*. Cilliers writes that "meaningful language evolves in time through a self-organizing process […] in which useful or effective forms of language survive, and obsolete forms decay" (126). For Cilliers, the meaning of words is created through relationships with other words in the system, relationships which are nonlinear and asymmetrical. Language is not fixed, but instead is an example of an "open system" which constantly evolves through interaction with its environment (124). This process of self-organization and development makes language "a vital, evolving system, capable of coping with great complexity" (126).

As we have seen there are researchers who investigate genre and language as evolving systems. I now address to what extent we can view a single novel as a complex system by turning to Mikhail Bakhtin for an acknowledgement of the novel's formal complexity which predates second-wave systems science. Though writing without any knowledge of complex systems theory, Bakhtin appears to show an early awareness of complexity in *The Dialogic Imagination* (translated in 1975), referring to the novel form as "a dialogised system", a "complex system of languages", and a "structured artistic system" (49). He suggests that a novel is not just *like* a system, but really *is* a kind of 'system' due to the way in which it employs language. Language within the novel is "stratified" into many discourse types (or subsystems) which combine to form a sort of emergent behaviour: "a stylistic unity [...] that cannot be identified with any single one of the unities

subordinated to it" (262). If we look at what Waldrop says about the structure of a complex system we find similarities with Bakhtin's account of the novel. Waldrop writes that within a complex system "each agent finds itself in an environment produced by its interactions with other agents in the system" (145). These agents are "constantly organizing and reorganizing themselves into larger structures through the clash of mutual accommodation and mutual rivalry" (88). Similarly, Bakhtin suggests that each utterance within the novel is subject to "centrifugal" and "centripetal" forces, to processes of "centralization and decentralization, of unification and disunification" (271). Encountering other forms of discourse within the process of dialogization, each word "weaves in and out of complex interrelationships, merges with some, recoils from others, intersects with yet a third group: and all this may crucially shape discourse" (276). Bakhtin's analysis of the novel, therefore, seems to suggest that texts mirror systems at a deep structural level and are thus in some sense comparably 'complex'.

Designed by a single author, the novel is perhaps not a complex system as the Santa Fe Institute would define it; such systems must be self-making, with order emerging from the activity of thousands of individuals. However, Bakhtin, I am sure, would argue that the author does not have complete control over his or her work, since there are always words and phrases that resist appropriation (294). Since the popular interpretation or dominant critical opinion of a novel is often formed from the input of many individuals, such readings may be termed an emergent property of the text. Our reading of a text is determined by more than the words of the text alone and in this sense the novel as a system is more than the sum of its parts. Though Bakhtin was not explicitly writing about systems theory, his concern was with language as what we might now term an 'agent-based structure': his aim was to show how different self-contained discourse types coexist within the novel. Each discourse type pursues its own ends with an accompanying set of ideologies in tow, yet as a collective, through a process of (sometimes uneasy) juxtaposition, they give rise to an emergent narrative whole. LeClair makes a similar point,

expressed explicitly in terms of systems, when he writes that “the systems novelist makes space in his novel for a multitude of linguistic subsystems, multiple, overlapping logospheres that the reader may ultimately understand as the constituents of a larger whole” (*Loop* 19). Bakhtin’s account of the novel’s complexity, however, is not dependent upon the physical size of the text, and, in that sense as well as others, anticipates contemporary systems realism.

Despite the formal difficulties involved in an accurate depiction of nonlinear systems, many authors still turn to the novel as a means of exploring complex content. There are many reasons why this might be the case. Bakhtin, for instance, suggests that the novel’s status as a “fluid” and “developing” genre means that it “reflects more deeply, more essentially, more sensitively and rapidly, reality itself in the process of its unfolding” (7). Certainly, the novel is generally acknowledged to be one of the least formally inhibited of genres, since though it has a “finite repertoire of forms and motifs [...] it is an extraordinarily capacious one even so” (Eagleton 2). It can contain within itself examples of all other literary forms, from history and social commentary to biography, journalism and lyric poetry. Like a living system itself, it can be said that the novel “cannibalizes other literary modes and mixes the bits and pieces promiscuously together” (Eagleton 2). If we take seriously Bakhtin’s assertion of internal conflict, the novel form is particularly suited to exploring systems content because it is itself a complex system of intersecting discourse types. In Bakhtin’s view “only that which is itself developing can comprehend development as a process” (7); therefore, to address systems with the aim of realistic representation, we would seem to require a genre which is comparably complex, one which like a complex system is able to ‘evolve’ and ‘adapt’ to the non-literary environment.

So far in this chapter I have outlined a number of ways in which complex systems science may be applied to literary studies. We can look at novels as systems, with words as agents which interact within the mind of the reader. We can address groups of novels (genres) as systems which adapt and evolve in response to other genres and to differing

environmental conditions. Or we can look at languages as systems, with words both written and spoken as interacting agents. In addition to the primarily genre-based and quantitative analyses which form the majority of systemic approaches to literature, there is also a content based approach which addresses the representation of systems within novels. This kind of inquiry is mainly associated with Tom LeClair, but has also been addressed by a small group of other theorists. It is this concern with the content and form of individual novels which forms the basis of my investigation of systems realism.

Some authors are more aware than others of the systemic nature of reality, and they are often those authors – like George Eliot in the nineteenth century or Richard Powers in the late twentieth and twenty first centuries – who have read widely in scientific texts or have a scientific background (either academically or professionally). In addition, some time periods lend themselves particularly well to systems-aware fiction because they place systems at the forefront of culture and society. LeClair suggests that the systems novel emerged out of and in response to "large-scale geopolitical disruptions" in the twentieth century (*Loop* 10). I would suggest that the nineteenth century witnessed comparable disruptions and that the systems fiction in this period was a response to changes in urbanization, industrialization and empire. Novelists at this time were concerned with new information and communication systems: the railway; the electrical telegraph and telephone; the rotary printing press; the spread of literacy and mass publication; the growth of corporations; increased migration and transatlantic trade. There is a case to be made for the extension of the term 'systems novel' to encompass certain realist novels of the nineteenth century which, before the terminology of systems theory existed, anticipated novels like *Gravity's Rainbow* in addressing global networks of information and communication exchange. When Wolfe talks of writing a large social novel which would engage with what I would term the complexity of New York, his model is Thackeray's *Vanity Fair* (1848). Wolfe draws an explicit connection between the kinds of social conditions and experiences which existed in the nineteenth century and those

that exist today. Discussing the inspiration which existed for writers in the 1960s, he writes that “Thackeray and Dickens lived in the first great era of the metropolis” and “now, a century later […] certain powerful forces had converged to create a second one” (45). The nineteenth and late twentieth centuries, in his view and mine, were periods of commensurate social complexity. This is the case which I make in the following chapter, where I explore the scientific and philosophical concern with organic wholes which influenced much nineteenth-century literature and culture. In this chapter I suggest that the origins of contemporary systems science and fiction can be found in nineteenth-century organicism and the social novels which absorbed and reflected that philosophy.

Chapter 3: Organicism: The Origin of Systems Theory

Reductionist disciplines such as molecular biology and quantum mechanics came to dominate scientific research in the twentieth century, leading to significant advances in our understanding of life at the atomic and subatomic levels.[24] However, as the millennium approached, dissatisfaction with the reductionist method reached a critical level in some sections of the scientific community. The development of a global information network was beginning to seem an achievable reality when the Santa Fe Institute was established in 1984, yet at that time research which addressed large, highly interconnected systems in their entirety was still relatively rare (and unlikely to attract funding). The impulse behind the creation of Santa Fe and other similar research facilities was a growing consensus that the departmental specialization which had been instigated by reductionism was no longer appropriate for addressing contemporary research questions. Though much was still being discovered about the smallest pieces of matter in existence, insufficient attention was being paid to how those pieces interconnected to form large systems. In addition, the rise of chaos theory in the 1960s and 1970s had brought to the foreground the idea that many systems are nonlinear and unpredictable, suggesting that reductionism was insufficient as a research method in all cases (Waldrop 328). Today it is generally acknowledged that, since so much information is found within the intricate relationships *between* the smaller parts, a reductionist analysis of systems actually destroys what it would seek to understand. Complex systems exhibiting emergence such as climate and the global economy are more than the sum of their parts, and as such can only be understood by means of large-scale simulation of the whole.

In this chapter I look at the nineteenth-century origins of both complexity science and systems fiction. The concern with interdependent wholes which we see displayed in

[24] Reductionism is the belief that systems are best understood by "dissecting the world into the smallest and simplest pieces". See Waldrop 60. Analysis of any subject must begin with an analysis of a single part. Molecular biology and quantum physics are examples of reductionist science.

systems science echoes that found in nineteenth-century organicism. As such, I suggest that organicism was an influential predecessor of systems science. In fiction we see that contemporary texts are staging a partial return to nineteenth-century forms of narration and that systems realism also echoes the social concern of literary naturalism. I investigate why this is the case and what relationship this trend bears to the nineteenth-century echoes found in contemporary science. Both scientists and authors in these two time periods were confronting similar developments with regard to globalization, advances in communications technology and transportation, and so on. This rapid social change gave rise to heightened knowledge of interdependence and increased levels of systems awareness compared to other times in history. In order to draw out these points of comparison more fully I compare a series of texts from the nineteenth and late twentieth centuries in Section 2. In the second part of this chapter I argue that complexity's preoccupation with metaphor and analogy is anticipated in nineteenth-century social thought, specifically in Herbert Spencer's comparison of social and biological forms. I end the chapter with the suggestion that George Eliot's *Middlemarch* (1874), which was influenced by Spencer's writing on the subject of the social organism, anticipates many of the concerns of contemporary systems realism.

By engaging with systems as organizational wholes which are more than the sum of their parts, complexity science is staging a qualified return to the kind of scientific inquiry which became dominant in the nineteenth century. In *Social Emergence,* R. Keith Sawyer contrasts reductionism (which suggests that a system is best analysed by first discovering rules or laws which appertain to isolated component parts) with holism, the position that:

> There are some complex systemic phenomena that must be studied in their own terms; that mechanistic, reductionist methods are not applicable to such systems; and that no part can be understood except in its relation to the entire system. (28)

Vitalism and organicism, two holist philosophies prevalent in the nineteenth century, bear strong similarities to complexity theory in their assertion that 'the whole' is more than the sum of its parts. Due to the analogies made between social and biological systems, Sawyer argues that analyses of social complexity made by the scientists at Santa Fe and their contemporaries can be conceived of as "modern variants of nineteenth-century organicism, the school of thought that proposed that society was analogous to a biological organism" (20). Though he advocates non-reductionist approaches to social studies, for Sawyer this tendency to view social and biological systems as analogous or equivalent is a weakness, since organicism has long since been rejected by contemporary sociologists. However, many scientists perceive analogy as a strength of recent complexity science.

Sawyer suggests that philosophical discussions of emergent behaviour actually began in the mid-nineteenth century and that "an awareness of this history can offer an important perspective on contemporary discussions of emergence" (27). Roger Lewin goes further, claiming that the opposition between reductionist and emergentist science can be traced back even further than the nineteenth century, to the mechanist and vitalist oppositions in the writings of Plato and Aristotle. He quotes Chris Langton, an Artificial Life specialist associated with the Santa Fe Institute, who suggests that complexity can be seen as "a new and thoroughly scientific version of vitalism: the ancient idea that life involves some kind of energy, or force, or spirit that transcends mere matter" (280). Lewin suggests that complexity is heir to the vitalist line of reasoning since it presupposes that knowledge of the material parts alone is not sufficient for a full understanding of a complex living system. However, later in the text he qualifies this assertion, quoting Brian Goodwin, another resident professor at the institute, who argues that although there is a convergence of sorts between vitalism and complexity, there are also important differences, since "the vitalists saw an outside force directing life while we [complexity theorists] see internal self-organizing principles" (182).

This sense of moving forwards by means of a qualified return is also seen in

contemporary literature, where authors attempting to find their way beyond postmodernism towards a new kind of post-postmodern social engagement find themselves caught in a complicated negotiation with forms and styles more usually associated with the nineteenth century. In a world where life is dominated by economic, social and information networks that are frequently global in scale, people in a variety of disciplines are now becoming aware of the importance of thinking in terms of large interconnected systems. When dealing with large-scale social issues, some authors – like Richard Powers – are aware that they are echoing the concerns of nineteenth-century writers who were also attempting to engage with vast social change. While today's authors are often influenced by the increased connectivity wrought by globalization and information technology, those writing in the nineteenth century were concerned with new networks of human interaction brought about by industrialization and urbanization. When asked about the "system-like unity" which emerges from his texts, Powers has remarked:

> I have often wondered if my connection does not even predate modernism in some way, if these books don't somehow resemble works of nineteenth-century encyclopedic social survey, like a survey in a Dickens novel on, let's say, the social effect of the factory system or the law courts. (Pellegrin par. 8)

Tom LeClair makes the same connection to nineteenth century fiction in *The Art of Excess*, where he writes that:

> The systems novelists are our new, scientifically and aesthetically sophisticated naturalists. The tradition of Norris, Dreiser, Dos Passos, Steinbeck, and Miller which the systems novelists continue appears more and more honourable as our culture forgets those earlier writers' warnings, sometimes inadvertent, against reductionism in science, economics and politics. (17)

Just as today's generation of authors are looking to complexity theory when talking about global systems, the postmodern writers of the 1970s were looking to the new scientific paradigm of chaos, as well as cybernetics and general systems theory. Yet they too were finding themselves (perhaps unconsciously) echoing the nineteenth century, a time when a similar preoccupation with interdependent wholes was evident in both literature and science. Talking about those authors which LeClair calls the first generation of 'systems novelists', Stephen Schryer argues:

> Pynchon and Gaddis were relentlessly sociological writers, who tried to map out the complex, global systems that shape our lives. Their works harkened back to the great realist novels of the nineteenth century that traced the transformations wrought by industrialization upon British and continental society.

There are a number of parallels at work here. Contemporary authors like Richard Powers, as well as postmodern authors like Pynchon, are influenced by the popular scientific concepts of the day in their treatment of large-scale systems. I suggest that this was also the case for authors in the nineteenth century; while today's authors turn to systems theory, nineteenth-century writers looked to philosophies such as organicism. Secondly, there is a sense in which contemporary science is also being influenced by scientific concepts from the nineteenth century when thinking about how to visualize large-scale systems. Thirdly, there is a sense in which the contemporary authors under discussion here have been influenced by the treatment of large-scale systems in nineteenth-century texts, or at least that they are aware of the similarities which exist between their own work and that of the earlier time period. Stephen J. Burn suggests that Jonathan Franzen, for instance, is deeply concerned with "the place of his fiction within a larger literary ecology" (2). Lastly, as a logical conclusion of these parallels we might also suggest that it would be reasonable to apply insights gained from contemporary systems

theory to our readings of nineteenth-century texts.

This return to nineteenth-century concerns involves more than the resurgence of lengthy, 'encyclopaedic' texts like those produced by Dickens and Eliot. LeClair suggests that systems theory offers the novelist "an extraliterary defence of the methods of 'earlier times': metaphor, the paradigmatic over the syntagmatic, the abstract mixed with the concrete, macro and micro worlds" (11). In "Home: An Interview with Richard Powers and Tom LeClair", LeClair talks to Scott Hermanson about another kind of "return" in recent literature, which constitutes, at least in part, a response to current scientific developments:

> One of the features, it seems to me, that genetics – and other non-linear science and chaos theory – shows to us, is that there is a return to correspondence, a return of analogy or homology. For about three hundred years now we've been really stuck on Newtonian cause and effect. There's a lot of throwweight. We can send people to distant planets by very carefully analyzing cause and effect. But the old medieval notion of correspondence made amazing connections through similarities. Think of the way people thought of themselves. "I am like a tree. I am like a plant." They believed that this theory of correspondences and analogies was a way to understand the world. And I think it's coming back around.

Correspondences and analogies are of central importance to complexity science. Within complexity studies, biologists, economists, and computer scientists are able to collaborate on research projects because they believe that biological, social and information networks can often be read as analogous self-organizing complex systems.

Drawing analogies between social systems and biological organisms (as analogous systems), organicism is the school of thought that most resembles today's complexity science. Just as complexity theory would later reject reductionism, organicism stressed the importance of not analysing the individual parts of a system in isolation, but of instead

considering a larger context of relationships and interactions. The *OED* lists the first recorded usage of *organicism, n.* as occurring in 1853. Originally, the word was conceived in relation to the terms *organic, adj.* and *organism, n.* as a medical or biological term: “the doctrine or theory that all disease is caused by or associated with localized structural alterations in organs” (Def. 1). By 1912 this usage has been superseded by a second more general usage related to *holism, n*.: “the theory that everything in nature has an organic basis or is part of an organic whole” (Def. 2.b). The word *organic, adj.* has a much longer history. In the 1400s it was conceived as a biological term related to *organ, n.*[1]: “of a part of the body: composed of distinct parts or tissues (obs.); of, relating to, or of the nature of an organ or organs” (Def. 2.a). By 1817 it had taken on more general structural meanings: “of or relating to an organized structure compared to a living being” (Def. 6), and “of, relating to, or characterized by connection or coordination of parts into a single, harmonious whole; organized; systematic” (Def. 6.a). Defining organicism in *World Hypotheses*, Stephen Pepper explicitly talks in terms of such ‘systematic’ or ‘systemic’ organization. He writes that within organicist thought “an isolated datum is a fragment” which “becomes precise and significant only when it is brought into a coherent system and connected with other data” (290). He also draws attention to the interdependence of those parts, writing that “an organic whole is such a system that every element within it implies every other [...] it is such a system that an alteration or removal of any element would alter every other element” (300). The ‘organic whole’, as represented here, appears as a precursor of the complex system in that it is densely interconnected, and these connections appear to be nonlinear.

A key figure closely associated with organicism was the social and evolutionary theorist Herbert Spencer, who frequently compared societies to biological organisms based upon a perceived similarity of structure. In his essay, “The Social Organism” (1860), Spencer writes:

> We commonly enough compare a nation to a living organism. We speak of the 'body politic,' of the functions of its several parts, of its growth, and of its diseases, as though it were a creature. But we usually employ these expressions as metaphors, little suspecting how close is the analogy, and how far it will bear carrying out. So completely, however, is a society organised upon the same system as an individual being, that we may almost say there is something more than analogy between them. (448)

Spencer lists four parallels between societies and organisms with which he hopes to justify the case for society as an organic entity. His first claim is that "commencing as small aggregations," they both increase in mass as they grow (391); secondly, he suggests that this increase in mass entails a corresponding increase in "complexity of structure" (392); thirdly, that "their parts gradually acquire a mutual dependence", culminating in an organic interdependence of parts which means that "the activity and life of each part is made possible only by the activity and life of the rest" (392). Here, Spencer equates the 'complexity' of the whole with the functional interdependence of parts in a way which resembles contemporary systems theory. In addition, his fourth point of similarity prefigures the claim of complexity theorists that 'the whole is greater than the sum of the parts'. Spencer argues that "the life of a society is independent of, and far more prolonged than, the lives of any of its component units" (392). Though Spencer's organic whole is dependent on the interaction of its parts, it is not reducible to those parts alone; the ability of a society to sustain itself via internal processes renders it more than merely a label applied to a collective of living beings, it makes the collective itself a 'living' being in some important sense:

> Thus do we find, not only that the analogy between a society and a living creature is borne out to a degree quite unexpected by those who commonly draw it, but also, that

the same definition of life applies to both. (455)

People in a society die and are replaced by succeeding generations, just as the human body replaces all of its constituent cells over a number of years. Spencer writes that just "as in a living body, the cells that make up some important organ severally perform their functions for a time and then disappear, leaving others to supply their places" (395). Therefore, "in each part of a society the organ remains, though the persons who compose it change" (395). Social organisms "continue to live and grow as wholes, while successive generations of their units appear and disappear" (395).

A popular and widely read figure during the latter half of the nineteenth century, responsible for coining the famous phrase frequently attributed to Darwin, 'survival of the fittest', Spencer became widely discredited in the decades after his death in 1903, due in part to the moral implications of his thinking on social evolution. Richard Hofstadter's book *Social Darwinism in American Thought* (1944), made a negative assessment of Spencer's social thought, suggesting that he was indifferent to the welfare of the poor. Hofstadter writes that Spencer's "categorical repudiation of state interference with the 'natural', unimpeded growth of society led him to oppose all state aid to the poor. They were unfit, he said, and should be eliminated" (41). Though it was Spencer's belief that the growing complexity of industrial societies would lead one day to a state of perfect equilibrium and moral altruism, this appeared to come at a heavy price for those less well adapted to the seizing and wielding of power. Removed from these moral considerations, Spencer's comparison between society and biological organisms has particular resonance for contemporary systems theory. However, the potential negative consequence of viewing the structure of society as 'natural' is that we appear to legitimise political and economic oppression. This is the main reason that organicist thought was discredited in the twentieth century, and is something which complexity theory as a new form of organicist thought must respond to. I address these implications in more detail in Chapter 5.

Criticisms of theories which posit society as a kind of organism, subject to natural growth, often centre on the problematic distinction between ‘nature’ and ‘culture’ as critical terms. Hofstadter’s criticism of Spencer (quoted above) partly rests on a pejorative sense of the word ‘natural’ in relation to Spencer’s theories. When complexity theorists today talk about social systems as ‘natural’ as opposed to ‘designed’, they are referring to self-making, self-sustaining patterns of order which emerge spontaneously from the actions of agents within the system. Such systems are open to their environment, as opposed to closed systems which are consciously designed, implemented and controlled by an external source. They are speaking ontologically, about what a system ‘is’, rather than speaking morally, about how things should be. However, today the word *natural* is loaded with implicit and generally positive value judgements. If, for example, we say that some form of oppression or inequality within society is natural, in the sense that it is something which is not externally designed and implemented, and which emerges spontaneously within the normal functioning of the system, then some of the associations we have with the word *natural* – healthy, beneficial, not man-made – attach themselves to the statement. It then appears that we are condoning oppression and saying not only that oppression exists, but that it is good and should continue to exist.

In *Keywords*, Raymond Williams refers to *nature* as “perhaps the most complex word in the language” (219).The earliest use of the term referred merely to “the essential character and quality *of* something”, having its root in *nasci* (to be born) from which the terms nation, native and innate are also derived (219). However, from the eighteenth century onwards nature has also meant “a selective sense of goodness and innocence”, and also that which “man has not made” (219). In the eighteenth century the term *organic*, once synonymous with *mechanical*, also “acquired a dominant reference to things living and growing” (227). Influenced by the Romantic movement and the new significance of machines in the Industrial Revolution, “when applied to social organisation, *organic* moved towards a contemporary specialisation of *natural*: an organic society was one that has

'grown' rather than been 'made'" (228). The connection between the words *natural* and *organic* and their shared associations of goodness and removal from that which is manufactured has continued into the twenty-first century with the associations given to the branding of 'organic' foods. If we look again at "The Social Organism", we see that Spencer's sense of society as organic or natural does not mean that which 'man has not made', for society consists entirely of interactions and relationships between people; neither does it mean anything inherently good or innocent.

Contemporary systems theorists continue to make similar functional analogies between the social and the biological. In the *SFI Bulletin*, a periodical which publicises current research at the Santa Fe Institute, Jenna Beck addresses the issue of "whether cities consume energy in the same way as biological organisms" (4). She refers to research conducted by SFI External Professor Luis Bettencourt and SFI President Geoffrey West, which suggests that a city "may have a social metabolism" (7). In discussing the findings of this research, Beck consistently draws on analogies between social and biological systems in a manner which is reminiscent of Spencer's writing in "The Social Organism". She writes as follows:

> Large cities, up to a point, are a more economic way of distributing resources than small cities and rural communities. This mirrors a relationship seen in biological organisms, where large animals economize on blood vessels by pumping more blood through proportionally fewer veins and capillaries. Fewer vessels support more mass, but the large animal's metabolism slackens because the blood is delivered more slowly. When a city grows, the highways deliver more people to and from their destinations, but traffic slows as the roads become congested. (7)

Though Spencer's reputation declined, his work was of great importance to the thinking of Emile Durkheim, who according to Beck is now "widely hailed as a 'founding

father' of sociology" (359). This demonstrates the continuing relevance of organicism to sociological thinking, as well as literary theory. Corning writes at length about the debt which Durkheim's thinking owes to Spencer: "Consider, for instance, the index to *The Division of Labor in Society,* Durkheim's preeminent and most frequently cited work. It contains forty-three references to Spencer. The next most frequently mentioned author, Auguste Comte, is cited only eighteen times" (359). In *Understanding Classical Sociology,* Hughes explains that Durkheim believed "social collectives were more than just aggregates of individuals"; they were "holistic phenomena possessing properties which were not those of separate individuals" (149). He refers to Durkheim's distinction between societies displaying 'mechanic solidarity' and those with 'organic solidarity' (164-66). In a society displaying 'mechanic solidarity' people lead similar lives and are virtually self-sufficient (for example, in isolated farming communities) (166). A society displaying organic solidarity in contrast is highly interdependent; each individual performs a different specialized role and is dependent on others in society for the other essentials of existence (more common in industrialised societies) (164). The concept of organic solidarity is based upon a biological analogy since this kind of unity is generally found in a biological organism (such as the human body), where "differentiated and specialized parts are combined into a single, functioning whole, with each part's own operations depending upon the whole" (165). The loss of an individual from the organic society can affect the system in unpredictable ways, since it disrupts complex and nonlinear ties of dependency.

In addition to sociological theory, literature, too, felt the impact of organic theory in the nineteenth century. Tracing the influence of thinkers like Herbert Spencer on fictional texts of the period provides a perspective on the way in which some of today's novelists are influenced by complexity theory. George Eliot's *Middlemarch* reflects in both its form and content the scientific views that were shaping society in the nineteenth century; as such it is considered to be the foremost example of the productive relationship which existed between fiction and organic social thought at that time. In *George Eliot and*

Nineteenth-Century Science (1984), Sally Shuttleworth discusses the connection between Eliot and organicism in detail. According to Shuttleworth, Eliot believed that "society is not an artificial creation of men, but an organic whole whose laws of natural growth must be observed" (4). In taking this view Eliot was greatly influenced by her romantic relationship and "close intellectual association" with George Henry Lewes, so that "her changing understanding of the social and psychological implications of organicist thought was, in fact, closely related to Lewes' own evolving social and scientific theory" (18).

Eliot was also a close lifelong friend of Herbert Spencer; their relationship is documented by Nancy L. Paxton in *George Eliot and Herbert Spencer: Feminism, Evolutionism and the Reconstruction of Gender* (1991). Spencer met Eliot in 1851 and soon described her to a friend as "the most admirable woman, mentally, I ever met" (17). He was a frequent visitor to the home of Eliot and Lewes during the period (1869-72) when Eliot was writing *Middlemarch* (172). Paxton claims that Eliot's famous pier-glass passage is a direct reference to Spencer (174). She writes that the "eminent philosopher" mentioned in the passage is Spencer, and that he uses the same concept in the October 1871 number of *The Principles of Psychology*: "a candle before a mirror creates the illusion of 'arcs of circles having the light at its center' and renders invisible all the other scratches in the mirror" (174).

Shuttleworth and Paxton both agree that Eliot's use of organicism was not blindly absorbed from the men that surrounded her. Paxton suggests that it would be a mistake to view her as "a passive vessel into which the ideas of Darwin, Spencer, Lewes, Comte, Bain and others were poured" (4). Paxton sets out various areas where Eliot disagreed with Spencer's theories, particularly in relation to his opinions on "women's physical and mental inferiority" (171). Paxton suggests that in *Middlemarch*, "Spencer is […] implicated when Eliot observes that the failures of Lydgate and Casaubon show how 'all of us, grave or light, get our thoughts entangled in metaphors and act fatally on the strength of them'" (174). This quotation comes from a passage in which Casaubon conflates love and

economics, expecting from his marriage a “compound interest of enjoyment” and “large drafts on his affections” (Eliot 79). Casaubon fails to realise that biology does not (always) operate in accordance with economic principles. Eliot’s critique of those who take metaphor too seriously may therefore represent a partial critique of Spencer, who takes seriously the equivalence between societies and biological organisms. However, Eliot does recognise the importance of analogy. In *Middlemarch*, Lydgate’s downfall stems from an inability to move beyond his critique of accepted biological theory into an analogous critique of the accepted social conventions about marriage. This is a problem which involves the inability to take analogy far enough. Therefore Paxton’s suggestion that the “characterisation of Lydgate demonstrates Eliot’s critique of the unself-conscious use of metaphors” seems misplaced (174).

Lydgate’s scientific aims are doomed because his search for the one “primitive tissue” is a reductionist quest. His suggestion that living bodies consist of “certain primary webs or tissues, out of which the various organs – brain, heart, lungs, and so on – are compacted” seems a legitimate claim, as does the comparison made between organs and the “various accommodations of a house” which instead of tissue, are composed of “various proportions of wood, iron, stone, brick, zinc, and the rest” (138). Lydgate’s error lies in seeking to reduce these building blocks further, to one singular “primitive tissue” or “common origin” (139). Similarly, his singular fixed concept of the ‘feminine ideal’ leaves him ignorant of and unprepared for “the complexities of love and marriage” (154). Casaubon’s inability to write his ‘key to all mythologies’ stems from a similar reductionist desire, his belief that “all the mythical systems or erratic mythical fragments in the world were corruptions of a tradition originally revealed” (22). His response to the field of mythical constructions “luminous with the reflected light of correspondences” is to “condense” these results until they “fit a little shelf” (23). As Gillian Beer suggests, “there is not one ‘primitive tissue’, just as there is not one ‘key to all mythologies’” because an “emphasis on plurality, rather than upon singleness, is crucial to the developing argument

of *Middlemarch*" (143). Plurality is important to systems thinking, since systems are composed of countless interacting agents, each with some measure of agency or individuality.

Spencer defines the social organism using four criteria that societies have in common with biological organisms: growth in size, growth in complexity, interdependence and a lifespan that exceeds that of the component parts (391-92). These resemble the four criteria which I used to define complex systems in the introduction: the existence of agents, emergence, nonlinearity and self-organization. Spencer sees society as composed of many interacting parts (which we would term agents), and his criterion of 'interdependence' is a vital precondition for both emergence and self-organization. He also sees the whole as in some way independent of the parts and as an object deserving of separate study. Where these theories differ is in Spencer's belief that the social organism is evolving towards a final 'completed' state of equilibrium marked by altruism and the absence of conflict. Spencer also applies value judgements which suggest that he values more complex societies as inherently 'better' than primitive ones. Sally Shuttleworth suggests that "the historical process of differentiation could, for Spencer, only be one of progress; the mutual dependence of unlike parts would necessarily be harmonious" (150). In opposition, she suggests that "the interdependence of Middlemarch life seems to be based not on harmony, but on conflict" (150).

In Chapter XI of *Middlemarch* there is a long passage dedicated to a large-scale description of the various kinds of movement which were shaping 'old provincial society' in the 1830s. This passage illustrates the influence of organicist thought on Eliot's writing. Society is described in terms of the interactions between people and is characterised by a gradual process of change which tends towards increasing interconnectedness. She notes that urban centres and their rural surroundings are becoming closer entwined (at least partly due to the railway mentioned in later chapters), as "municipal town and rural parish gradually made fresh threads of connexion" (88). This process involves a greater

mixing of classes as (through involvement in politics) squires, baronets and lords gather a "closer acquaintanceship" with the civic mind. There is a "stealthy convergence of human lots" and this is "begetting new consciousness of interdependence" (88). As well as gradual change toward greater interdependence, Eliot's description of society is characterised by constant movement. The "fluctuation" of society has the physicality of water; people find themselves caught in "currents", some slip or struggle to "gain a higher footing", while others stand with "rocky firmness" above the tide. Like a liquid, its "boundaries" are "constantly shifting" (88). Liquidity is an emergent property of water, having characteristics that cannot be described using terms of reference that apply to the component parts (hydrogen and oxygen). Therefore, the use of language in this passage supports the idea suggested by Lydgate, that the living body (in this case provincial society) cannot be understood by studying the parts "first apart, and then as it were federally" (138).

In both organicist thought and contemporary complexity science the system (society) must be considered as a whole. Sally Shuttleworth suggests that because "each part of Middlemarch life is related to every other part" we can say that "individual identity is not only influenced by the larger social organism, it is actively defined by it" (143). The importance of each individual agent lies in its relationships with others in the system. Shuttleworth claims that in *Middlemarch*, "character cannot be defined apart from social opinion, for each individual is only the sum of his constantly changing relations with the social organism" (152). Echoing Spencer, Eliot also makes an explicit reference to society as an organism: "Middlemarch […] counted on swallowing Lydgate and assimilating him very comfortably" (144).

Recent complexity science has echoed the comparisons between society and the organism found within organicist theory. As I explained in the previous chapter, Louis Bettencourt has drawn attention to the way that cities are still talked about in biological terms, from the familiar notion of ‘‘living systems’’ or ‘‘organisms’’ to the more

contemporary notions of “urban ecosystem” and “urban ‘metabolism’’ (7302). However, Bettencourt also suggests that the analogies used to describe cities are beginning to change. Though noting the visual similarities between urban and biological structures, he also describes distinct differences in the way that they function, specifically with regard to scaling. Complexity researchers suggest that there is a “social metabolism” in cities which scales differently to that of an organism (Beck 8). As the size of a city population grows, crime rates and levels of innovation and creativity keep growing. This is one area where the analogy between cities and organisms breaks down:

> As a city grows, its social metabolism speeds up. Individual productivity rises (15% per person when the city doubles) as people get busier. Average walking speeds increase. Businesses, public spaces, nightclubs and public squares consume more electricity. The city draws in more inventors, artists, researchers and financiers. Wealth increases, as does the cost of housing”. (Beck 8)

Bettencourt has suggested that perhaps a more fitting analogy would be comparing cities to stars instead of organisms, since with both stars and cities ‘the larger it gets, the faster it burns’ (“Origins”).

Middlemarch is an example of a text which reflects nineteenth-century organicist thinking and yet also anticipates the way in which contemporary systems-aware texts think about social interconnection. Moving away from reductionist methods prevalent in the twentieth century, complexity science makes a qualified return to organicist thinking. The directionality of this scientific trend is mirrored in fiction where we see a renewed interest in nineteenth-century concerns and methods, such as a return to realist narration, a restatement of the ‘social novel’ or ‘social problem novel’ project, increased awareness of contemporary scientific discourse, and the increased prominence of correspondence and analogy. Both contemporary literature and contemporary science are influenced by

their nineteenth-century predecessors. In addition, both contemporary and nineteenth-century novels are influenced by the scientific theory of their time. These historical parallels create a number of similarities in the content of fiction from these two periods.

In the following section of the thesis I present three paired case studies which illustrate the similarities between late nineteenth century (1890-1920) and late twentieth century (1995-2001) approaches to the systemic nature of both society and the self. In Chapter 4 I explore the relationship between the individual and the social system in William Dean Howells' *A Hazard of New Fortunes* (1890) and Richard Ford's *Independence Day* (1995). I address where meaning is derived from within a system and how the individual perceives their own role or purpose within a social system. Both novels take the real-estate industry as a point of entry into the complexity of the urban landscape. In Chapter 5, I look at the representation of systems and the question of value in Frank Norris' *The Octopus* (1901) and Richard Powers' *Gain* (1998). Both novels have corporations as their subject matter and engage in a similar debate about how we attribute blame or judge the morality of complex systems. In Chapter 6, I develop questions of value and agency with regard to systems in Edith Wharton's novels *The Custom of the Country* (1913) and *The Age of Innocence* (1920) and Jonathan Franzen's *The Corrections* (2001). Moving from a consideration of novels which take the public sphere as their subject to novel's which engage with domestic realism, I engage with the claim that "family is the great determinism" (Wood 192).

Section 2: Systems-Aware Fiction

Chapter 4: The Self and the Social System: William Dean Howells and Richard Ford

> And I am in the crowd just as the drums are passing […] their *boom-boom-boom*ing in my ears and all around […] Someone calls out, "Clear a path, make room, make room, please!" The trumpets go again. My heartbeat quickens. I feel the push, pull, the weave and sway of others. (Ford 451)

A Hazard of New Fortunes (1890) and *Independence Day* (1995) are novels which explore the role of the individual within complex social systems. Written during the closing decades of two different centuries they are nevertheless similarly concerned with representing society as a self-organizing network of independent agents, all of whom are engaged in complicated relationships of competition and cooperation. The emphasis which Howells and Ford place upon social systems suggests that self-determination is a central issue for the texts: they address, in effect, the individual's ability to "clear a path" through the crowd or disentangle themselves from the "weave" of the social fabric (Ford 451). Both novels draw attention to the organic and autopoietic (or 'self-making') nature of social forms, suggesting that, in a kind of feedback loop, society helps to shape the very individuals who are themselves responsible for the creation of society.[25] Furthermore, both novels address the extent to which the individual is responsible for the wellbeing of others within the same system. The complex nature of the particular historical moment represented in these texts is expressed through a systems-aware realism which simultaneously reflects both the increasingly interconnected and interdependent nature of society and the failures of communication within it.

In this chapter I explore how these authors represent the ways in which the individual and society influence and shape each other. I argue that Howells and Ford

[25] For a full definition of *autopoiesis,* see Maturana and Varela.

specifically structure this reciprocal dynamic in systems terms as the interaction of interdependent agents within a complex system. In particular, I focus upon problems of perception, addressing the difficulties which individuals encounter when trying to visualize the totality of a city or nation. From a systems science perspective, we know that no individual agent is able to possess total knowledge of the wider system they exist within, because the number of interactions occurring at any one moment is unthinkably vast and also because the system possesses attributes only visible at a higher level, that of the whole. I suggest that this inability to fully comprehend the complexity of the social system leads to a further problematizing of meaning in both novels: since the individual is unable to perceive global order, their particular role within the system becomes unclear, which in turn produces feelings of disorientation and alienation. In a complex system, meaning (information) is not contained within individual agents, but is instead located in – and created by – interactions between agents. By extension, I ague that in these two novels the individual character's search for purpose and value leads to a realization on the part of the reader that meaning is not inherent to the individual, but is instead an emergent phenomena created through social relationships.

To demonstrate that Howells and Ford perceive society in systems terms I draw upon concepts from systems science when conducting my close reading of both texts. Looking in detail at the relationship between micro and macro system levels, I address the novels' concern with the role of chance in determining events at the micro-level and explore how the presentation of nonlinear causality affects the search for global meaning. I show how familiar anxieties about freewill and determinism are reformulated as questions of agency with regard to the role of individual agents. My analysis begins with a description of the isolated nature of the novels' main protagonists and moves towards an assessment of the extent to which these characters are able to make connections with others and achieve limited awareness of the important role society plays in the creation of selfhood. In the main body of the chapter I assess challenges which large-scale

simultaneity and nonlinearity present to the perception and representation of a complex social totality. I conclude with some thoughts upon the “new network” created by the loss of inherent meaning (Ford 208), one in which agents are (somewhat paradoxically) connected by feelings of isolation, and I consider the extent to which this network may be altered or transcended.

Until the concluding paragraph of *Independence Day* (see the epigraph to this chapter), Frank Bascombe refuses fully to immerse himself ‘in’ the crowd, preferring instead to maintain the role of a distanced observer, driving through town “to take a look but not to touch or feel or be involved” (424). Though Bascombe’s narration is at its most lyrical when speculating upon the actions and possible motivations of the people whose voices are carried to him on the breeze, he prefers them to remain the “sounds of faceless, nameless others” (323). Following his divorce and the death of his son Ralph he is reluctant to connect with others, withdrawing into what he calls the ‘Existence Period’: “to ignore much of what I don’t like or that seems worrisome and embroiling, and then usually see it go away” (10). However, in this final passage the call to “clear a path” and “make room” suggests the close proximity of others, an encounter which rather than being suffocating or oppressive quite literally makes the heart beat. Only a few pages prior to this scene, Bascombe expresses the view that “narrowly missed human connections […] can in fact be fatal” (434), and though he is here speaking in relation to the death of romantic love, we can take the statement as representative of the novel more broadly (it is a failure of connection that has partially contributed to the near blinding of his son Paul in an earlier chapter).

Keeping himself at a distance, Bascombe records multiple fragments of other lives captured from overheard conversations and voyeuristic glimpses. From these observations the reader is able to assemble within his or her mind a kind of collage of the nation, a picture composed of many individual agents acting simultaneously in a particular moment in time. William G. Chernecky suggests that that during the course of the novel,

Bascombe realises that “freedom and independence are not the same thing”, and that “true independence” necessitates “being a part of society” (174). Though Bascombe initially seeks to remain isolated from this collective, the novel progresses towards the paradoxical awareness that true ‘independence’ comes from being ‘independent together’, since even the individual self is a kind of collage, composed of not one, but many. We also see this presentation of simultaneity in *A Hazard of New Fortunes*. Phillip Lopate claims in his introduction to the Penguin edition that Howells was happiest when “showing simultaneous lives proliferating and streaming into the ocean of the quotidian” (xxiv). March’s descriptions of the urban panorama are full of the vibrancy and clamour of many simultaneous lives brushing up against one another, creating a collage of city life comparable to that seen in *Independence Day*. Through the preoccupation of their central protagonists with the “imagined communities” of city and nation, both novels reflect Benedict Anderson’s conception of the novel as “a device for the presentation of simultaneity […] or a complex gloss upon the word ‘meanwhile’” (25).

Like Frank Bascombe, Basil March is a detached observer of the human collective who, though finding the spectacle of the crowd “unfailingly entertaining” in a purely aesthetic sense, “did not take much trouble about […] what these poor people were thinking, hoping, fearing […] who and what they individually were” (162-63). Voyeuristically observing the lives of other city dwellers from the window of a coupé or an elevated train, as Basil likes to do, permits him only a “fleeting intimacy”, whilst the glass partition both inscribes a barrier of separation and frames the image as ‘spectacle’ (64). The Marches’ failure to make real connections with other city dwellers and engage with the reality of other people’s lives is the result of a limited middle-class perspective, and like Frank Bascombe they often choose to ignore anything which is unpleasant. Howells describes them as “very much wrapped up in themselves and their children” (21), and “too self-enrapt to perceive the chaos to which the individual selfishness must always lead” (164). This lack of connection, however, is more than just a reflection of individual

selfishness: it is also a result of the structure of the rapidly expanding city which works to facilitate communication but to frustrate meaningful connection.

One issue that negatively affects the extent to which the Marches are able meaningfully to connect with other city inhabitants is linked to the very multiplicity of perspective which the novel endorses: the sheer *scale* of the rapidly expanding metropolis. Basil informs Isabel that New York is so "vast" that "one could remain a stranger here […] indefinitely" (272), while Isabel's initial reluctance to move there is also based on its size: "I can't find myself in it […] I couldn't make my sympathies go round two million people" (22). As the novel expands the idea of simultaneity to encompass the nation, the thought that "at the same hour the same thing was going on all over the country" is "almost more than he [March] could bear" (269). The vast size of the city or nation frustrates attempts to perceive the whole, and provokes feelings of disorientation and loss of selfhood. We see a further example of how large-scale simultaneity frustrates perception in *Independence Day*, since it would be a physical impossibility for Bascombe to connect personally with everyone he happens to drive past on his journey across New Jersey. People in this situation are to some extent necessarily "faceless, nameless others" because it is just not possible to possess detailed knowledge of such a large system (323). Benedict Anderson suggests that belonging to a coherent and unified nation is a form of mental abstraction; in *Imagined Communities,* he writes that "an American will never meet, or even know the names of more than a handful of his […] fellow Americans" (26). We see an analogous relationship between the individual and the collective in complex systems science. Paul Cilliers suggests in *Complexity and Postmodernism* that "each element in the system [in this case, the individual citizen] is ignorant of the behaviour of the system as a whole" (4). A city or nation is so complex, and the number of agents and relationships within it is so vast, that any of its individual agents has no choice but to respond "only to information that is available to it locally" (4). In both texts the relationship between individual and collective reflects what we know about the structure

and functioning of agent-based systems.

Systems like the city or nation are characterised by large-scale simultaneity and are difficult to imagine in their totality. They exist in the mind as a kind of abstraction, while the detail of who and what people are 'individually' is inaccessible. As such, these novels deconstruct our perception of America as a unified entity with a single form of identity and mode of belonging. While the Marches take pride in the idea of nationhood, having their hearts warmed by "the friendly care the nation took" of its immigrants, Howells uses the character of Lindau to problematize and undermine the idea of a centrally controlled, unified nation (274). It is Lindau's view that a poor man has no country, and that furthermore "dere *iss* no Ameriga anymore!", if America means the right to 'liberty' for every individual (80, 287). Amy Kaplan draws attention to Lindau as a "hybrid presence" in *The Social Construction of American Realism,* since the hand lost in the Civil War marks him out as resolutely American, while his heavy German accent simultaneously foregrounds his immigrant origins. She suggests that: "instead of viewing the country as a common possession, Lindau represents the entire nation as a battlefield" (57). This sense of a social order created through internal conflict reflects the nature of all complex systems, within which there is no top-down control and where agents are "constantly organizing and reorganizing themselves into larger structures through the clash of mutual accommodation and mutual rivalry" (Waldrop 88).The idea of a singular, indivisible national identity is placed under further scrutiny in *Independence Day*, where in the wake of his son's accident Bascombe claims that communities are not continuous wholes but are instead "isolated, contingent groups trying to improve on an illusion of permanence, which they fully accept as an illusion" (386). Later he reinforces this view with the claim that, though "we want to feel our community as a fixed, continuous entity [...] we know it's not, that in fact beneath the surface (or rankly all over the surface) it's anything but" (439). Here Howells and Ford are both drawing attention to the fact that any community (city or nation) exists as a system of disparate individual agents whose existence as an

organizational structure depends on the continued agreement of its agents to conform to certain conventions of action and belief.

Both novels present the nation as diverse and multiple with patterns of communication which link together disparate agents into coherent network structures. Sub-systems of organization are created which form microcosms of the larger national system. In *A Hazard of New Fortunes*, the magazine *Every Other Week* provides a connecting link between otherwise unrelated individuals within the city. March comments on the "incongruities" the magazine involves, bringing together as it does "a fraternity and equality crank […] a belated sociological crank […] a truculent speculator […] a humanitarian dreamer […] a sentimentalist […] a nondescript […] a pure advertising essence […] and a society spirit" (293).The realty office in *Independence Day* is full of people from diverse backgrounds: "one person had a Ph.D. in American literature; another had left a seat on the Exchange; a third was a dentist", while the man who recruits Bascombe (a former sportswriter) had previously been a supermarket developer and a policy strategist (112). Ford presents the real-estate industry as an important connecting factor between all of the individual agents that make up the nation, since as Bascombe suggests, "most Americans will eventually transact at least some portion of their important lives in the presence of realtors or as a result of something a realtor has done or said" (40). At some point in their lives almost every American is likely to be involved in the buying, selling or renting of a home through the mediation of a realty agency. In addition, Bascombe's specific role as a realtor mediating between buyers and sellers within the system mirrors his connective function in the text: as the narrator he is responsible for loosely grouping together all of the characters in the novel (though his perspective is by no means always authoritative, and he is hardly ever in control).

Despite these connective factors both novels are full of missed communications and failed connections, evidence perhaps that the authors sense something amiss in the functioning of the nation as a system. In *Independence Day*, Bascombe has a host of

communication problems: he claims that his partner Sally communicates by sending "coded messages" which he has "no idea how to translate" (9), while his ex-wife, too, he finds "harder to read these days" (181). He attempts unsuccessfully to communicate with his troubled son Paul through the indirect medium of historical texts like Emerson's "Self-Reliance" and *The Declaration of Independence* instead of engaging the boy on his own terms (8). He also often worries about "not getting [his] message across" and fears that he does not project his own identity successfully (192). The novel contains many telephone calls, a medium of communication meant to connect individuals, yet all too often in this text the caller gets only "rings and more rings" and the message remains undelivered (194). Bascombe checks his answering machine at one point and receives ten missed messages: some are repeated calls of increasing urgency, some contain no information at all (the caller hung-up), and some contain garbled 'noise' (for example, "bark, bark, bark, bark, bark" from his son Paul) (179). Such messages leave him frustrated and "at a complete loss", not only because he missed the initial attempt at connection, but also because he is unable to communicate a response, since it was "all recorded hours ago" (171).

While information transfer within the private sphere is not working correctly, the novel also indicates that there may be corresponding problems within the public sphere and thus the nation as a whole. We have already seen how increased scale of society frustrates connection; Bascombe also comments on the increasing pace of life within society as something which makes it difficult for the individual to be in control and to act decisively. He suggests that "maybe the thing you see coming from far away is not the real thing, the thing that scares you, but its aftermath. And what you've feared will happen has already taken place" (5). Basil March has a similar realization in *A Hazard of New Fortunes* when he remarks that the motion of the train which causes the foreground to rush away behind him creates the effect of "retreating past, and advancing future, and deceitfully permanent present" (34). It seems impossible for the individual to keep pace

with the speed of change and corresponding increases in social complexity. In addition, whilst *A Hazard of New Fortunes* is set against the backdrop of civil unrest, *Independence Day* is also set against a period of economic decline and widespread alienation from the political system (the week prior to July 4th, 1988). The forthcoming presidential election (which saw the election of George H. W. Bush) is mentioned briefly alongside the comment from Karl Bemish that "we're all distanced from government. It don't mean anything in our lives. We're in limbo" (137). When Bascombe encounters a state minimum-security facility, he speculates that the inmates are "probably just people we all voted for and will again", whist house-seller Ted confirms that "an alderman from West Orange" once climbed over the fence" (81). Random acts of violence are also seen to be changing the nature of the system: as Bascombe witnesses the fallout of two random and apparently motiveless killings (that of Clair Devane and a man at the Sea Breeze Motel), he remarks that those left behind are "no longer connected in the old manner", but are in "some new network now, where caution is both substance and connector" (208). As the social system increases in complexity, individuals are paradoxically united by feelings of isolation, unable to perceive a meaningful sense of community.

What worries Bascombe about this "new network" is the role of chance (208). He is troubled by the feeling that events could have turned out in a number of different ways, and that as a result, there is no sense of necessity or purpose in his life. Everything that happens to characters in the novel is the result of apparently random occurrences, some beneficial (Bascombe's chance meeting with his estranged step-brother) and others harmful (the apparently motiveless murder of Clair Devane). This lack of inherent meaning creates problems both for the perception and the narration of systems. At the micro-level of a complex system, events happen largely by means of chance collisions, while meaning in the sense of a coherent pattern or design only emerges at the macro-level, the level of the system as a whole. This emergent meaning is only accessible to the individual through fleeting glimpses, such as momentary feelings of simultaneity or synchronicity.

What connects individuals here is precisely this shared feeling of isolation, of not being able to perceive a total pattern. We see this inability to perceive a sense of global order, too, in *A Hazard of New Fortunes*, when March complains about the "economic chance world" in which we find ourselves, within which no one's access to employment is certain (396).

Within *Independence Day*, an awareness that the individual is in reality but one small agent within a larger system is often a cause of anxiety. For example, Joe and Phyllis Markham suffer from what might be termed 'purchase related anxiety' as a result of their realization that the individual is equal to, and yet as a result largely indistinguishable from, other home-buying agents within the system (57). Bascombe refers to this condition as "the realty dreads", and suggests that it originates "not in actual house buying [...] but in the cold, unwelcome, built-in-America realization that we're just like the other schmo, wishing his wishes, lusting his stunted lusts [...] all of us popped out from the same unchinkable mold" (57). This relative anonymity is a source of concern because it would appear to negate the individuality and independence of the 'I'. It suggests that within any system of organization (the nation or the real-estate industry) each individual has an identical status and is therefore replaceable, since their value is not inherent to their being but instead lies in their function (as homebuyer or taxpayer, for example). The real-estate industry provides an excellent example of the relative indifference of the system to the individual, since if you don't buy a particular house then it is likely that someone else will. Bascombe states that no one ever ends up with the house that they want because: "a market economy [...] is not even remotely premised on anybody getting what he wants" (41). The aim of the market is to continue its own existence by whatever means necessary, not to cater to the needs of a specific individual. Howells makes a similar point in *A Hazard of New Fortunes,* when he has the Marches conclude their flat search with the realization that "you can't get what you want"; though the Marches blame "illusory" house agents for this problem, rather than recognizing that their expectations are

unrealistic (44). In addition, Fulkerson suggests that no member of staff is essential to the continued existence of the magazine (which functions as a microcosm of the wider social system), since “it’s astonishing how you always *can* get along in this world without the man that is simply indispensable” (400).

Howells draws on Darwinian ideas of natural selection in order to suggest the social system’s indifference to the individual. Following the death of Conrad Dryfoos, Fulkerson exclaims: “what a lot of the raw material of all kinds the Almighty must have, to *waste* us the way he seems to do” (401). Nature works by overproducing: each species creates a surplus of individuals and, as a result of predation or other environmental factors, not all individuals in any generation survive to reproduce. This surplus is constantly being refined by natural selection, since only the best adapted (not necessarily the ‘fittest’) will survive. Foregrounding both the role of chance (‘hazard’) as a shaping force in society and the living, organic nature of the social, March points to the city exhibiting a “play of energies as free and planless as those that force the forest from the soil to the sky” (164). The word ‘planless’ indicates that March feels that there is a lack of design in the biological and the social world and thus a lack of meaning or purpose. Since natural selection deals only with populations, the fate of a particular individual is largely irrelevant to the survival or functioning of the whole. To March, the ”fierce struggle for survival, with the stronger life persisting over the deformity, the mutilation, the destruction, the decay, of the weaker” seems “Godless” because it lacks human (specifically religious) morality, or “intelligent, comprehensive purpose” (164). Natural selection does, however, possess aspects of design or purpose, albeit ones which remain invisible to the individual. Daniel Dennett argues in *Darwin’s Dangerous Idea* that though evolution springs from chance mutation it does make sense to talk about design in relation to the process of natural selection (68-73). This represents, in effect, a form of ‘systemic design’ (my term), since the overall pattern or plan is only visible at the level of the whole. Evolution occurs gradually and invisibly over unthinkably vast periods of time. We do not perceive it as

design because it does not emanate as a unified concept from the mind of a single individual; instead it is the sort of design which accumulates over time, the result of a whole system 'learning' how best to live, in conjunction with its environment (72, 205). Meaning, in this sense, is problematized at the level of the individual but restored at the level of the collective, and in perceiving systemic reality in this way, Howells (though not March) strongly anticipates more recent systems novelists.

John H. Holland explains the replaceable nature of system agents by suggesting that the patterns of interaction which characterise a system "persist despite a continual turnover in the constituents of the patterns" (7). Holland uses the example of a standing wave in a white-water river to illustrate this point, suggesting that: "the water molecules making up the wave change instant by instant, but the wave persists" (7). Within the human social system an individual life has the importance of a single water molecule in a wave: it is replaceable. This position evidently has serious moral and ethical ramifications: it stands in opposition to theological teaching, which has consistently stressed the importance of each individual soul in the eyes of God; it runs counter to our own subjective experience of what it means to be an individual. If no one is of any real importance to the social collective then of what importance are emotional attachment, love, loss and grief? Paul Cilliers suggests that meaning in a complex system is derived not from matter, but from the connections and relationships between entities. For example, he argues that:

> The carbon atoms in my body can all be interchanged with carbon atoms from the wood of my desktop, and there will be no noticeable difference. The significance of each atom therefore is not determined by its basic [inherent] nature, but is a result of a large number of relationships between itself and other atoms. (35)

Therefore, we might conclude that though our bodies are replaceable (new people are always being born to take our place in various systems), there are certain relationships,

connections or influences between individuals which continue to resonate after this loss. For example, Bascombe and Dryfoos are agents who have lost children and whose characters have been deeply and irrevocably influenced by this.

Both the novels I have been discussing explore the relation between free will (or independence) and social or biological determination. In *Independence Day*, all the agents in the realty business "worked as independents but acted in concert whenever possible" (112); similarly, in *A Hazard of New Fortunes*, the contributors to the magazine are largely freelance independents who collaborate in the production of a particular issue. As such, Fulkerson argues that together they symbolize: "a lot of literary fellows breaking loose from the bondage of publishers and playing it alone" (8). However, following a disagreement with the financial backer Dryfoos, March weighs up his ethical and economic priorities and comes to the conclusion that his independence is illusory: "he realised, as every hireling must, no matter how skilfully or gracefully the tie is contrived for his wearing, that he belongs to another, whose will is his law" (318). With his actions seemingly determined by the system which employs him, March also recognises the additional constraint placed upon him by family ties; that "he was not master of himself, as he once seemed, but the servant of those he loved" (83). Despite the significant influence which Dryfoos has upon the lives of the magazine's employees, however, it would be a mistake to conclude that as a result *he* has the ability to determine his own life. Dryfoos is equally constrained within the system of industrialised capitalism, as he admits to his wife: "I feel like I was tied hand and foot […] I don't know which way to move" (210). Money has no impact on the amount of control an individual has within the system, since as 'Liz'beth says: "the richer you git, the less you aint able to stay where you want to, dead or alive" (205). Howells illustrates that it is rather the action of economic exchange that controls the individual, describing New York as the place "whither the men who have made money and do not yet know that money has made them all instinctively turn" (236). There seems no way for the individual single-handedly to reverse or undo the actions of a nonlinear

system: Dryfoos and his family cannot go back to their old farm and leave the system of which they are now a part, since due to expanding industrialization “there is no farm anymore to go back to” (205). Dryfoos sees his entry into the financial system as determined or inevitable, that “it had to be […] I couldn’t help but sell the farm” (210). Similarly March ends the novel by insisting that human lives are determined, in effect “forecast from the beginning of time” (440).

Though this seems to imply that all individuals are determined by the system or systems of which they are a part, Howells does not endorse an attitude of passivity as a response to this possibility. The character of Beaton, who blames his faults on “human nature” and gets “bitter at fate” when things don’t occur as he would like (149), along with March and his belief in divine justice, are gently satirized and thus kept at an ironic distance from the authorial viewpoint. March’s assertion that people should go to the theatre and forget the conditions of the poor is not endorsed by Howells, who seems to suggest that we should act ‘as if we could’ change the system even if this is not always possible (326-27). In contrast to Beaton, for example, Alma resolves to determine her own life and be “free” (352). With regard to marriage she resolves that, in opposition to the prevailing system of social conventions, “I shall pick and choose as a man does; I won’t merely be picked and chosen” (431). In addition, the decision of Conrad Dryfoos to defy his rich and powerful father and decide upon a religious calling instead of a business career is regarded positively within the text, even if it ultimately leads to Conrad’s death. Similarly, in *Independence Day*, Bascombe takes the view that though the feeling that “we’re in control of anything” is “a fiction” (52), you must still “make choices and live with them, even if it you don’t feel like you’ve chosen a damn thing” (66).

Both novels suggest that causality is a complex matter involving multiple factors, an attitude which reflects the dynamics of nonlinear systems. Within complex systems nonlinear activity means that “small causes can have large results, and vice versa” (Cilliers 4). The large number of agents involved means that “the changes that occur at

the macro-level are the aggregate consequence of thousands, millions or even billions of tiny stories that play out at the micro-level" (Abbott 235). At the beginning of *Independence Day*, Bascombe suggests that although "one event rarely *causes* another in a simple way" there must be *some* form of connection or relationship (though invisible to the individual agent) between such disparate aspects of the nation as the economy, real-estate values and the national well-being (5). Here, Bascombe also references a kind of 'butterfly effect' (the most famous example of nonlinear causation), claiming that if a "firm's stock took a nosedive" then its "people" would be affected in all kinds of unpredictable ways, like staying at their desks an extra hour and then having disagreements with family members who themselves would be affected, and so on (5). When Basil March or Frank Bascombe encounter something beyond their own limited middle-class perspective, it is always seemingly by accident or through a chance collision. The Marches attempt to impose a religious reading onto Conrad Dryfoos' death, claiming that he "suffered for the sins of others" and that the events of the strike prove a "moral government of the universe" (409). However, this attempt is largely undercut by the apparently random nature of Conrad's death which does not proceed in any obvious cause and effect relation from either his political opinions or his ethical intentions. At the time he is shot, Conrad is walking "aimlessly" with only a vague intention of intervening peacefully in the strike and has not yet spoken to the strikers (383). In his introduction to *A Hazard of New Fortunes*, Lopate is critical of the ending, arguing that Conrad's death "cannot bear the weight of a character acting wilfully, irrevocably, tragically"; that instead it "seems almost an accident" since "it does not emanate from the plot preceding it" (xxiv). However, rather than a failing within the narrative, I would suggest that this part of the novel's ending reflects the complexity of real life more accurately than a more contrived tragic climax would have. Everett Carter suggests that Howells' concept of realism led him to the view that "a novel would be misleading and harmful if the people, or the circumstances, were contrived" and therefore "arranged without regard to the truth of

men's motives and passions, and the facts of their physical surroundings" (101). Howells presents a world which is ruled at the micro-level by chance collisions. When March attempts to impose a religious reading upon Conrad's death in the suggestion that he "suffered for the sins of others", his words sound hollow and inadequate (409). March is unable to conceive of a world which is ruled by randomness and which is indifferent to the fate of the individual, hence his suggestion that the well-dressed beggar in the street might (must!) be a confidence man (398). At the micro-level, perceptions of individual meaning and purpose can only be gained in fleeting glimpses, such as the feeling of "dreamlike simultaneity" which Conrad briefly experiences before his death (383), or the "feeling of bright synchronicity" experienced by Bascombe in *Independence Day* (94).

For Ford, the individual self is also seen as a complex entity composed of multiple conflicting agents and for the self to become independent in the sense of united and whole it is necessary for all of these competing constituent agents to "agree to be independent together" (259). Bascombe describes his relation to Paul as coaxing "by some middlemen's charm his two foreign selves, his present and his childish past, into a better, more robust and outward tending relationship – like separate angry nations seeking one government" (15). Later he makes reference to this same issue: "Paul's difficulty in integrating his fractured past with his hectic present so that the two connect up in a commonsense way and make him feel free and independent" (259). Though the analogy between self and nation is complicated by the somewhat distanced and satiric tone which Ford often takes toward Bascombe, in this case the analogy is reinforced by a host of other references to the complexity of the self and of modern life. Bascombe abandons a literary career at least in part because he realizes that he cannot make his words meet the complexity of real people. He claims that he never wrote about his wife because: "if I could encapsulate her in words, it would mean I'd rendered her less complex than she was" (158). Though Bascombe claims that his life is "simplicity's model", he follows this statement with the contrasting claim that his life is approaching "some

tightening, transforming twist in the kaleidoscope" (7), thus acknowledging his existence to be a complex and ever-changing series of patterns.[26] Bascombe also sees his life as being in flux, wishing that he could see himself as "occupying a fixed point rather than being in a process" (285), and also confessing that sometimes he senses that "I myself am afloat and cannot always feel the sides of where I am" (117).

The complexity and inner multiplicity of the individual self also emerges as an issue in *A Hazard of New Fortunes*. Near the conclusion of the text March claims that we don't 'change' but instead develop, since "there's the making of several characters in each of us; we are each several characters, and sometimes this character has the lead in us, and sometimes that" (440). This solipsistic interpretation of multiplicity suggests that environmental influences do not change us. Yet earlier, in reference to Mrs Leighton, Howells writes that "she was not merely a prevailing mood, as people are apt to be in books, but was an irregularly spheroidal character, with surfaces that caught the different lights of circumstance and reflected them" (94). This quotation again stresses the multiplicity of the self but more accurately suggests the way in which as open systems we are shaped by our environment.

When Paul quotes the following line of Emerson's "Self-R*eliance*": "the great man […] is he who in the midst of the crowd keeps with perfect sweetness the independence of solitude", his "pseudo-reverent Charlton Heston voice" combined with his literal tearing out of the page suggests that in this text "independence and isolation [are] not the same" (369). Paul's translation of the text back into nonsense: "quack, quack, quack, quack. I am the great man, the grape man, the grape fruit, the fish stick –", suggests that the

[26] Waldrop relates that W. Brian Arthur has drawn analogies between the patterns formed by complex systems and kaleidoscopes. Waldrop writes that the patterns created by diverse systems "reminded him of nothing so much as a kaleidoscope, where a handful of beads will lock in to one pattern and hold it – until a slow turn of the barrel causes them to suddenly cascade into a new figuration" (31). Chernecky refers to Richard Ford's use of "an intricate montage of cultural images that Frank turns like a kaleidoscope of contemporary America" (158). See also my reference to Wharton's use of the term *kaleidoscope,* quoted in Chapter 6 (132).

communication of meaning has failed (between Emerson and Paul but, more importantly, between Paul and his father), and that as a 'quack', Emerson is unqualified to prescribe for the complex experiences of the modern age (291). *Independence Day and A Hazard of New Fortunes* suggest that life in the social system of America at the turning point of the twentieth and twenty-first centuries was at a similar stage of heightened interconnection and interdependence, yet also rife with alienation, isolation and persistent failures of communication. In addition, though technology, science and social thought have undoubtedly advanced in the period between the writing of the two texts, the fundamental human concerns of free will and fate have remained the same, though they are now figured as an opposition between individual agency and the social structure. The "complex independence" (230) of *Independence Day* (and *A Hazard of New Fortunes*) is somewhat paradoxically based on achieving freedom from the constraints of the self through the creation of meaningful and often complicated relationships with others.

In the following chapter, the concern with the simultaneous activity of individuals within a single community or nation is expanded to a consideration of simultaneous activity occurring across the entire globe. Frank Norris and Richard Powers extend the limits of the social system under consideration in order to encapsulate the complex processes of globalization. In particular they represent corporations as complex systems, interrogating the extent to which they shape individuals and are shaped by them in turn. The next chapter continues and develops this chapter's insight into the extent to which being part of a social system gives rise to feelings of anxiety and alienation. From an investigation of perception – how we perceive the role of the individual within larger systems – the next chapter turns to the questions of representation and value. I investigate the importance (or relative unimportance) of an individual agent to the functioning of a large social system and the ethical implications raised by the application of this aspect of systems science to human relationships. I consider the tension which Norris and Powers create between two contrasting interpretations of value, as they debate

whether social and economic systems enhance our lives or endanger them. Moving beyond a consideration of the way in which characters perceive systems, I also address how authors themselves attempt to conceptualise and narrate the vast complexity of global networks and whether it is possible to represent the activity of complex systems within the form of a realist narrative.

Chapter 5: Frank Norris, Richard Powers and the Representation of Corporate Systems

Both the late nineteenth and late twentieth centuries were periods of intensive globalization, when advances in communication and transportation technologies brought countries across the globe closer together in space and time. Politically, socially and economically, people began to interact more freely across national borders. The complexity of trade increased rapidly in the nineteenth century, and not only because of the expansion of global markets for the buying and selling of goods. As a result of a series of legal rulings, in particular *Dartmouth College vs. Woodward* in 1819, the corporation became defined in United States law as a single individual, afforded all of the rights and protections which individuals could expect, but also protected from legal challenge (Harris 167-69).[27] This greatly accelerated the growth of corporations in the nineteenth century, providing considerable incentives for businesses to incorporate. In the late twentieth century, corporations became increasingly transnational, and as Philip Leonard notes, "increasingly detached from particular national or geographical locations" (6). The emergence of the corporation as a complex, powerful and seemingly invulnerable global entity, neither confined to nor regulated by any national market, is the subject of the two novels considered in this chapter.

The Octopus (1901) and *Gain* (1998) share a concern with how the individual and the corporation interact and shape each other in an increasingly global age. Both novels approach this inquiry from a systems perspective, by which I mean that they represent corporations as complex systems: agent-based, self-organizing structures which are more than the sum of their parts. As I explain in more detail shortly, Richard Powers' writing is directly influenced by wide reading in various areas of scientific theory, and in particular a knowledge of systems science. However, even without this background, Frank Norris, too,

[27] For more on the "emergence of the modern corporate form of ownership" (Trachtenberg 4), and its expression in late nineteenth-century literature, see Trachtenberg, Michaels and Harris.

saw the importance of thinking contextually, situating characters within the wider systems of which they are a part and connecting the small-scale and local with the global. Like *A Hazard of New Fortunes* and *Independence Day*, these novels consider how the individual and the collective interact: how they communicate, or perhaps fail to communicate, because of their incommensurate scales. They question whether it is possible to 'think globally' and translate this thought into action on a global scale.

After an initial discussion of Richard Powers' knowledge of systems science and how this influences his fiction, I focus my close reading in this chapter upon issues of value and representation. With regard to the question of value, I suggest that both Powers and Norris make the relationship between corporations and individuals deliberately ambiguous. In each text, corporations are compared to biological organisms because they are both complex systems and as such have certain structural features in common. However, these analogies are also deliberately complicated by these authors' introduction of what would usually be seen as a Marxist perspective. By this I mean that they consider the possibility that rather than reflecting fact, biological analogies merely obscure human controlled systems of oppression. Whether we are to regard this relationship as parasitic and harmful or mutualistic and beneficial is an issue which, I suggest, Norris and Powers leave unresolved. I also address what form of value is accorded to a single individual within a complex social and economic system, a concern which again gives rise to conflicting Marxist and systemic (biological) readings.

Moving on to the issue of representation, I argue that complex systems, particularly ones such as corporations which operate on a global scale, are difficult to imagine in their totality and difficult to represent in narrative form. Their nonlinearity and distributed structure make the attribution of cause and effect, in particular, extremely complicated. We see this representational challenge reflected within *The Octopus* and *Gain* in a debate over whether it is reasonable to hold individual employees or shareholders responsible for processes which they can influence but not directly control.

The novels question how we apportion blame when guilt cannot be proved and when the alleged guilty party is a collective organization composed of millions of individuals. Both novels are situated firmly within the broad field of literary realism, yet I argue that there are ways in which systems-awareness forces Norris and Powers to adapt their mode of narration in order to engage with these formal difficulties.

Richard Powers' use of systems content in *The Gold Bug Variations* (1991) has been documented in essays by Trey Strecker and Scott Hermanson.[28] Strecker in particular is of the opinion that within this novel, "Powers's writing foregrounds a passionate interest in the life sciences, in particular, the dynamics of complex adaptive systems". I would argue that Powers' interest in system dynamics is also evident in previous and subsequent novels, particularly in *Gain* (1998). In addition to possessing an awareness of contemporary systems science, Powers is also familiar with Tom LeClair's analysis of novels which are influenced by global systems and sees himself as writing systems-influenced fiction.

LeClair refers to Powers' first novel, *Three Farmers on their way to a Dance* (1985), as "systems influenced but not excessive in […] form or style" and thus not suitable for inclusion in his new 'systems novel' genre (*Excess* 29). In "Making the Rounds", Powers agrees that his fiction does not exactly fit LeClair's formulation of "excessive […] exhaustive and exhausting" systems novels (306). He states: "I'm not sure that all or even most of my books have ever fit comfortably into the framework that LeClair initially envisioned" (306). Powers argues that LeClair "clearly positioned the newly-named genre as a variety of postmodernism", through his choice of novelists such as Pynchon as exemplars of the form (306). Powers, by contrast, writes largely realist fiction; he does, however, see this realist fiction as systemic. As such, Powers suggests that LeClair's formulation of the concept may need revising in order to reflect how "the human world and

[28] See Scott Hermanson's "Chaos and Complexity in Richard Powers's *The Gold Bug Variations*" (1996), and Trey Strecker's "Self-Organization and Selection in Richard Powers's *The Gold Bug Variations*" (2004).

its conditions of existence have been transformed many times over in the years since 1987" (307). Powers strongly indicates that the concept of a systems novel has continuing relevance for fiction writers today, since LeClair stresses the importance of thinking contextually and of situating character within wider environments, and this is something which Powers sees as being important for his own writing practice. Powers writes that within a systems novel, authors are presented with an opportunity to represent "complex processes of reciprocity in which selves and environments come to bring about and shape each other" (306). This emphasis on process and contextual thinking can be seen throughout his fiction.

Powers suggests that a twenty-first century 'systems novel' would function as a "hybrid" of realism and postmodernism, "forcing the reading self into constant reciprocal renegotiations by always insisting that no level of human existence means anything without all the others" (308). For Powers, therefore, the aim of a systems-aware novelist is to reorient the reader's perspective towards a consideration of wholes by taking into consideration "the levels above and below the eye-level self" (306). Powers raised this issue of moving beyond the 'eye-level' when he and Tom LeClair were interviewed by Scott Hermanson as part of the University of Cincinnati's 2005 Ropes Lecture Series. During that interview he made the following remarks on character construction:

> Character is in fact much smaller and much larger than simply this middle, eye-level gauge. Temperament is just a single, unstable node in a web that fiction can trace all the way down into levels as low as brain chemistry and all the way up into levels as complex as geopolitics and global history. For me, the goal of writing has always been to pull apart and to widen that little aperture of narrative identification and connect our sense of character both downwards and upwards – to represent our sense of self as a function of everything else there is. ("Home.")

Powers' concern with systems manifests itself within his fiction, therefore, through the inter-relating of micro and macro-levels. A consideration of the self must take into account both individual agents – neurons, cells, enzymes – and large contextual wholes such as the economic systems which individuals operate within.

This attempt to widen the aperture of narrative identification can be seen in the following passage from *Gain* (1998), which details the vast network of production and assembly required to produce a small, everyday object like a disposable camera. Both Powers and Norris are concerned with revealing the complex relationships between people created by globalization, particularly as a result of the influence of large corporations. The section of the text from which this passage is taken encourages the reader to consider how individuals, including themselves, fit contextually within the processes of globalization. Having indirectly informed us of the death of Laura Bodey by showing us a nurse emptying the contents of her hospital room, Powers then immediately engages in a long digression examining the construction of a camera left abandoned in one of the room's drawers:

> The camera jacket says: "Made In China With Film From Italy Or Germany." The film itself accretes from more places on the map than emulsion can cover. Silver halide, metal salts, dye couplers, bleach fixatives, ingredients gathered from Russia, Arizona, Brazil, and underwater seabeds, before being decanted in the former DDR. Camera in a pouch, the true multinational: trees from the Pacific Northwest and the southeastern coastal plain. Straw and recovered wood scrap from Canada. Synthetic adhesive from Korea. Bauxite from Australia, Jamaica Guinea. Oil from the Gulf of Mexico or North Sea Brent Blend, turned to plastic in the Republic of China before being shipped to its mortal enemies on the mainland for molding. Cinnabar from Spain. Nickel and titanium from South Africa. Flash elements stamped in Malasia, electronics in Singapore. Design and color transfers

> drawn up in New York. Assembled and shipped from that address in California by a merchant fleet beyond description, completing the most heavily choreographed conference in existence. (347-48)

By juxtaposing an individual's death with a disposable product like this camera, and then illustrating the complex web of relationships which brought the camera into being, Powers suggests that we too are complex, both in terms of our biological construction and in terms of the social and economic networks which shape our lives. We too are a "disposable miracle": entities with only a single life, whose mortality means that, like the camera, we too are in a sense "designed to be pitched" (348). In this passage, Powers shows that in today's globalised world a single product is frequently only a small part of a vast and complex system of production, whose operations may span continents. By extension, the individual people touched by this manufacturing process are also entangled within such systems. By drawing our attention down to the micro-level of chemical components and then subsequently connecting this outward to the macro-level of trade relationships between nations, Powers shows us the systemic nature of the globalised world.

These vastly distributed processes of action and interaction are largely invisible to the consumer who buys the camera, and we may argue that this is a deliberate strategy on the part of the corporation – an attempt to obscure the potential harm (environmental and human) which underlies our first-world conveniences. Fredric Jameson suggests in *Postmodernism; Or, The Logic of Late Capitalism,* that "reification", the "effacement of the traces of production from the object", plays a significant role in consumerism today, since individuals are freed from guilt if "they are not able to remember the work that went into their clothes and furnishings" (314-15). However, the intangibility or inaccessibility displayed by the corporation is not only a conscious marketing strategy, but also an indirect result of the corporation's distributed and complex structure. A multinational

corporation is not directly tied to any particular country with regard to where its goods are produced or sold, and the relationships between its consumers and producers are constantly changing as processes evolve to meet changes in supply and demand. Our lack of awareness about the way that corporations operate may thus also be attributed to our inability to comprehend global complexity. Powers' reference to "a merchant fleet beyond description" suggests that these vast numbers of corporate interactions may also be beyond the ability of language to represent with any accuracy (348). The scale of a corporation's activities may even be beyond the comprehension of a single human mind. Powers refers to the camera's assembly as "a feat of master engineering […] too complex for any user to follow" (348). In a moment I explore more fully the tension between a Marxist reading of systems (which sees our inability to fully perceive corporate complexity as a deliberate strategy of obfuscation) and a systems reading (which would suggest that difficulties of perception and understanding result directly from the complex nonlinear structure of the system). Clearly, there are significant moral or ethical distinctions to be made between these two perspectives. Systems theory, for instance, seeks to be morally neutral, concerned only with the description of what is and not the suggestion of what should be. The oppression of workers, therefore, being a political or philanthropic issue, is not of concern to system theory's analysis of corporate structure. The systems-aware novel, however, while acknowledging the extent to which corporations embody biological principles, cannot escape the issue of morality.

In its momentary glimpse of a complex, global whole, this passage provides an example of what Bruce Robbins refers to as the "sweatshop sublime" and that which Jameson calls the "postmodern sublime". Jameson thinks that the "whole new decentred global network of the third stage of capital" (referred to as late capitalism or multinational capitalism) is "difficult for our minds and imaginations to grasp" (38). Various features of postmodernism represent an attempt "to think the impossible totality of the contemporary world system" (38). For example, disorientation in the wake of late capitalism's reshaping

of space is for Jameson a symbol of “the incapacity of our minds, at least at present, to map the great global multinational and decentred communicational network in which we find ourselves caught as individual subjects” (44). Similarly, Bruce Robbins’ concept of the ‘sweatshop sublime’ is seen when a person is given a “moment of insight” into the global, social whole. Robbins describes it as a moment of power, where “in thought, at least, you are launched on a one-click leap […] to the outer reaches of a world economic system of notoriously inconceivable magnitude and interdependence” (268). This insight can only be momentary, however, because we are forced to confront, in accordance with Kant’s view of the representational difficulties inherent in the experience of the sublime, “a feeling of the inadequacy of the imagination for presenting the ideas of a whole” (268). Thus the experience evokes both pleasure (feelings of transcendence and power) but also pain, as “suddenly, just as shockingly, you are returned to yourself in all your everyday smallness” (268). For Robbins at least, this experience can promote positive social action, since it forces upon us “the knowledge of social interdependence”. Bruce Robbins uses the following passage from David Lodge’s *Nice Work* (1988) to illustrate his concept. This passage anticipates the previous passage from *Gain* in its concern with promoting awareness of systemic processes which tend to be ignored or neglected. Such relationships exist outside of our eye-level perspective in part because they pertain to objects which are so common and mundane, and in part because the system of production is excessive and almost unthinkably complex:

> The housewife, switching on her electric kettle to make another cup of tea, gave no thought to the immense complex of operations that made that simple action possible: the building and maintenance of the power station that produced the electricity, the mining of coal or pumping of oil to fuel the generators, the laying of miles of cable to carry the current to her house, the digging and smelting and milling of ore or bauxite into sheets of steel or aluminium, the cutting or pressing

> and welding of the metal into the kettle's shell, spout and handle, the assembling of these parts with scores of other components – coils, screws, nuts, bolts, washers, rivets, wires, springs, rubber insulation, plastic trimmings; then the packaging of the kettle, the marketing of the kettle to wholesale and retail outlets, the transportation of the kettle to warehouses and shops, the calculation of its price, and the distribution of its added value between all the myriad people and agencies concerned in its production and circulation. The housewife gave no thought to this as she switched on the kettle. (269)

Like Powers, Lodge here is engaged in reorienting the reader's perspective from local to global. He presents the majority of people in society as "inhabiting their own little worlds, oblivious of how they fitted into the total picture" (269). By addressing the parts which come together to form a kettle and then expanding this perspective outwards to the processes which come together to make a whole manufacturing system, Lodge raises awareness of how each individual exists as a single agent within the social whole. Like Powers, Lodge is ambivalent as to whether we should view corporate systems like these as beneficial or harmful. The individual who sits contemplating the housewife and her kettle relates that "it was difficult to decide whether the system that produced the kettle was a miracle of human ingenuity and cooperation or a colossal waste of resources, human and natural (270). The "added value" from the process which Lodge refers to in this passage is financial profit, the emergent 'gain' from which Powers' novel gets its title. Both texts also indicate, however, that there is no gain without loss.

The nineteenth century too was a period of unprecedented globalization, and we see this depicted in *The Octopus* through changes in farming practices. This new global system of agriculture is registered by Alan Trachtenberg in *The Incorporation of America*; he suggests that during the latter part of the nineteenth century "agricultural products entered the commodities market and became part of an international system of buying,

selling and shipping" (21). We see the result of this process in *The Octopus,* where the arrival of railroad and telegraph brings to the ranchers of the San Joaquin an increased awareness of their entanglement within just such a system. Russ Castronovo claims that "at the start of the twentieth century […] the international crisscrossing of markets, commodities, and value comes to be conceptualized as a unified structure – the globe" (159), and that in keeping with this historically specific formulation, *The Octopus* forms "an aestheticized portrait of the global" (158). Connected by wire and rail to a network of other wheat producers and distributors across America and England, the new reliance (or dependence) on machine technology forces the ranchers to feel "the effects of causes thousands of miles distant" (54). In bringing distant geographical locations closer in time, such technology provides individuals with a heightened awareness of the simultaneous activity of other agents acting within the same economic system. When Vanamee contemplates the vast empty space that surrounds him on the ranch, Quien Sabe, he thinks not of his isolation as an individual but of "other ranches, and beyond these others, and beyond these still others, the immensities multiplying to infinity" (130).[29] This has a disorienting effect on the individual. In *A Hazard of New Fortunes*, we saw Basil March experience "an almost loss of individuality at times" when contemplating the simultaneous lives of other occupants of his particular social system (the city) (268). Similarly, in *The Octopus* Norris claims that the ranchers occasionally felt themselves "merely the part of an enormous whole", a single unit in a "vast agglomeration", something which at times causes them to lose the sense of "their individuality" (54). Like the individuals in our earlier discussion of the sublime, these characters struggle to fully imagine the immense scale of simultaneous activity contained within the social whole.

Being part of a collective often improves an individual entity's chances of survival, and throughout evolutionary history individuals have been banding together into large groups. Despite fearing a loss of individualism, characters in *The Octopus* frequently turn

[29] Quien Sabe translates into English as "who knows?".

to collective action when they feel threatened or are engaged in seeking greater power. When 'mob mentality' takes the place of individual rational action, Norris describes the crowd as a single unit, "the human animal", whose actions are governed by collective instinct rather than individual rationality (272). Elsewhere Norris describes a flock of sheep in similar terms, as "no longer an aggregate of individuals" but a single "solid, slowly moving mass" (31). Since there is strength in numbers, it is unsurprising that when the ranchers decide to fight back against the corporation behind the railroad they do so by seeking to organize themselves into a similar structure. After the corporation sets its prices for the ranchers' land, Osterman gives a speech asserting that the men must "stand together", and "form the beginnings of a vast organization […] the League", which in mirroring the railroad would give them "a machine with which to fight" against it (275-76).

As a means of suggesting the importance of social ties in shaping and constraining individual action, Norris repeatedly uses the image of a web. Gillian Beer emphasises the prominence given to the trope of the web in nineteenth-century literature, suggesting that "web imagery is to be found everywhere in Victorian writing" with "woven fabric" being the predominant association (156). In *The Octopus* this kind of imagery is used predominantly to explore Magnus Derrick's battle between maintaining personal integrity and acceding to the demands of the social group. Norris writes that following the League's demands for Magnus to join their organization, he "was entangled [...] his foot caught in the mesh that was being spun" (188). Later, Magnus finds himself "involved and entrapped in the fine-spun web of a new order of things" (448). When the League ride toward their final confrontation with the representatives of the railroad, Norris writes that "their passage through the wheat sounded like the rip and tear of a gigantic web of cloth" (508). Elsewhere the network of threads turns to that of veins and arteries, descriptions which further blur the boundaries between the organic and mechanical. Gillian Beer suggests that "tissue and cloth are contiguous images" and that "the webs of bodily order – veins, nerves, tissues – allow the metaphor of the web to move into the intimate ordering of life"

(157). The “complicated network of red lines” which represent the railway on the map bring to mind a “veritable system of blood circulation” (Norris 289). In addition to carrying the suggestion of veins and “arteries”, the description of branching lines moves from animal to plant biology, as the rails send out “feelers, off-shoots, tap-roots, feeders” (Norris 289).

The image of the web unites the social and the biological, and echoes the analogies between social systems and biological organisms found within organic philosophies of the time. Both *The Octopus* (1901) and *Gain* (1998) represent corporate bodies in such a way that social and economic structures are made to appear analogous to biological organisms. Norris describes the activity of the Pacific and South-western Railroad in biological terms, as an “octopus” or “leviathan” (51). Its activity is described in animalistic language, as the work of “iron hoofs” and “tentacles of steel” (49, 51). Specifically, Norris suggests that the corporation is a “huge sprawling organism” (289). In *Gain*, Powers similarly represents the Clare Corporation as an organism: he writes that, like humanity itself, “the work of this compound organism outstripped the sum of its cells” (155). Powers writes that the redesign of the corporate structure “strengthened the core nervous system and increased the number of limbs” (273), while money is the “great enzyme” which catalyses growth (266). In the case of both novels, the shared characteristics (agency, desire, and competitiveness) which drive the comparison between social and biological forms originate in the fact that a corporation, a cancer and an octopus are all types of agent-based complex system. The language of ‘systems’ (drawn either from systems theory, or its predecessor, organicism) allows both writers to create structural and functional analogies between biological, social and economic entities.

As a means of reflecting the extent to which these corporate organisms use people and resources to ensure their own growth and survival, both novels represent their featured corporations as specifically *parasitic* organisms. Norris refers to the railroad as “a

giant parasite" with tracks branching out like "diminuitive little blood-suckers" (289). In *Gain*, the growth of the Clare Corporation is repeatedly juxtaposed with the growth of Laura Bodey's cancer. However, these corporations are not presented simply as a social evil. It becomes apparent to the reader that humanity and the corporation have entered a *symbiotic* relationship, one of co-evolution between complex systems which throughout the last two centuries has been broadly beneficial for both, when considered at the macro-level. Clare arrives in Lacewood while moving westward across America "seeking new hosts" (94), and while based there it sustains the life of the community. Laura relates that "the town cannot hold a corn boil without its corporate sponsor […] the company cuts every other check, writes the headlines […] staffs the hospital" (6). After the townspeople reject Clare as a potentially carcinogenic parasite the corporation relocates its Lacewood facilities, thus effectively 'killing' the area by "precipitating Lacewood into economic ruin" (Heise 769). Laura suggests that "her life depends on more corporations than she can count" (Powers 304). As well as manufacturing the herbicide that potentially kills her, Clare also produces the chemicals used in the chemotherapy which, though ultimately unsuccessful, does attempt to save her life. It is in the interest of the corporation to learn to adapt its organization in order to keep its hosts alive. Powers notes that during the nineteenth century "business changed to meet the upheavals that business instigated" (180), upheavals which at the end of the twentieth century focus upon the discovery and remedying of invisible and global toxicity. *Gain* does not seek to represent the corporation as socially exploitative in an ideological and traditionally Marxist sense; the novel shows that the entanglement of business and humanity is more complex than that. We also see this complexity in *The Octopus*: the character of Shelgrim, seen by many characters as the source of the railroad's injustices, also displays fairness and compassion (573). In addition, though they feel victimised by the corporation, Presley notes that the ranchers "had no love for their land"; like the railroad they see it only as a resource, a means to generate profit (291).

The industrial process creates production loops which are themselves autopoietic or self-sustaining. We see this reflected in Upton Sinclair's *The Jungle*, since "there was scarcely a thing needed in the business that Durham and Company did not make for themselves" (50). By-products of both industrial systems (its outputs) are fed back into the system as the inputs for new products, thus eliminating waste and making the company efficient and profitable. Powers notes that Clare's production system worked by "feeding the scraps of the one [process] into the other's maw" (33). Durham's treatment of its human agents (or workers) lends a darkly ironic and cannibalistic edge to the phrase "no tiniest particle of organic matter was wasted" (50). In *The Jungle* individuals are quite literally *consumed* by the cycle of the industrial system. Sinclair writes that:

> As for the […] men who worked in tank rooms full of steam […] their particular trouble was that they fell into the vats; and when they were fished out there was never enough of them to be worth exhibiting – sometimes they would be overlooked for days, till all but the bones of them had gone out to the world as Durham's Pure Beef Lard!. (120)

However, to argue that *Gain* represents merely the crushing of the many by a privileged and powerful few would be incorrect. In "Risk Society", Ulrich Beck suggests that the risks and hazards created by modernity have a "boomerang effect", meaning that "risks of modernization sooner or later also strike those who produce or profit from them" (23). In *Gain,* we see that Clare's employees and executives are not exempt from the damage which they unintentionally cause. Though, admittedly, it is also true that to some extent "the wealthy can purchase safety and freedom from risk" (*Risk Society* 35). Laura is informed by a medical aide that a better version of her anti-nausea drugs exists; though in order to receive it she would need to pay extra, since "the one that works is always too expensive to use" (*Gain* 152). Ursula Heise suggests that, within the novel, "the real

poison lies not in any concrete substance but in the complex technoeconomic system that has evolved over more than a century to deliver chemical products to the individual" (766). Blame lies with the self-organizing, self-adapting system which has evolved over time, not with the individuals who are at any one time responsible for running it. The essence of *Gain* is that actions cannot be separated from the feedback of their consequences, since: "every win has somebody's loss pegged to it. Someone has to go down for someone else to rise" (123). Ursula Heise suggests that "the most serious risks derive from technological systems with such a degree of complexity that even experts cannot understand all the connections and feedback loops they contain, and, therefore, cannot predict some of their most dangerous failures (759). By intervening with systems as complex and nonlinear as ecosystems and human bodies, consequences are impossible to predict or control.

The League of ranchers is ultimately unsuccessful in its fight against the railroad because its members fail to recognize that the source of any system's strength is the distribution of its means of control. In "demanding to be led" by Magnus, the ranchers impose a centralized and hierarchical means of control, which creates a single point to which blame can be attributed (279). Though Magnus longs to be "powerful, to command, to dominate" with "thousands of men beneath him" (184), having an individual as the head of a system renders it vulnerable and open to attack (the League loses all credibility after Magnus is disgraced). Though Presley initially sees the General Office of the Pacific and Southwestern Railroad as "the stronghold of the enemy […] the centre of all that vast ramifying system […] the nucleus of the web", and Shelgrim as its leader (to which he can apportion blame), he comes to see this view as mistaken (569). A complex system has no centre and no single controlling agent. Presley throws a bomb into the home of S. Behrman (560), but later regrets this action, having arrived at the conclusion that even if he had succeeded in killing the Railroad's local manager, nothing significant would have been achieved. In *Gain*, similarly, Laura's husband considers bombing the Clare headquarters; standing outside the building he contemplates being "fifteen feet away from

being able to change things forever" (256). However, Don soon realizes that such an attack would achieve nothing, since the corporation is not really centred anywhere: "there is no ground zero. Nothing an anarchist could ever hit, even in imagination" (257). The corporation as a complex system is invulnerable to such a localized attack.

Alan Trachtenberg suggests that in the late nineteenth century the huge influence of the machine on everyday life lent to it "an aura of supreme power, as if it were an autonomous force" (41). He also suggests that a pervasive sense of technological determinism in social thought "implied that machines demanded their own improvement, that they controlled the forms of production and drove their owners and workers" (54). We see this technological determinism reflected in *The Octopus* when Shelgrim argues that: "I can *not* control it [the railroad] no man […] can stop it or control it" (576). As Mark Seltzer suggests, "the ideological character" of his defence is evident: by claiming that "you are dealing with forces […] not with men", Shelgrim absolves himself of blame for those "complications" which may inadvertently crush the individual and asserts the impossibility of changing conditions. Mirroring Jameson's account of reification and consumerism which we considered at the beginning of the chapter, Shelgrim replaces relationships between people with impersonal relationships between abstract forces and thus absolves himself of corporate guilt. However, it may also be the case that corporations do, in fact, exceed the control of any individual agent within the system, and that within that system the individual only has agency at the micro-level. Shelgrim's claim that "railroads build themselves" in response to laws of supply and demand, and that "no man – can stop it or control it", suggests an early awareness of the autopoietic or 'self-making' nature of complex systems (576).

Norris does give voice to the Marxist argument that a coherent organization and rebellion on the part of working people would overthrow the railroad, notably through the person of Cedarquist, who argues that any trust or monopoly "exploits the People, *because the People allow it* […] The People have but to say 'No,' and not the strongest

tyranny […] that was ever organized, could survive one week" (304). This position is reinforced by the fact that it is the League's failure to mobilize in significant numbers during the final confrontation which leads to so much bloodshed. Marx does allow for some level of environmental determinism in his writing. In *The German Ideology* (1845), he states that "circumstances make men just as much as men make circumstances", thus suggesting that individuals do not choose their position in the economic structure or their means of production (172). Marx makes this suggestion again in the later work, *The Poverty of Philosophy* (1847), when he argues that:

> Productive forces are […] the result of practical human energy; but this energy is itself conditioned by the circumstances in which men find themselves, by the productive forces already acquired, by the social form which exists before they do, which they do not create, which is the product of the preceding generation. (195)

Therefore, we may also question the level of 'agency' or 'control' that any particular member of the bourgeoisie has within capitalism. Change, after all, would seem to require collective class consciousness and it is not clear whether this is ever possible in reality.

Whether individuals can or should be held responsible for corporate activities is a matter which I suggest Norris leaves deliberately unresolved. Using analogy, he consistently models the corporation as a biological organism; this model would suggest that railroads do, in fact, build themselves, and that employees as individual cells or agents do not bear moral responsibility for harm inflicted by the whole. However, Donald Pizer interprets Norris's suggestion that the railroad is a "morally neutral" force as merely the dramatization of "a false argument", and thus not a viewpoint which Norris "wishes us to trust" (139). The "intellectual confusion" and lack of "a coherent system of belief" which Pizer identifies in the novel, is, I would suggest, a reflection of uncertainty about the morality of systems which persists in social and scientific thought to this day (133).

The extent to which we should take seriously the analogy between social and biological forms which we see in both organicism and systems theory is uncertain. Complexity scientists themselves are divided about how literally we should take the idea of a structural homology between systems. Some take the similarities very seriously. Stephanie Forrest researches ways in which we can develop computer systems which behave more like a biological organism such as antivirus software that behaves like the human immune system. She has written that her work requires "taking seriously the analogy between computer systems and living systems" (228). Melanie Mitchell has written that "computing is, or at least has the potential to be, a natural science […] that is, the science of computing may someday contribute the conceptual building blocks upon which is built a more unified understanding of biological phenomena" ("Biological Computation"). In his book on the Santa Fe Institute, *Complexity*, Roger Lewin suggests that "consistency of pattern" between the biological, cultural and technological realms is "more than mere coincidence or mere analogy" (71). Some scientists, however, take a more qualified view of the similarities, pointing to context dependence and the limits of analogy. Melanie Mitchell suggests that analogy is a useful starting point for thinking about complex systems, but goes on to argue that the prevalence of analogy in complexity science tells us more about the way that we do science and the way that we think as a species than it tells us about the systems themselves ("An Introduction to Complexity Science").

The hesitation which some scientists display with regard to more literal interpretations of analogy may be linked to a wider distrust of narrative as a system. Ken Baake suggests that "a scientist who employs a metaphor does so, knowingly or not, at the risk of losing control of that metaphor – of having it move in unintended ways" (73). The emergent meanings created as part of the reading process are unpredictable, and this might be troubling for those who continue to be committed to empirical enquiry. In *Metaphor*, David Punter writes that both metaphors and their component words are

"radically unstable; their meanings are always fluid, changing according to historical and cultural context, with the meanings trapped inside them constantly overflowing, refusing to be pinned down" (106). Using *Paradise Lost* as an example, Punter writes that Milton was "undone by his own writing", since his characterization of Satan has proved more vivid and memorable than his intended message of the goodness of God. No author of literature has total authority over meaning, and this is something that science views as unsettling. Punter writes that "metaphor […] is not necessarily embedded in the text; it is rather a measure of what happens to the text when it achieves its freedom" (12). In this sense, meaning is an emergent quality and is not inherent to the words themselves. Language without metaphor, in contrast, would be fixed and "approach the condition of mathematics" (3). From a scientist's perspective, this tendency for the implications of metaphor to proliferate and escape the author's control may result in a scientific article giving a misleading impression to the lay public. What most scientists want is for language to possess exactly the precision of mathematics, yet this can never be the case, since as Punter suggests, all language is necessarily invested with "metaphorical potential" (3).

How seriously we take the analogies between systems has serious implications. If, for example, we start talking about social organizations as 'natural' and assume that they are merely extensions of biological systems then some will say that we are legitimising a human imposed structure of oppression. On the other hand, science is concerned with describing what is, not what ought to be. It aims to stand apart from questions of morality. This stance is not without its problems, however. In *Flight Behaviour*, a novel which I discuss in Chapter 8, Barbara Kingsolver stages a debate about the role of morality in science. An entomologist, Ovid Byron, gets into an argument with the novel's protagonist, Dellarobia, when he states that he is not in the business of saving endangered species, and that his role is merely to observe and document their decline: "'That is a question of conscience,' he said. 'Not of biology. Science doesn't tell us what we should do. It only tells us what is'" (320). For Byron, the limits of science are unusually clear and narrow. But

Kingsolver exaggerates to make a wider point. Part of the role of systems-aware fiction, she suggests, is to do what science cannot, which is to stage a debate about the morality of systems and how we should act in relation to them. Whether the activity of a corporation is considered as the conscious self-directed activity of individuals or the collective, emergent behaviour of a system which works to limit the agency of its constituent individuals, depends in part upon the attitude which we take towards causality. Both *The Octopus* and *Gain* explore the extent to which it is reasonable to blame individuals for the faults which emerge from a self-organizing system which is truly global in its spatial distribution. Within *Gain* we see the repeated complication of causality: attempts to apportion blame to corporations are never wholly successful, and are always qualified by the awareness that humanity is a willing participant in the human-corporate relationship. Rather than writing an exposé which would establish a direct causal link between corporations and cancer, Powers depicts the causes of Laura Bodey's cancer as uncertain: while it is strongly hinted that "certain pesticides" made by Clare's Agricultural Division, including a "common herbicide" used by Laura, may have carcinogenic effects, it is also highlighted that there are a variety of other hereditary and genetic risk factors (191). Norris too resists the urge to write a direct exposé. Mrozowski writes that: "Norris initially imagined writing a muckraking story single-mindedly championing an oppressed people over a blood-sucking corporation, yet his research uncovered a complex conflict that resisted easy polemics against the railroads" (341). The identification of a strong, objective causal link is unlikely considering the complex and nonlinear nature of interactions within the bodily system, and the complexity and quantity of our interactions with corporations. Laura comes to the conclusion that "life causes cancer" since her life has been "moulded […] in every way imaginable" by the products which corporations supply her with. She cannot imagine a life without "all the little carcinogenic amenities, the dangers she's known but risked anyway […] from hairspray to charred barbeque burgers" (283), so much so that she confesses that "she'd do it all over again, given the choice"

(304). Though the parallel which Powers draws between the rise of the Clare Corporation and the growth of Laura's cancer in the juxtaposition of their two narrative strands does imply a causal link (when combined with Laura's professed lack of a family history of cancer), this connection is complicated when Laura's daughter Ellen contracts the same cancer at the end of the novel, thus suggesting a possible genetic cause for the disease. However, towards the end of the novel Laura also reveals that her father worked for another soap-making corporation: "Lux […] her Dad's old brand […] The one that bought their house, fed and clothed them" (305). In this way Powers adds yet another layer to the causal complexity of the Bodeys' cancer by suggesting that even pre-existing genetic factors may have their origins in environmental exposure. As Marx suggested, the circumstances in which we find ourselves are in part a product of the circumstances which we inherit from the preceding generation.

In a recent article for *The Huffington Post*, George Lakoff suggests that a new kind of causation is needed to explain things that result directly or indirectly from the activity of complex systems. Lakoff defines "direct causation" as "any application of force to something or someone that always produces an immediate change to that thing or person". Using the word 'cause' in relation to this kind of action is unproblematic because the effect is immediate and visible. Lakoff suggests that this kind of causation is unsuitable when dealing with nonlinear complex systems and that we need an alternative concept – 'systemic causation' – to enable us to talk about things like global warming, a process which is largely invisible and widely distributed in space and time.[30] He defines systemic causation as follows:

> A systemic cause may be one of a number of multiple causes. It may require some special conditions. It may be indirect, working through a network of more direct causes. It may be probabilistic, occurring with a significantly high

[30] See also Rob Nixon on 'slow violence'.

> probability. It may require a feedback mechanism. In general, causation in ecosystems, biological systems, economic systems, and social systems tends not to be direct, but is no less causal. And because it is not direct causation, it requires all the greater attention if it is to be understood and its negative effects controlled.

Neither Powers nor Norris are able to present a direct causal link between the activity of corporations and the losses suffered by individuals. Instead they use juxtaposition to imply a sense of systemic causation. Just as Powers seems to imply a causal link between the growth of the Clare Corporation and the growth of Laura's cancer by forcing the reader to switch between the two parallel narrative strands, so, in *The Octopus*, Norris juxtaposes scenes of starvation and feasting in order to imply that the railroad is responsible for Mrs Hooven's death. Towards the end of Chapter 8 of Book II, the switches between the two parallel and simultaneous narratives (of Mrs Hooven's death and a dinner party at the home of a railroad magnate) become so abrupt that there are only a few lines between transitions. Presley considers the issue of causation and blame, stating that: "the railroad might indeed be a force only, which no man could control and for which no man was responsible, but [...] Because Magnus had been beggared, Gerrard had become Railroad King; because the farmers of the valley were poor, these men were rich" (608).

Beyond the attribution of causation, another factor which complicates the assessment of blame when dealing with large corporate systems is the difference of scale between the individual and the system. On the scale of global systems an individual part or agent is replaceable. Neither Laura Bodey's death nor the loss of a disposable camera is of any consequence to a complex corporate system, yet Powers suggests that even those things "designed to be pitched", which will inevitably die, are a source of value not measured in purely economic terms. The camera is "a disposable miracle, no less than

the least of us" (348).Though J. Clare & Sons begins its existence with the positive aim of transforming waste animal fats (from food processing) into sources of cleanliness (soap) and illumination (candles) in order to improve the conditions of human existence, once the company reaches a self-sustaining level of complexity it becomes clear that "on the corporate scale, one [human] life is insignificant, not even a statistical aberration" (Maliszewski 173). All that matters to the incorporated system is that enough agents (organic or mechanical) exist within it (as workers) or outside it (as consumers) in order to sustain its current organization and level of output. Any of those individual agents are replaceable since within any complex system "the components change continually", forming "a ceaseless flow of matter" through the system while its organizational structure remains roughly constant (Capra 159). Powers notes that at Clare "an endless supply of stopgap labour waited to replace the discontented" (204).

Both authors are committed to a broadly realist mode of narration. However, in order to engage with the structural complexity of the corporation they are forced to adapt their mode of realism to incorporate a reconsideration of both causality and character. As we have seen, a new kind of systemic causality may be required to reflect the large number and distribution of agents within the corporate system. Richard Powers also seeks to redefine our conception of character to reflect the global scale of contemporary systems, and to reflect their apparent agency and independence. In addition to being compared to a biological organism, the Clare Corporation is also compared to a person. The corporation becomes personified properly at the moment of incorporation, where it becomes a single individual in the eyes of the law: J. Clare and Sons becomes the Clare Soap and Chemical Company (frequently referred to as just 'Clare'): "one composite body: a single, whole and statutorily enabled person" (158). One consequence of this transformation is that Clare then "enjoyed all the legal protections afforded any individual" (159). Thanks to advertising, Clare becomes personified to the public in the form of 'Clara Clear'. Powers writes that "Clare had long been a person in the eyes of the law. Now it

became one in the minds of its customers" (222). In "Home", Powers relates how we might think of corporations as characters in their own right: "legal individuals that have lived for two centuries, that have personalities all their own […] Talk about character!". In the same interview he explicitly states his desire to depict a corporation as a single character:

> I decided to write a book where such an individual – 200 years old and made up of tens of thousands people – meets another individual – a 42-year-old divorced woman with two children who begins to suspect that a Clare factory in her home town has caused her cancer.

Powers wants to initiate a dialogue between these characters, to interrogate "how […] that small individual and that large individual negotiate a place where each can understand the other". The dialogue is complicated because the two characters are "of completely incommensurate sizes". A single person equates to just a single agent or cell within the corporate body. Advertising may give Clare a human name and the familiarity of a friend, but this relationship is deceptive because Clare cannot relate to people on a human level. The corporation only operates at the level of populations, market shares, and profit flows. Paul Maliszewski argues that "what Laura wants is personal interaction […] but the corporation converses only on its own level, indirectly […] Laura wants the corporation to communicate on her level, the level on which human stories get resolved" (176).

LeClair sees the systems novel as being primarily dialogue based; however, to stage a dialogue between two systems of incommensurate size, Powers is forced to minimise the amount of actual spoken dialogue in the sections of text which depict Clare's growth. Maliszewski writes that "in order to dramatize the life of a corporation, Powers had to commit several anti-literary acts" and that "dialogue between characters in the Clare

sections is almost non-existent" (169). Powers minimises the extent to which human agents in the Clare sections are depicted as fully rounded individuals because the real agents here are "the movement of capital, technical refinements in the chemistry of soap-making, or economic principles" (169). Charles Harris too notes that "*Gain* generally avoids the extended dramatic particularization associated with characterization in realist fiction" but argues that "this is a strategy rather than a flaw" (100).

As I mentioned at the beginning of this chapter, Powers sees character as a kind of "web", a multiplicity of parts and levels which range from the micro-level of brain chemistry up to the macro-level of global economics, politics and history. His representation of character, therefore, necessitates an emphasis upon process rather than fixed forms of definition or value, and it must also involve significant contextual thinking. In this chapter we have seen that an individual's perception of the global can only be achieved in fleeting glimpses, as in the momentary awareness of simultaneity or "bright synchronicity" which was experienced by the characters I discussed in Chapter 4 (Ford 94). This inaccessibility is primarily due to the incommensurate scales of human and corporate activity: global systems operate at a level which is generally incompatible with one-to-one human connection, the level at which realist narrative tends to operate. Norris and Powers use biological analogies to draw attention to similarities of structure between economic and biological systems, and these analogies provide a means of conceptualising corporate agency, which would otherwise remain invisible because of its vast scale and global distribution. Both authors redefine or reshape certain formal aspects of conventional realism, specifically character and causality, in order to comprehend and narrate nonlinear systems in their totality. Their use of systemic rather than direct causality takes into account the multiplicity of direct and indirect factors involved in corporate cause/effect relationships. Dealing with degrees of probability and influence, it mitigates but does not resolve tensions between Marxist readings of the system (which suggest that control lies in the hands of a few individuals, who can be held responsible for

the consequences of their actions) and systemic readings (which suggest that order is decentralised and emergent, beyond the control of any individual agent). With regard to the value of an individual within a corporate system, the novels offer a restatement of the distinction between inherent and emergent meaning seen in the previous chapter. The individual body is seen to be, in a sense, disposable (like the disposable camera I discussed earlier); its value within corporate or more domestic social systems is emergent rather than inherent. An individual's worth is found not within his or her component cells, which may mutate and become cancerous, and which will all eventually die and be replaced. Instead, meaning is found within the various networks of relationships maintained internally (between cells), and externally (between and in conjunction with other individuals).

The novels in this chapter deal primarily with the public sphere and the manner in which business and society influence the individual. In the following chapter, I look at two novels which are set primarily in the private sphere, and are concerned with domestic and family relationships. I address the extent to which these largely private relationships are also conceived in terms of systems, and the extent to which they too are influenced by wider economic and social systems. I also address the extent to which an individual is perceived not only as a single agent within wider systems, but is also seen to exist as a system in his or her own right.

Chapter 6: Open and Closed Systems: Edith Wharton and Jonathan Franzen

Edith Wharton's interest in anthropology and evolutionary science has been well documented; however, her interest in science extended far beyond these areas. In this chapter I argue that Wharton had an understanding of system structure and function which was at least as important to her writing as her knowledge of Darwinian thought, though it has so far remained unnoticed by those writing about her fiction. While she is largely associated with the 'novel of manners', I suggest that, like Norris and Dreiser, Wharton was keenly aware of large-scale processes of globalization which were shaping society in the late nineteenth and early twentieth centuries. In this chapter I compare Wharton's novels, *The Custom of the Country* (1913) and *The Age of Innocence* (1920), with Jonathan Franzen's novel, *The Corrections* (2001). Both Wharton and Franzen represent the subject matter of domestic realism – marriage and divorce, parent-child relationships, friendships and rivalries – as the interaction of agents within complex systems.

Once again I apply concepts and discourse drawn from systems science to a close reading of the novels, focussing my analysis upon questions of value and agency. I argue that a distinction between open and closed systems is key to understanding the social critique within each of these three novels.[31] Broadly speaking, Wharton and Franzen value open systems for their qualities of adaptation, growth and learning, and are fearful of closed systems because of their association with restriction, fixedness and loss of agency. This appreciation of open systems prefigures the positive valuation of biological complexity seen in the ecological turn which I discuss in Section 3. Following this investigation into open and closed systems, I turn in the final part of the chapter to the

[31] In *Jonathan Franzen at the End of Postmodernism*, Stephen J. Burn suggests that "*The Corrections* […] criticises the tendency of both people and corporations to create closed systems in their lives" (76). For Burn, the tendency of Franzen's characters to isolate themselves within "small incestuous units" represents a wider critique of the extent to which both social groups and literary movements (such as postmodernism) have sought to stand apart from "larger social and political currents" (113).

novels' construction of models. Developing the corporate-biological comparisons seen in the previous chapter, I show how Wharton and Franzen use a variety of analogies between systems to reveal that the individual is not only shaped by interaction with complex systems, but is itself systemic in nature. The importance of analogy to systems-aware fiction is raised again and discussed in more detail in Section 3.

The distinction between closed and open systems was first defined by Ludwig Von Bertalanffy in *General System Theory* (1968). Closed systems are isolated from their environment, so the number of parts in such a system is fixed and no energy, matter or information may enter or leave. Such systems are also linear and subject to entropy. Open systems, in opposition, are nonlinear and locally reverse entropy, tending towards increasing order by exchanging matter and information with their environment. Von Bertalanffy defines an open system as "a system in exchange of matter with its environment, presenting import and export, building-up and breaking-down of its material components" (149). Living things are open systems: "every living organism is essentially an open system. It maintains itself in a continuous inflow and outflow, a building up and breaking down of components, never being, so long as it is alive, in a state of chemical and thermodynamic equilibrium" (Von Bertalanffy 38). Modern complexity science is based upon analysis of open systems.

The catalogue of Wharton's library compiled by George Ramsden reveals that she read extensively in anthropology and evolutionary science, possessing (often underlined and annotated) volumes by Darwin, Haeckel, T.H. Huxley, and Herbert Spencer. Wharton referred to this reading in *A Backward Glance,* crediting close friend Egerton Winthrop with introducing her to "the wonder-world of nineteenth century science", from Huxley, Spencer and Westermarck, to other "popular exponents of the great evolutionary movement" (94). The impact that this reading had upon the content of Wharton's fiction has been the subject of much critical study, particularly in relation to *The Age of Innocence*. Nancy Bentley has written extensively about the extended comparison which

Wharton draws between old New York society and a tribe engaged in “anthropological rites” (48). Janet Beer and Pamela Knights have both discussed the way in which the evolutionary discourses of adaptation, descent, dominant ‘types’ and variation are displayed in this novel, with Beer suggesting that “the language and imagery of Darwinism permeate her [Wharton’s] fiction” (8). The most striking example of this Darwinian influence is seen in Newland Archer’s speculation that May Welland, his future wife, resembles a particular type of “Kentucky cave-fish which had ceased to develop eyes because they had no use for them” (58). This is an example of the adaptation and inheritance seen in natural selection, where traits not essential to survival or reproductive success (in this case independent thought or imagination) will eventually cease to be transmitted to the next generation. While Wharton’s use of evolutionary discourse has been well documented, it has not yet been observed that Wharton perceived society in systems terms, and that this perception influenced to a significant extent her engagement with other forms of scientific discourse, including that of natural selection.

Wharton explicitly talks in systems terms in *The Age of Innocence*, where she refers to New York society as a “system” (6), a “social system” (30), and a “system of mystification” (32). What strength and resilience this system possesses exists in the collective, rather than the influence of specific powerful individuals. Archer confesses himself to feel superior to any specimen of the “old New York gentility”, yet he willingly bows to the collective on issues of morality and ‘form’. He states that “singly they betrayed their inferiority; but grouped together they represented ‘New York’” (6). This society is structured by the principles of ‘form’ or ‘taste’ (a whole series of conventions and unspoken rules about how things are done) and ‘family’ (complicated ties of blood and marriage that connect the various family trees) (7). Each family (or sub-system) enforces the acceptance of certain rules and codes, and thus ensures that each new generation maintain the existing collective structure. May Welland is described as a “product of the system” (6), and comes to represent for Archer the “embodied image of the family” (233).

In particular she comes to represent the awareness that “people cling to any convention that keeps the family together”, with “the individual […] nearly always sacrificed to what is supposed to be the collective interest” (79). In ‘Forms of Disembodiment’, Pamela Knights suggests that “a social body with its own collective, even physical, identity is at large in the text”, a body whose “interests, reactions, and mechanisms of survival go beyond those of any single member of the group” (28). Knights characterises this social body as “a highly alert and powerful working system [...] alive to what will advantage it and prompt to respond to danger” (29). As such it represents (at least until the concluding section) “an effective self-regulating system” (39). Society is also structured as a single, living system in the earlier novel *The Custom of the Country,* where Undine Spragg is referred to as “the monstrously perfect result of the system” (131). Wharton has Undine make reference to ‘The Family’ (the concept of family) in French society as “a powerful and indivisible whole” (321).

Though displaying the collective agency associated with biological systems, Wharton generally depicts old New York society as having become closed, fixed and unadaptive. This perception of stasis results in a series of references to the ailing health of the system. Society is described in *The Age of Innocence* as a “small and slippery pyramid”, with a “firm foundation” of respectable yet obscure families at the base, narrowing upwards to the two or three families located at the “apex” of this structure who are said to have “aristocratic origins” (34). Beyond the fixed and fiercely defended borders of this system lies an “almost unmapped” territory of independent thinkers: artists, musicians and writers who “had never shown any desire to be amalgamated with the social structure” (72). These “inexorable conventions that tied things together and bound people down to the old pattern” make the structure of the pyramid absolutely fixed (31), with the result that everything in society “invariably happened in the same way” (13). Archer delivers a damning assessment of the homogeneity of this society, claiming that “we’re all as like each other as those dolls cut out of the same folded paper” (58). As a

closed system which has isolated itself from cultural influences and views Europe with suspicion, life within the pyramid lacks the diversity of experience generally associated with open, living and adaptive systems (72). May, the perfect product of that system, has been carefully trained not to possess “freedom of judgement” (31) and is described by Archer as totally “lacking in imagination” (244). Archer makes the mistake of underestimating her because of this, suggesting that she would never surprise him and that her nature lacked “the twists and defences of instinctive guile” (32). Ironically, it is she (with the backing of the family) who so perfectly engineers Ellen’s eventual removal. The system is dangerous precisely because of its lack of imagination; it makes the simplest possible assumption of Archer and Ellen’s situation (that they are lovers) and carries out its punishment with a single-minded focus.

Living systems depend upon feedback from their environment in order to grow, adapt and evolve; they are constantly in a process of development and as such, stasis can only mean one thing: eventual death. During the period in which the majority of the novel is set (1871-73) the New York social system is beginning to show signs of decay. The van der Luydens are described as appearing “rather gruesomely preserved”, like “bodies caught in glaciers” (37), and May too shares this association with death, with Archer suggesting that her blood “might have been a preserving fluid” (132). The exclamation, “I shall never be happy unless I can open the windows!” points to Archer’s feelings of suffocation within a society which he increasingly perceives as a sealed and airless tomb (208). Throughout the novel we see small incursions from the system’s external environment, suggesting that the fixed borders of the system are beginning to break down. Hermione Lee writes that “this is a society which wants at all cost to preserve itself, but which is in a continuous process of evolutionary slippage” (569). Those characters within the novel who defy the system’s conventions (individuals who are normally associated with a Puritan dismissal of the ‘decadence’ of Europe) make various references to new technologies beginning to encroach upon the old ways. Beaufort refers

to the new innovation of “talking along a wire” and the scarcely believable prospect that one day people will be able to talk to each other from town to town (96). Mrs Manson Mingott states the belief that one day cobblestones will be replaced by smooth asphalt like that which exists in Paris (19). There is also evidence of the encroachment of the nouveau riche; people like Julius Beaufort are increasingly tolerated, despite obscure origins, because of great wealth.

The abrupt shift between time periods which occurs at the end of the novel accentuates the evolutionary change which has occurred within New York society between the 1870s and the turn of the century. The pyramid has been replaced by a much more fluid, fast-moving and open social system: a “kaleidoscope where all the atoms spun around on the same plane” (248). The image of the kaleidoscope suggests a pattern which is constantly changing and adapting, a level plane where various (social) circles are seen to overlap and intersect in simultaneity.[32] The reference here to “atoms” also points to a wider breadth of scientific knowledge than is generally attributed to Wharton, and I will discuss this in more detail shortly. With reference to men of his generation, Archer suggests that “their vision had [previously] been limited” to a “narrow groove of money-making, sport and society”, whereas young men of his son’s generation were now “taking up all sorts of new things” (242). In the lives of Archer’s children we see that there is now much more diversity of experience, and in the marriage of Dallas and Fanny Beaufort (born out of wedlock) we see that ‘form’ and ‘family’ do not stratify this society in the same way as before. Archer suggests that a person’s past, their origins and ancestry, are no longer of any consequence (248).

Though the social change which characterizes the end of the novel is broadly welcomed, there is a certain level of nostalgia: Wharton has Archer note that “there was good in the old ways”, and that the new generation had “swept away all the old landmarks, and with them the signposts and the danger signals” (251). The old social system

[32] See Note 25.

provided stability in the form of a fixed set of moral values and a behavioural code which has since been lost in the flux of modernity. Since the form of the narrative (the time-shift) places emphasis on the disjunctions between the two time periods we may conclude that the old social organism has in effect 'died' and been replaced by a new one which is more open, adaptive, and so on. However, this time shift masks what would have been a more gradual evolution, an evolution of the type consistent with the way Wharton states that New York had always "managed its transitions: conspiring to ignore them till they were well over, and then, in all good faith, imagining that they had taken place in a preceding age" (182). Therefore, we might argue that despite initial resistance to change, old New York was eventually able to evolve and become more open, and that by letting in "new blood and new money" it was able to successfully stave off stasis and eventual death (22). Despite the "dramatic social change" displayed in this final section, Pamela Knights suggests that particular examples of change (such as Dallas Archer's marriage to Fanny Beaufort) might "equally [...] be seen as successful adaptations of that world [...] maintaining its cultural heritage in the face of the twentieth century" (40). After all, not everything in the society has changed: "in a world where all else had reeled on its foundations, the 'Grace Church wedding' remained an unchanged institution" (242). Even after a significant change in social structure, aspects of the earlier closed system remain.

The Custom of the Country, like the final section of *The Age of Innocence*, is set in the 1900s and depicts a similar transition in social systems. Though Undine Spragg arrives in the city with the idea of "'old families' ruling New York", she comes to realise that this view is outdated and that society is now a decentralised network of small social circles all competing on an equal footing for wealth, status and prestige (121). She notes that some people whom the old Washington Square 'set' left unvisited "were at the centre of social systems far outside its ken", and that the one principle that united all of these systems was their pursuit of money, since they all "joyously revolved about their central sun of gold" (121). In her references to 'atoms', and now to the sun, Wharton relates

individual experience to both micro and macro-level perspectives of physical systems. Increasing acceptance of divorce within this society means that movement between social circles is becoming easier, and as such, the boundaries of previously closed systems – the circle of old New York families and the "inaccessible 'Faubourg'" (179) – are becoming increasingly porous. The rules or codes by which society organizes itself are constantly changing in this novel. Undine is keen to belong to the right 'set', but is frequently waylaid by "unsuspected social gradations" (19). Ralph warns her that "you know nothing of this society you're in; of its antecedents, its rules, its conventions" (101), though in actuality those rules are constantly evolving, and of the two of them, it is Ralph's inability to perceive this fact that marks him out as "a survival, and destined, as such, to go down in any conflict with the rising forces" (176).

Though this society is characterised in part by shiny reflective surfaces and "layers upon layers of insubstantialness" (171), we might also suggest that there are ways in which its organization possesses the depth and complexity associated with organic living systems. It is more interconnected, socially and technologically, than the New York of the 1870s; there is more emphasis on fluidity and adaptation, and more variation in lifestyles. Society is no longer the dry, airless tomb seen in *The Age of Innocence.* However, this perpetual social flux is not universally praised. Raymond de Chelles suggests that in American society "buildings are demolished before they're dry, and the people are as proud of changing as we (the French) are of holding to what we have" (342). In a situation where 'everything that is solid melts into air', references to simultaneity of experience which represented freedom and liberation in *The Age of Innocence* have here become disorienting and dizzying. In *The Age of Innocence* Archer claims that "seeing other houses, roofs, chimneys [...] getting the sense of other lives beyond his own, other cities beyond New York, and a whole wide world beyond his world, cleared his brain and made it easier to breathe" (207). By the time we reach *The Custom of the Country*, this same kind of experience has very different effects. When Mr Spragg tries to "reckon up [...] the

number of travellers who could be simultaneously lodged, bathed and boarded on the continent of Europe", the incalculable numbers involved affect him with a kind of depression which lasts for several days (240). Generally Wharton values open systems in her fiction, but she also acknowledges that the experience of living in such a system can produce feelings of disorientation and anxiety.

New York society of the 1900s still retains a certain level of fixedness and rigidity, particularly with regard to the pervasive influence of capitalism. Commerce provides a new set of laws and standards which influence behaviour and provide social boundaries. Wharton articulates the structure of capitalism using the language of astronomy, since the movement of the planets is an example of a fixed, linear and predictable closed system. Wharton's use of the discourse of physics and astronomy has not been widely discussed in academic circles, but I suggest that an exploration of this area provides real insight into the way that she thought about social relationships. Bowen highlights that in American society at this time it is business and not love which is the "emotional centre of gravity" (130). Wharton's use of planetary terms, "atoms" and "gravity" in relation to the structure of social systems is significant since it points to a wider use of the language of physics within her fiction. From the catalogue of her library we can see that beyond the knowledge of evolutionary science and anthropology previously mentioned Wharton was also familiar with developments in contemporary physics and astronomy. She owned volumes by influential physicists and mathematicians such as John Tyndall and Henri Poincaré, as well as books by Robert Kennedy Duncan and Karl Pearson which aimed to explain recent developments in physics to a non-specialist audience. Also listed in the catalogue are five books on astronomy, including Simon Newcomb's *Astronomy for Everybody* (1902) and William Tyler Olcott's *A Field Book of the Stars* (1907). Wharton seems to have been particularly interested in Tyndall; her copy of *Fragments of Science* (1871) is listed as "much marked, underlined and with some annotation". She quotes Tyndall in *A Backward Glance* (1934), writing that "my mind was full of my new subject, and whatever

else I was about, I went on, in Tyndall's brooding phrase, trying to 'look into it till it became luminous'" (206). In *A Backward Glance* she also mentions x-rays (first detected in 1895) and radium (discovered in 1898) (6). Wharton had a keen awareness of developments occurring in scientific thought of the time and was conversant in many forms of scientific discourse, including, I would argue, the developing discourse of systems and emergence.[33]

The language of physics occurs throughout Wharton's writing but is particularly explicit in *Ethan Frome* (1911). During his time at college Ethan is said to have "dabbled in the laboratory with a friendly professor of physics" (13). He also borrows a "volume of popular science" from the narrator which includes "some recent discoveries in biochemistry" (7). This novel also mentions "waves of light" (14). A. J. Fresnel's wave theory of light (the idea that light was formed from waves travelling through the ether rather than particles) was generally accepted from the 1830s onwards (Harman 3). This theory, also known as the 'undulatory' theory of light (as opposed to 'corpuscular' theory) provides another possible origin for the name of Undine Spragg in *The Custom of the Country*, who is continually associated with images of light. The novel's conflation of money and power with the radiating light of the sun is seen most clearly in Undine, who at one stage looks at the "blaze of the central chandelier" and concludes that "she herself was the core of that vast illumination, the sentient throbbing surface that gathered all the shafts of light into a centre" (39). Undine's pursuit of money, power and fashion is voracious, but only to further her need to be the sun around which others orbit. However, this dispersed system of various intersecting social systems has no centre – there is no longer a fixed 'Apex' to the social pyramid – and so Undine is doomed forever to be

[33] The term *emergent*, *adj.* defined in the contemporary sense, as signifying "an effect produced by a combination of several causes, but not capable of being regarded as the sum of their individual effects", was first used in the late 1800s (*OED,* Def.3). The *OED*'s first recorded usage of the term in a scientific sense is from G. H. Lewes in 1874. *Emerge, v.* had previously been used in optics and astronomy from 1704 onwards (Def. 3b). Use of the word *system, n.* in physics, and specifically astronomy, began in the 1690s (Def. 2). Use of the term *system, n*. in meteorology first occurs in 1893 (Def. 4.a).

searching for the "something beyond" (35). Astronomical references here point to Undine's fixed, immovable nature and the appearance which she gives of being impervious to environmental influences. John Tyndall, who we know that Wharton read extensively, refers to each wave of "interstellar ether" as "each being endowed with an individuality as indestructible as if it alone had disturbed the universal repose" (quoted in Beer 157). Since the behaviour of light is linear, each ray acts independently, indifferent to and uninfluenced by the actions of others. By modelling Undine's relationships with her peers in terms of astronominal systems, Wharton uses her knowledge of contemporary scientific discourse to 'illuminate' the individual's place with the wider social system.

So far in this chapter I have outlined how I believe Wharton's knowledge of emerging scientific discourse (particularly relating to physics and astronomy) influenced her engagement with the complexity of the modern world. In the second part of this chapter, I turn to a discussion of Jonathan Franzen's *The Corrections*. Though these authors may initially appear to have little in common, I suggest that there are a number of parallels which we can draw between the two authors' engagement with systems. Franzen, too, has a well-documented interest in various aspects of science, and this influences the content of his novels.[34] Both authors are primarily associated with the representation of domestic situations, but, as I demonstrate, the scope of their fiction far exceeds the limitations suggested by this remit. Modelling familial and wider social relationships in terms of interacting systems, they illustrate their awareness of contemporary scientific thinking, and direct our attention to both the micro-level of atoms, light waves, cells and neurons, and the macro-level of the city and the nation. All of the novels considered in this chapter reflect and comment upon the complex and rapidly changing nature of the social world within which the authors were writing.

[34] Stephen J. Burn relates that Franzen enrolled at college as a prospective physics major and later worked for some time as a research assistant at Harvard University's Department of Earth and Planetary Sciences ("Art of Fiction").

Like Wharton in *The Custom of the Country*, Franzen uses the sun as a recurring motif which provides a connecting principle between different social orbits. Wharton's "central sun of gold" signifies a fixed entity or value (the pursuit of money) around which others move (121). Similarly, the analogies between Undine and the sun also signify fixedness and immovability. In *The Corrections*, however, the sun is a fluid and evolving image which is constantly changing form: at times, for instance it is transformed into a vase of sunflowers or the mane of a lion. The image of the sun connects all characters in the novel, and the fluidity of this connection reflects the rapidly changing and ever-evolving nature of contemporary social relationships. Both Albert and Chip are struck by the beauty of sunflowers (146, 150), with Alfred confusing the flowers with children. Alfred reads *The Chronicles of Narnia* to his children (389), and later Gary's son Jonah reads the same books (161). Enid takes a drug called Aslan, and each gold caplet of the drug is "emblazoned with a many-rayed sun [...] or [...] the head of a richly maned lion" (369). This symbol also forms part of the logo of Alfred's employer, the Midland Pacific railway. The drug Aslan is also consumed by Chip under the label of Mexican A. Various characters are described as lions: Enid calls Gary her "little lion" (310); Denise sees Don Amour's head as "a lion's head"; and Alfred is described as "the lion lazy with depression" (278). Someone accosts Gary in a lift with the news that "the lion he ascendant now" and that this is "also a good time to remember the saviour" (253).

While the sun, here, is generally speaking an outward-tending model which points to the possibility of meaningful connection, Franzen also models society as a prison or 'correctional facility' (an image thus connected to the novel's central motif of 'corrections'), and this points to a more pessimistic reading of the social system. The images of the sun and the lion are generally applied to hopes for positive and redemptive change, in that they are frequently associated with pharmaceutical fixes and with children (the hopes of parents for a new generation). Prison motifs, however, are linked to ideas of determinism and the impossibility of correction. Alfred (quoting Schopenhauer) suggests that "if you

want a safe compass to guide you through life […] you cannot do better than accustom yourself to regard this world as a penitentiary, a sort of penal colony" (294). In this novel everyone is similarly imprisoned in their own cell of isolated selfhood. This is both a physical imprisonment, that of the body which contains us, and a psychological imprisonment, the inability to escape the particular characteristics (inherited and learned) which compose personality or character. It also points to a sense of solipsism, in that our mental and physical confines mean that we can never really know whether our perception of the world accords with that of another person. Upon realising that his perception of reality may be different from that of others, that concepts like 'real' and 'authentic' may be relative and subjective, Alfred concludes that the world must be "a penal colony, and he was doomed to be violently lonely in it" (316). Despite the high levels of social and technological connectivity portrayed in the novel, individuals in this 'global' society are seen to have become isolated from even their close family members. Prisons are closed systems because they limit individuals to fixed and predictable forms of action. They impose repetitive cycles of activity and provide little opportunity for learning and growth. By modelling both the individual and society as closed systems, Franzen, like Wharton in *The Age of Innocence*, comments upon the difficulty of forming meaningful relationships in the contemporary globalised world.

References to prisons connect together all individuals in the novel, signalling that (as I discussed in Chapter 4) what connects us together in contemporary society is frequently, and somewhat paradoxically, feelings of profound isolation.[35] I will now outline this method of connection. When Alfred is in hospital at the end of the novel he asks

[35] Alfred's son Chip lives in campus accommodation which adjoins land owned by the "Connecticut State Department of Corrections", designated for development as "a medium security prison" (39). Chip's employer, Gitanas, has spent time in prison and Chip compares this to his own life spent in a "different kind of prison", that of American society (155). Chip's brother, Gary, once made a jail out of popsicle sticks, complete with electric chair (294). Gary's mother, Enid, has a friend, Sylvia, whose daughter who was murdered by a man now awaiting the death penalty (346). Enid's daughter, Denise, has a lover, Robin, who marches in protest against this impending death sentence (493). And the list continues.

himself the question, “how to get out of this prison?”, referring both to St. Luke’s Hospital, which in his deluded mental state he believes to be a prison, and also his desire to be free from the prison of his physical body (635). As well as the prison of isolated consciousness, Franzen also considers inescapable social connections like family relationships as a form of imprisonment. Alfred states that “among the evils of a penal colony is the company of those imprisoned in it” (297). The novel also features surveillance; most obviously when Gary finds himself under observation by his son Caleb (178), but there is also a sense that surveillance features more broadly within the text, particularly among the family as a system, where there is a constant struggle for privacy. For example, Gary (incorrectly) tells Enid that Denise is involved with a married man; Denise and Gary discover Enid’s drug use; Gary spies on his wife Caroline through his camera lens while she is playing football; Caroline eavesdrops on Gary’s phone calls, and so on. Denise notes that she could do her father no greater kindness than to “respect his privacy” (605). In this focus upon imprisonment and surveillance there is an obvious connection to be made with *The Age of Innocence*. Hermione Lee suggests that Wharton’s survey of 1870s New York “uses, and describes, surveillance [...] this novel is all about being watched [...] it describes a society of spies and observers, and attempts at secrecy and concealment” (566). Lee cites the example of Ellen’s final dinner in New York where Archer compares himself to “a prisoner in the centre of an armed camp” (235), as well as Ellen’s exclamation that Americans are “so public” that in their houses “one can’t be alone for a minute” (94). Sally Preston suggests that “constriction – geographical, intellectual, even physiological and genetic” is a feature of all Wharton novels (38). What we have been seeing in my reading of these novels, then, is the extent to which both Wharton and Franzen address the ways in which social systems, modelled as fixed and constricting, determine the actions of individuals living within them.

As well as distributed networks or webs of similar motifs spread throughout the text there are also cyclic patterns of repetition which illustrate the inability to adapt and evolve

within a closed system. In *The Corrections* characters are searching for the means of correction, seeking to correct their own personalities and to correct the mistakes of their parents, but this often fails because “family determinism tends to turn correction into repetition” (Wood 192). Gary states that “his entire life was set up as a correction of his father’s life”, yet we see him falling into the same patterns of depressive behaviour which he so resented in Alfred (207). Returning to Wharton, Pamela Knights suggests that in *The Age of Innocence* “replication seems everything”, since we observe certain traditions repeated year after year, and “characters growing into copies of their parents” (26). For instance Newland finds that soon after his marriage he had “reverted to all his old inherited ideas about marriage” (136). Knights also suggests that “the novel’s formal structure underlines the pattern, as scenes re-enact themselves in a closed number of variants” (27). In both of these novels there are cyclic features with regard to the development of family relations through time: children seek to break away from the ways in which their parents do things but find themselves returning to the same patterns of behaviour. This sense of repetition is reflected in the use of planetary orbits as illustrative models.

Having set out how both authors model social systems in terms of open and closed systems, in the next part of this chapter I move towards a more detailed consideration of their use of reciprocal analogy as part of the modelling process. Both authors suggest that our understanding of systems can be enhanced through comparisons between different types of system. In Chapter 5 we saw how Richard Powers compared a corporation to a biological organism in order to highlight not only its ability to evolve and adapt but also its capacity for consumption and destruction. In both Wharton and Franzen’s fiction we see many analogies made between the individual, the social and the economy. Part of the reason for these comparisons is to provide social critique: both authors suggest that our lives are now too frequently viewed in economic terms. However, there is also another level to the comparison. Minds, societies and

economies are all kinds of open and adaptive complex systems, and as such they share certain underlying structural homologies (agents, emergence, and so on). Thus modelling social relationships in economic terms may communicate valuable information about the complex structure of globalised society.

James Annesley highlights Franzen's tendency to talk about mental states in economic terms, using financial "metaphors of boom and bust" ("Market Corrections" 115). He attributes this strategy to Franzen's critique of corporations, and his desire to show how even the psychological states of individuals are "increasingly finding themselves coordinated and controlled" (115). There is no disputing that in this novel, as Annesley suggests, "the interior world of the individual is subject to the logic of the market" (116). However, it would seem erroneous to attribute this state of events to the influence of corporations. Though characters' lives are to some extent shaped by corporate influences, it is also the case that there are actual and pre-existing similarities between the structure of minds and economies – both are open systems, for example – and Franzen's use of analogy brings such similarities to the foreground. Franzen provides a critique of the extent to which we view our lives in economic terms, but he also shows that, like the economy, our minds operate as systems. What he is trying to do in the novel moves beyond economic critique and beyond a simple denunciation of one particular system (the one which happens to be privileged in Marxist thought).

Wharton, too, makes extensive use of economic language to describe character in *The Custom of the Country*. Following her divorce, Undine perceives that she has lost "value" in social terms, and that her maiden name was "like the coin of a debased currency testifying to her diminished trading capacity (227). This is despite her separation being "as carefully calculated as the happiest Wall Street 'stroke' (229). Hermione Lee suggests that in this novel "personal life is expressed in terms of the fluctuations of the stock market: characters have their exchange value and their market price" (432). Wharton also traces parallels between the financial career of Elmer Moffatt and Undine's

personal career. Claire Preston suggests that "like Undine [Moffatt] makes and forfeits several fortunes; hers are in the marriage market, his in the stock market" and as such "they trace nearly parallel careers of boom and bust" (110).[36] While Wharton, broadly speaking, values the fluidity of open systems, the way in which she models personal life in economic terms signals that she is aware that fluidity also leads to instability and unpredictability. As such, the novel is openly critical of the effect which a business-centred, money-driven social system has upon the people living within it.

Franzen takes the analogy between biological and corporate systems down to the micro-level of cells and enzymes. Presenting the mind as a kind of corporate structure, it is suggested that Alfred feels better during the morning because after taking his medication "the blood was crowded with commuters […] lactic and ureic sanitation workers, hemogobinous deliverymen […] enzymic middle-managers […] everyone riding the aortal elevator" (382). We also see that this model is composed of reciprocal analogies: while bodily systems are described in corporate terms, corporate entities are also described in biological terms, frequently using the language of human biology. Alfred notes that the Midland Pacific had "attracted predators" (79) who had dismantled its "copper nervous system" (81). Gary notes the futility of finding someone within Orfic Midland to hold accountable for closing the Midland Pacific, since "its executives had been replaced like the cells of a living organism" (177). Franzen writes that "the brain of the Midland Pacific" was the building in which its offices were housed and that "higher order consciousness had its cortical seat in the board room" (407). Moving down the corporate structure, "at the reptile-brain bottom of the building were billing, payroll, personnel" and "inbetween were mid-level skill functions" such as signals (407). When Alfred relates that

[36] Wharton is critical of the separations imposed between women and the business world (forcing women to exercise any natural talent for business upon the marriage market). Incidentally, we also see this criticism in *The Corrections* when Enid, who has a head for figures, is forced to quit work in order to become a housewife and is prevented by her husband Alfred from making financial investments which would have made them more financially secure in later years .

"the betrayal had begun in signals", he is referring to the Railway's signal office (where his daughter begins an affair with one of his work colleagues) and to the breakdown of signals between the various parts of his body (as the result of his Alzheimer's disease) (78).

Beyond the analogies presented between biological and corporate structures, which as I have shown, have been relatively well documented, additional sets of analogies are used in both texts. Comparisons are frequently made between minds, societies and astronomical or meteorological systems, in order to emphasize the distinction between open and closed systems. In Wharton's fiction, as we have seen, astronomical references point to an aspect of the individual or the social which is closed, fixed and unadaptive, since the movement of the planets, for example, is linear and predictable. Meteorological references, however, as I discuss shortly, point to something about the structure of the self or the social system which is nonlinear, unpredictable and complex, like the movement of a hurricane or an area of turbulence. Though it has been noted by James Annesley and others that Franzen depicts the mind in economic terms, at various points during *The Corrections*, the mind is also compared to a meteorological system. Before his argument with Caroline, Gary suggests that "the weather in his brain was as warm and bright as the weather in northwest Philadelphia" (159). When Enid is attending a financial talk on her cruise, it is suggested that "atmospheric disturbances still lingered in her head", including a "squall" of resentment towards the other women in the room (386). Creating links between economic and weather systems, the financial adviser Jim Crolius suggests that he can see "clouds on the horizon", and that the financial "climate" was about to change (386). He also draws similarities between the cyclic movement of the seasons and that of financial markets: "the year has its rhythms […] you got your upswings in the spring, you got your downturns in the fall […] it's just like the market" (387).

Wharton, too, frequently makes use of weather imagery to describe the mental states of characters. Though there is no evidence of any familiarity with meteorology in

her library or her letters, the late nineteenth and early twentieth century was an important period for the science of weather: the first international cloud atlas (or catalogue) was published in 1896 and the US Weather Bureau was established in 1870 (and made a civilian enterprise in 1890) with its aim of predicting storms and implementing a warning system for affected areas. We see the discourse of meteorology within *The Custom of the Country*; when Undine is angry it is said that her parents "could read the approaching storm in the darkening of her eyes" (26). After one particularly severe outburst of temper Wharton writes that "everything had gone down before her, as towns and villages went down before one of the tornadoes of her native state" (78). Clouds are important recurring motifs in Wharton's writing, occurring in *Ethan Frome* at the point when Ethan's scientific reading had "made him aware of huge cloudy meanings behind the daily face of things" (14). Hermione Lee attributes this phrase to Wharton's love of Keats, a reference to the line "huge cloudy symbols of a high romance" from his poem 'When I have fears that I may cease to be' (379). However, I suggest that this is not merely a literary allusion but part of a larger pattern of reference in her fiction. Wharton also uses clouds in *The Custom of the Country*, at a moment of crisis for Ralph Marvel who is at this point severely depressed and recovering from a serious, near-fatal illness. She writes that as "he watched the great clouds form and dissolve" he contemplated that "all his past life seemed to be symbolised by the building up and breaking down of those fluctuating shapes, which incalculable wind currents shifted and remodelled or swept from the zenith like a pinch of dust" (210). In Robert Kennedy Duncan's *The New Knowledge* (1905), which is recorded as being in Wharton's library, very similar language is used to describe the behaviour of atoms in a process that we might commonly refer to today as 'the circle of life'. Duncan writes:

> What a phantasmagoric dance it is, the dance of atoms! […] For mark you the mutabilities of things. These same atoms, maybe, or others like them, come

> together again, vibrating, clustering, interlocking, combining, and there results a woman, a flower, a blackbird or a locust, as the case may be. But to-morrow again the dance is ended and the atoms are far away; some of them are in the fever germs that broke up the dance, others are 'the green hair of the grave', and others are blown about the antipodes on the winds of the ocean. (15-16)

Here, the "interlocking" and "combining" atoms suggest that people, flowers and locusts are all, analogously, structures which are emergent from the interaction of parts at a lower level. The passage stresses movement and change in the construction of living systems. Wharton's use of meteorological references signals that, perhaps unconsciously, she is aware that both atmospheric and human social systems share similarities of construction, being characterised by the "building up and breaking down" of fluid and adaptive agent-based structures.

In this chapter we have seen aspects of systems which are valued, namely openness, adaptation, growth, change and movement. As we saw in Chapter 5, however, systems have attributes which are undesirable, namely fixedness, stasis, control and repetition. It is those lifelike qualities of growth and adaptation which make systems a source of value in Section 3, where biological systems are characterised as in balance (as opposed to human social systems which are characterised as stagnant and fixed as in this chapter, or chaotic and displaying unrestrained growth, as in Chapter 5). We have also seen the importance of metaphor and analogy in modelling these qualities. The use of analogy is not only a useful narrative technique, it is a functional part of the narrative, pointing to actual homologies between different kinds of system and suggesting a new (old) way of conceptualising the world in terms of correspondences. Such model construction offers the systems novelist a means of engaging constructively with the task of system representation, despite our necessarily partial and incomplete knowledge of complexity.

Section 3: Systems Realism and the Ecological Turn

Chapter 7: Avian Systems and Symbols in *The Echo Maker*, *Freedom* and *Open City*

In 1989, LeClair identified the subjects of systems fiction to be “mastery”, “power”, “force” and “authority” (6); it was the author’s task to critique, counter and reformulate “large-scale human control systems” in the realm of politics and business (2). In recent years, however, the focus of systems-aware fiction has shifted towards a more positive appreciation of some, primarily biological, systems. Thanks to the work of complexity scientists, systems thinking has become central to problem solving in a wide variety of disciplines, and in fiction too authors are beginning to see systems as not only the particular structural manifestation of social and environmental problems, but also as the source of potential solutions to these dilemmas. While many works of systems-aware fiction still engage in valuable and relevant social critique with regard to economic and political systems, a perception that biological systems possess inherent value and that systems thinking plays a significant role in enabling us to act constructively in the world is now also a widespread feature of such fiction.

In this third and final section of the thesis, I suggest that in the last few decades we have seen an ecological turn in recent fiction which has been shaped by systems awareness. Recent novels addressing urgent environmental concerns are underwritten by a commitment to scientific accuracy which necessitates an engagement with social and biological complexity. Thus, in recent years, an environmentally conscious strand of systems-aware fiction has developed. In Chapters 7-9 I analyse a series of novels which address the complexities of today’s ecological problems and aim to educate the reader to understand, appreciate and preserve natural systems. The main challenge which contemporary authors face when writing fiction motivated by ecological concern is how to represent the complexity of the problems involved. Unlike oil spills and overflowing landfill sites which are immediately visible and easily depicted within a narrative, today’s ecological problems, such as climate change, are systemic: their effects are frequently

invisible and widely dispersed, and they involve a multitude of causal factors. This is a specific instance of the more general problem of how to narrate complexity – a problem faced by all systems-aware novelists. In the case of climate change, writers must somehow convey in narrative form a series of processes which we cannot see in action (being largely composed of the interaction of gases in the atmosphere) and whose totality may be beyond the capacity of our understanding.

The authors discussed in this section attempt to solve the representational difficulty I have identified through the creation of a series of analogous structural models which change the focus of our identification from the individual to the collective and reinforce the perception of interdependence between species. In the previous section, I suggested that Richard Powers redefined character in *Gain* so that he could model the agency exhibited by a multinational collective as a form of personhood. In this section we see, for example, authors model widespread ecological processes as those of a single organism so that ecological harm can be understood as a form of illness. While I engage with the criticism that this strategy is merely personification, and thus detrimental to our perception of the natural world, I argue that the process of modelling involves reciprocal analogy, and that, as a result, the ecosystem is just as important to a systems-aware understanding of the human as the human is to a systems-aware definition of the ecosystem.

Max Black refers to an "existential use of models" by scientists who think of a particular theoretical model not "as if" it were the thing modelled, but "as being" that thing in reality (228). These scientists work "not by analogy" – which would entail "a detached comparison reminiscent of simile" – but actually "through and by means of an underlying analogy", requiring "an identification" more typical of metaphor (228-29). I suggest that, while complexity science uses analogue models to highlight similarity of structure within different mediums, systems-aware novels frequently go one step further and use existential models to denote real equivalence or structural homology. For example, in this

chapter I address the use of bird migration as a model which creates equivalence between mental and environmental processes. In *The Echo Maker,* migration is a form of memory exhibited by the ecosystem as a whole, while memory is seen as a form of migration (in the act of remembrance, we follow the route home to where we began). This is more than a comparison; migration is not 'like' memory, it actually is memory in the context of the novel. As Black acknowledges, the existential use of models is more of a risk than the use of analogue models, since we "are exposed to the dangers of self deception by myths", or, in other words, we risk having a subsequent model prove us wrong (228). However, this form of model has greater explanatory and persuasive power, and, as such, is the form of analogy which is most useful and valuable within systems fiction. It allows authors to move beyond detached comparisons based upon some visual similarity, to propose instead a form of underlying structural identification.

In this chapter I consider three novels, *The Echo Maker* (2006), *Freedom* (2010) and *Open City* (2011), which use the structure or pattern of bird flocking and bird migration to create an easily visible model of a complex system which illustrates through analogy how environmental harm affects the biosphere. These texts move beyond the use of birds as a symbolic repository of value, as static images of 'liberty', or 'loss', towards the creation of models which are functional and allow the author to make suggestions about how to act in regard to systems, despite our limited knowledge of system function. After outlining the resurgence of environmental fiction which has taken place in the last few decades, I move on to a consideration of the extent to which the three novels I am concerned with use bird imagery as a symbolic comment upon the human. To this end I highlight the intersection between systems fiction and the syndrome novel, where the individual's experience of the world frequently becomes an expression of their own state of mind. Since one of the more overt messages of *The Echo Maker* and *Freedom* is that natural systems should be preserved, I argue that these novels develop their argument beyond anthropocentrism towards an awareness that humans, bird flocks and ecosystems

are all analogous complex systems which deserve equal consideration. I discuss the narrative strategies with which these authors begin engaging with the whole of an ecosystem, including the alternation of micro and macro system levels. I describe how these texts are aware of the complex nature of environmental harm and the difficulties involved in habitat preservation, and as such explore the necessity of compromise, the difficulty of achieving consensus, and the inability of the individual to perceive him or herself as part of a collective. I conclude the chapter with some indication of how these contemporary systems-aware texts mirror novels from the nineteenth century in their consideration of large interconnected wholes, whilst also addressing post-postmodern anxieties about whether language, and specifically narrative, is adequate for an expression of complexity.

I turn now to an exploration of the means by which Franzen models environmental issues as a biological concern, in order that damage to the environment is made to appear as a form of illness. A cancerous cell is one which has 'forgotten' how to be part of a multicellular organism. When a cell becomes cancerous it loses the ability to coexist with other cells and begins to disrupt the body's homeostatic mechanisms. Mutated cells multiply and spread outwards until the host environment can no longer function normally and death ensues. My use of the word 'environment' here is significant. Walter Berglund's outburst in *Freedom,* "WE ARE A CANCER ON THE PLANET! A CANCER ON THE PLANET!" (484), is based upon an analogy between body and biosphere; his anger at the world's overpopulation stems from what he perceives as the failure of individual humans to recognise that they too are part of a collective system, which, like a biological organism, cannot sustain infinite growth in the number of its component parts. In an earlier conversation about the economy, Walter makes the same kind of analogy: comparing social systems to biological organisms, he argues that unlimited economic growth cannot be a positive thing, since "for a mature organism, a growth is basically a cancer" (122). When Walter exclaims that we are "a cancer on the planet", he is suggesting that the

relationship between cancerous cells (agents) and the human body (system) can communicate information about the relationship between human beings (who function in this case as agents) and the biosphere (system).

Both cells and human beings function as agents within various systems: cells form part of the immune system, the circulatory system and the nervous system, for example, while humans exist within both social systems and the wider ecosystem. All of these agent-based structures can be understood using a common conceptual framework, the science of complexity. This shared framework facilitates the perception that systems such as brains, cities and ecosystems are structurally analogous. When innovation occurs in systems science, it is often tied to the identification of a new and unexpected correspondence between two systems whose analogous qualities had previously not been considered. In systems-aware texts, unexpected parallels are frequently used to similar effect, enhancing our knowledge of system function.

In Chapter 5 I discussed in some detail the analogies made between cancers and corporations in Richard Powers' *Gain*, where the unrestrained growth and competitiveness of cancerous cells is reflected in the expansion of corporate structures. Analogies between biological and social systems can also be found in research conducted by scientists associated with the Santa Fe Institute. For example, in the *Santa Fe Institute Bulletin,* Daniel Rockmore makes an explicit analogy between tumours and social systems, stating that: "the behaviour of the population of cancer cells, in essence, breaks the implicit social (and biological contract) binding together the cellular populations within the multicellular society that is a tissue" (20). In my initial quotation from *Freedom* – "WE ARE A CANCER ON THE PLANET!" – that which is already known and agreed about the rapid growth of cancerous tumours is applied to the contested subject of population dynamics in order to argue that the planet is overpopulated. By suggesting that cancer cells are a "population" bound together within a "society", Rockmore offers a reversal of this insight: he suggests that tools used in the study of human population dynamics can

be applied to the study of cancer. According to Rockmore, issues such as "resource competition" and "reproductive fitness" are proving useful in the attempt to understand how cells fight for dominance within the body (21). As I set out in Chapter 2, literature and science frequently approach complex systems in a similar way, creating models which posit structural analogies or underlying homologies between different systems.

Communicating an underlying structural homology between systems is especially important for those novels which have an ecological emphasis. In Richard Powers' *The Echo Maker*, Jonathan Franzen's *Freedom* and Teju Cole's *Open City*, comparisons are drawn between migratory flocks of birds and human biological and social systems, adding a new chapter to the long history of bird symbolism in literature.[37] Beyond making the suggestion that individual birds have human characteristics and are deserving of our care, *The Echo Maker*'s descriptions of bird flocks and brains as analogous systems serve to highlight the delicately balanced ecology of the American Midwest. The self-organizing assemblage of bird flocks during their migration is seen to echo the emergence of consciousness from neuronal activity; by extending this analogy, Powers enables us to see environmental harm as a form of brain damage. With species densely interconnected within a single ecosystem, damage to one part of that system (the sandhill cranes) will inevitably affect us, too. In *Freedom*, the predatory relationship between domestic cats and migratory songbirds creates a discourse about personal liberty which is then transferred via analogy from the issue of cat ownership to that of human reproduction. The decision to own a cat, like the decision to produce a child, has a disproportionately negative impact upon the environment when each individual is considered as part of a wider system. In *Open City*, the ability of migratory birds to cross national borders is

[37] *Open City* is not explicitly concerned with inspiring action on environmental issues such as climate change and habitat preservation, but I include it in this chapter because its focus is 'ecological' in the wider sense of being concerned with contextual thinking about man's relationship with built and non-built human environments.

juxtaposed with the complex history of human migration, both voluntary and forced, as well as current U.S. immigration policy.

These novels form part of an established tradition of environmental thinking in American writing which has been extensively documented by Lawrence Buell in *The Environmental Imagination* (1995), and *Writing for an Endangered World* (2001). From James Fenimore Cooper's *The Pioneers* (1823) and Henry David Thoreau's *Walden* (1854), through to Don DeLillo's *White Noise* (1985) and Richard Powers' *Gain* (1998), Buell traces how American writers have for centuries engaged in an interrogation of humanity's relationship with built and non-built environments. The novels that I have chosen to discuss in this third section, though representative and exemplary in their themes and representational strategies, are only a small sample of a wider set of environmentally-aware fictions. I argue that since the 1990s there has been a particular concentration of fiction concerned with the negative effect which humanity has had upon the environment. In addition to the novels considered in this chapter, Jonathan Franzen's *Strong Motion* (1992), Joyce Carol Oates' *The Falls* (2004), Lydia Millet's *How the Dead Dream* (2008), Margaret Atwood's *The Year of the Flood* (2009), and Karen Russell's *Swamplandia* (2011) are novels produced in recent years which have depicted such environmental harm. This same period has also seen the rise of ecocriticism as an area of academic research; initially defined as "the application of ecology and ecological concepts to the study of literature" (Rueckert).[38]

My concern in this chapter, however, is not to give an 'ecocritical' reading of Powers, Franzen and Cole, but to show how systems realism participates within the recent environmental turn in fiction and to illustrate points of intersection between ecocriticism and systems analysis. Fritjof Capra argues that "all systems thinking is environmental thinking", since systems theory involves thinking contextually and

[38] The term 'ecocriticism' was first used by William Rueckert in the essay, "Literature and Ecology: An Experiment in Ecocriticism" (1978). For more on the definition and remit of ecocriticism see Glotfelty xix, Garrard 5 and Buell 25.

conducting analysis with reference to a "wider whole" (37). Likewise, modern environmentalism must be systems-aware, concerned as it is with the eco*system* as a self-organizing and self-regulating entity, as well as complex global issues of pollution, overpopulation and climate change. Those who apply these scientific discourses to literary analysis have similar areas of interest: the relationship between part and whole, for instance, or the difficulty of attributing linear cause and effect. The two research areas also share a similar historical trajectory. Ecocriticism began in the 1980s, a period when public awareness and concern about environmental issues had reached an unprecedented level.[39] This same period has seen the rise of systems analysis in literature, thanks in part to the establishment of the Santa Fe Institute in 1984 and also to the publication of texts like LeClair's *In the Loop* (1988), events which have facilitated the spread of systems-awareness and systems discourse. Ecocriticism is, however, like the recent turn towards systems-thinking, "an emergent discourse […] with very ancient roots" (Buell 2). Just as we have identified a kind of proto-systems awareness in texts written a hundred years before the advent of systems science, the literary ecocritic may argue that literature has been engaging with the environmental debate for centuries. In British Romantic poetry, for instance, we find an appreciation and understanding of the natural world which recent criticism has revaluated as "proto-ecological knowledge and environmentalist commitment" (Buell 2). As the remit of ecocritical analysis is increasingly understood to include texts which interrogate man's relationship with built as well as non-built environments, theorists are beginning to see "environmentality as a property of any text" (Buell 25).

A predecessor of novels such as *Freedom* and *The Echo Maker* that explicitly foreground harm to natural environments and advocate action to reform human behaviour, Rachel Carson's *Silent Spring* (1962) is generally argued to be the founding text of literary

[39] Highly publicised environmental disasters in this period include the gas leak at Union Carbide in Bhopal, India in 1984, the fire at the Chernobyl Nuclear Power Plant in 1986 and the Exxon Valdez oil spill in 1989. A hole in the ozone layer over Antarctica was first reported in *Nature* in 1985.

environmentalism (Garrard 1). Though primarily a factual text detailing the harm done to plants, animals and humans by the widespread use of agricultural pesticides, *Silent Spring* nevertheless "relies upon the literary genres of pastoral and apocalypse" and takes its epigraph, and by extension its title, from a poem by John Keats (Garrard 2). Showing an awareness of the way in which systems behave that anticipates contemporary systems thinking, Carson's concern is to illustrate the effects of toxicity upon millions of agents who are all caught up in a web of interdependent relationships. She describes the passage of toxins through various food webs, addressing soil and plant ecology and genetic inheritance. She also considers the unintended consequences which result from what we would term the system's nonlinear unpredictability, pointing out, for instance, that substances introduced into the environment may return to us in an unfortunate feedback cycle, causing cancers and other health problems. Both *Freedom* and *The Echo Maker* display a debt to *Silent Spring* in their awareness of the complexities involved in any attempts to modify humanity's influence on the ecosystem, of how environmental reform inevitably involves compromise, and of how in a nonlinear system positive intentions can have unintended consequences.

Like Powers and Franzen, Carson was faced with the problem of how to narrate damage to a complex ecological system; the invisible, incremental and widely distributed damage caused by "systemic insecticides" (46). Recurring references to the "sudden silencing of the song of birds" provide the reader of *Silent Spring* with an experientially verifiable example of the harm caused by invisible chemical agents which act at the level of cells and genes and whose effects are often incremental and slow to make themselves known (100). Rob Nixon refers to this kind of invisible environmental damage as "slow violence", because it "occurs gradually and out of sight […] dispersed across time and space" (2). Nixon argues that converting slow violence into image and narrative poses a representational challenge, since toxic build-up is a disaster which is "slow moving and long in the making", as well as being "anonymous and star[ring] nobody" (3). In Chapter 2

I discussed in similar terms the aspects of scientific complexity which render it difficult to represent, including the wide distribution of agents within a system (sometimes across the entire globe), the lack of one single, centrally important agent and nonlinear relationships of cause and effect. Carson faces similar narrative challenges in *Silent Spring,* which is without a central protagonist unless we consider the insecticide DDT a character in its own right; its journey through the food chain unites the various chapters and carries us through the text. The text's recurring reference to birds also functions as an important narrative anchor: their migration points us towards the cycle of the seasons, evoking images of continuity, closure and promised renewal. In this context, death is a source of anxiety because it symbolises a wider disruption in the natural order. If "not even the return of the birds may be taken for granted", then how is the "grip of winter" to be broken? (101).

Birds have long been used in fiction as repositories of symbolic value and this trend has continued in recent years. In 9/11 fiction in particular we see a concern with flight and falling, with birds used as symbols of loss or ultimate transcendence. In Jonathan Safran Foer's *Extremely Loud and Incredibly Close*, for example, a guide at the Empire State Building relates that "during the spring and autumn bird-migration season, the lights that illuminate the tower are turned off on foggy nights so they won't confuse birds, causing them to fly into the building" (250). Oskar Schell comments that "ten thousand birds die every year from smashing into windows" (250). In *The Echo Maker,* Gerald Weber observes a bird colliding with a window: "a male cardinal […] attacking his reflection" (357), and *Open City* concludes with the image of "fatally disoriented birds" meeting their deaths by flying into the Statue of Liberty. In 9/11 fiction, we tend to find that birds are valued, not for their own sake, but for their ability to contain and reflect some human quality. For example, Foer juxtaposes descriptions of the flight of birds with images of the falling bodies from the September 11th attacks, and in the form of the "birdseed

shirt", which Oskar believes could have saved his father, offers an image of imagined transcendence (2).

If we look at *Open City*, what causes birds to fly into the Statue of Liberty is unknown; the deaths are not attributed to adverse weather conditions or light levels. Instead, Cole writes that "the sense persisted that something more troubling was at work" (259). Later, the narrator refers to bee populations which are being killed by a mysterious "colony collapse disorder" (200). The cause is unknown, but the narrator suggests that "maybe they [the bees] are connected to us in some essential way […] and their death is a warning" (200). Cole is less concerned than Franzen and Powers with the ecological implications of these deaths. Instead, birds in this text again have a primarily symbolic role. Cole's narrator explicitly refers to the connection between birds and humans in visual art, where birds in paintings often serve as symbols of, for instance, the human soul (39).[40] As we saw with *Extremely Loud and Incredibly Close*, this use of symbolism is related to the novel's status as a post-9/11 novel. The narrator's only reference to the site of the World Trade Center is as an absence, "a great empty space" or "freestanding shadow" which resists representation, "completely veiled" in "light-absorbing" blackness (52). The absence is disorienting, and the experience of confronting the vast shadow is mirrored by the birds who "somehow lost their bearings when faced with a single monumental flame" (258).

T.J. Lustig writes that the cranes in *The Echo Maker* function symbolically as a "repository of lost or silenced human possibility", and as such, their inclusion in the text suggests that the "new naturalism" practised by Powers echoes the limit problems of naturalism set out by Raymond Williams in *Drama from Ibsen to Brecht* (132). Williams argues that in Ibsen's *The Wild Duck* and Chekhov's *The Seagull*, the symbolic function of the birds is to represent some "total atmosphere" of the play which is "not available as

[40] For more on the particular resonance of the word 'soul' in post-postmodern fiction see Burn, "Mapping" 45-7.

action" (Williams 57). Absence, loss, and frustration are not easily represented through the physical action of individuals and therefore frequently remain unarticulated. The bird symbol solves this problem: it is "a substitute for adequate expression of the central experience of the play in language" (Williams 104). The birds in *Silent Spring*, for example, also possess this function, since their "sudden silencing" gives concrete and emotive expression to something which otherwise evades representation (100): invisible and systemic environmental harm whose effects are dispersed widely through space and time.

For Williams, the problem for the naturalist dramatist is how to indicate "a total pattern", when "fidelity to the representational method" dictates that this must be shown through the everyday actions of individuals who may not be aware of the total pattern or able to articulate it (104). This is also a problem for the systems realist: how to represent the system as a 'whole' when each individual agent involved in it operates independently and at a primarily local level, with no knowledge of the system in its entirety. The bird symbol offers a solution insomuch as it allows the dramatist to hint at something which is more than the sum of the parts, or "more than the sum of the relationships" between individuals (58); however, Williams suggests that Ibsen and Chekhov are not entirely successful in their use of birds to represent the experience of a group. As a representation of the whole, he suggests that the birds are problematic because "what is written as an outward process – the direction of separated people to that which connects them – can become a series of inward, self-conscious and self-regarding gestures" (58). Of the three novels I discuss in this chapter, Cole in particular seems most aware of this contradiction: *Open City*'s first-person narrator makes constant reference to events which should inspire feelings of connectedness and group cohesion – the New York marathon, public demonstrations, journeys on crowded public transport, – yet these events transmit to the reader only his profound isolation. Despite his careful observations of crowds, the narrator is unable to transcend his own limited perspective to articulate the experience of the social

whole. His crowds remain nameless and faceless figures “pushed by a counterinstinctive death drive, into movable catacombs” (7). Both individual consciousness and the city location appear in *Open City* as solipsistic closed systems, “sealed away world[s], visible from without, but impossible to enter” (37). Cole’s description of birds flying into the Statue of Liberty, therefore, is a symbolic gesture which attempts to move beyond the experiences of the narrator to indicate something not directly accessible as action: the failure of a collective ideology of freedom. This image is, however, only partially successful since, articulated by the narrator, it also appears as an extension of his mental state and the preoccupation with birds, depression and suicide which permeates the rest of his narrative.

Within a systems-realist novel the problem of how to represent the whole is frequently solved, or at least mitigated, by changes in narrative viewpoint: third-person narrators with omniscient qualities may be used to provide a global perspective not available to the naturalist dramatist. What we see in *The Echo Maker*, for example, as the focalization shifts between micro and macro system levels, is a synthesis of the nineteenth-century naturalist’s concern for the very small and the nineteenth-century realist’s aerial view of the whole. In addition to connecting part and whole, these novels attempt to create a balance between symbolism and realism. In order to avoid charges of anthropocentrism, texts with an ecological message must ensure that birds possess some value beyond their existence as a symbolic comment upon the ‘human’. *The Echo Maker* and *Freedom* are inspired by real ecological dilemmas: the sandhill crane and the cerulean warbler are actual endangered species and the novels seek to encourage their preservation. For Powers, sandhill cranes may represent some aspect of the human (neurons), but he is also conscious of their existence as a real species at risk of environmental harm. What allows him to reconcile these two narrative functions is complexity theory’s particular relationship with analogy: a bird can be simultaneously animal and neuron because the ecosystem itself is both habitat and brain.

In Chapter 4 we saw the difficulty which individual characters face when attempting to perceive the whole of any system which they exist within. Similarly, in *Freedom*, Franzen expresses the inability of individuals to comprehend a "total pattern" by drawing attention to the plight of migrating songbirds, which collide (quite literally) with ever-expanding human settlements, mown down by "high-rises and power lines and wind turbines and cell phone towers and road traffic" (485). The two main threats to bird survival, the fragmentation of habitat and predation by domestic cats, are attributed to each human individual's inability to see him or herself as part of larger systems. At the micro-level of any complex system, the activity of each individual agent has little observable impact on either the system as a whole or the non-system environment; however, when we look at that system on a macro-level, the sum total of millions of agents each acting according to their own self-interest may have a devastating impact upon the rest of the world. In a discussion about how individual decisions to reproduce contribute to global overpopulation, Walter Berglund suggests that "what's still 'normal' at the individual level is heinous and unprecedented at the global level" (222). The novel also draws attention to the connection between micro and macro system levels using the example of cat ownership. Walter's crusade against the cat owners of Canterbridge Court, a conflict which plays out in the final section of the novel, is based upon the statistic that "every year in the U.S. one billion songbirds are murdered by domestic and feral cats" (222). Walter's nemesis, Linda Hoffbauer, fails to see what harm could result from her decision to allow her cat to roam free outdoors. Her declaration of "so Bobby kills birds […] so what?" speaks of an inability or unwillingness to see beyond the level of the individual to that of the wider ecosystem (542).

Within *The Echo Maker*, too, the complexities of environmental reform are illustrated in systems terms. Powers begins the novel with a visually striking instance of sandhill cranes gathering on the Platte River, Nebraska, during their annual migration. This spectacle is, however, a somewhat incongruous sign of their approaching extinction:

as humans take more and more water from the Platte River, the wetlands decrease in size until we see the “same number of birds crammed into half the space” (57). Tourism worsens the situation by using more water, but this increases the spectacle, which in turn increases the number of tourists. The wetland ecosystem is therefore trapped in a self-sustaining feedback loop of environmental harm because people cannot perceive the impact which their actions have upon the collective system. The conflict between developers and conservationists hinges upon the issue of whether real-estate and retail development can ever be “pro-bird” in an area so sensitive to ecological change (348). On a character level, Powers rather simplistically opposes the morally righteous conservationist, Daniel Riegel, against the developer with questionable morals, Robert Karsh. However, though he uses war as a metaphor to describe their debate – with participants “charging and countercharging” or “landing a couple of stinging blows” (346) – what Riegel and Karsh represent cannot be reduced to a simple opposition between ‘good’ conservation and ‘bad’ development. The issues involved are complicated; all the systems involved are interconnected and it is difficult to see how in this situation human impact could be minimised. The systems involved are so large and so complex that they almost seem to transcend simple moral categories like ‘good’ and ‘evil’.

Powers uses the language of military conflict primarily in order to juxtapose the “invisible new war on wetlands” against the highly visible coverage of the Iraq war (437). He also uses it to set apart the posturing and rhetoric of the staged public debate from the complexities of the real issue. Robert Karsh, the developer, uses the kind of language which we would actually associate with *positive* environmental initiatives: he talks of absorbing tourists “as ecologically as possible”, by building a tourist village with “environmental principles of construction” and a “low impact” upon its surroundings (346). Though eventually his proposals are exposed as a charade which masks the plan to create a water park in a region with limited and highly contested water resources, the initial ecotourism initiative outlined at the town meeting is persuasive (411). The main

problem with his proposals is that they are anthropocentric and view the landscape as a resource for human use rather than a system within which we play, or should play, only a small part. Karsh sees “the whole point of nature” being “to preserve wildlife for our appreciation” (346). Discussion of “water-rights trading” suggests that water is a human-owned product to be bought and sold (264). The ecosystem and the economic system are represented as deeply interconnected: Karsh’s only interest in ecology is that in today’s market “good conscience actually sells” (295). The novel does not end with any prospect of a solution to the ecological dilemma; no tidy narrative resolution is offered to us. The suggestion is, perhaps, that real world systems are incompatible with such resolutions. Karin’s decision to expose the true goals of the developers is ultimately futile, since “she will save no one […] she will barely slow the humans, who can’t be stopped” (410).

The plan of ecological reform outlined in *Freedom*, of “locking up habitat to save it from development” is full of similar seemingly inevitable compromises due to the densely interconnected nature of the agents involved (212). For example, oil and gas billionaire Vin Haven funds the project by opening other parcels of land to ecologically destructive gas extraction (212). In addition, people living on the proposed site are resettled using money from another oil company, which is indirectly involved with supplying faulty equipment to soldiers in the Iraq war. Involving a whole series of moral dilemmas, ecological preservation becomes inextricably tied to corporate and legal systems as well as government policy and international relations. Within a capitalist economic system, where water rights or mineral rights are traded as commodities and land is always defined as human ‘property’, ecological preservation inevitably costs money and money involves compromise. Like the ecotourism initiative outlined in *The Echo Maker*, the drive to establish a preserve for the cerulean warbler is motivated by the self-interest of those providing the funding. However, the text also suggests that there is little alternative to this kind of scheme, since inspiring the collective population to act together to preserve habitat is very difficult. Walter’s frustration at failing to instigate environmental change lies with the

distributed nature of the human social system. He complains that “there’s never any center, there’s no communal agreement”, and that as a result he is not able to accomplish “anything systemic” (218). However, this lack of centre is precisely how a complex system like a city or a nation is necessarily structured.

Both *The Echo Maker* and *Freedom* address the seeming inability of the individual agent to influence the wider system when real change seems to require the agreement of a majority of agents. This brings us to the importance of the word ‘freedom’ in *Freedom*. The novel’s central figure, Walter Berglund, claims that “the reason the system can’t be overthrown in this country […] is all about freedom” (362). While the concept of individual liberty is enshrined within American law, a social system ‘united’ by independence necessarily involves some contradiction, and therefore conflict. Michael Foley writes in *American Political Ideas* that “America’s ethos of freedom allows the free play of liberties to wander into confrontation with one another” (27). After all, “one person’s liberty will very often not be conducive to another person’s liberty” (23). An agent within a complex system acts largely independently, yet there is a delicate balance involved: without some kind of deferral to the interests of the whole, the system would devolve into chaos. As Foley writes, “liberty is directly concerned with the reduction of coercive constraints”, yet “it is also, ultimately, dependent on order and control” (23). What is depicted in *Freedom* is the chaos that results from agents having too much independence and too little concern for the whole. When making individual decisions to have a child, few consider what this will mean in the context of the whole system, and this results in a chaos which threatens ecological destruction. This issue provides an example of what Garrett Hardin has termed “the Tragedy of the Commons”.

Hardin’s argument in “The Tragedy of the Commons”, is based upon the premise that “a finite world can only support a finite population”. He imagines a group of herdsmen keeping cattle on a pasture, each of whom is faced with the decision of whether or not to add another cow to his herd. In all cases, the economic benefit of this addition to the

individual outweighs the negative consequences which result from overgrazing, because these negative effects are shared between the whole group. Thus, the logic of individualism generates eventual environmental tragedy, since "each man is locked into a system that compels him to increase his herd without limit – in a world that is limited". Hardin applies this scenario to the issues of pollution and overpopulation. He suggests that some kind of constraint or "mutual coercion" must be applied to the issue of liberties, since "individuals locked into the logic of the commons are free only to bring on universal ruin". This is a restatement of the problem discussed previously, that individuals are frequently unable to perceive their own actions as part of some total system.

Powers depicts humanity as out of step with the rest of the natural world: we are "the animal perpendicular to all the others" (447). Unlike the birds whose migration is tied to the cycles of the natural world, we are a species "that flies at right angles to the seasons" (447). This disconnection from the rest of nature is presented as a problem of memory. I began the chapter with the suggestion that cells which become cancerous have 'forgotten' how to coexist with other cells within the body. In the attempt to turn a delicately balanced wetland ecosystem into a waterpark, humans in *The Echo Maker* have similarly 'forgotten' how to coexist with other species. This act of forgetting too is medicalised: humanity's inability to recognise cranes as kin suggests that "the whole race suffered from Capgras" (347). People are able to perceive the similarity between themselves and birds but they are not able to fully experience or 'remember' the appropriate emotional connection (347). As well as participating in an ecological turn which has been gaining momentum since the 1980s, the shared preoccupation which Cole, Franzen and Powers have with memory and medical conditions places their novels within another recent 'scientific' trend in contemporary fiction, which T. J. Lustig and James Peacock have termed the "syndrome syndrome".[41] Their recent collection, *Diseases and Disorders in*

[41] In addition to Powers' use of Capgras syndrome, medical conditions feature strongly in the other novels discussed in this chapter. In *Freedom*, Patty's autobiographical accounts are written at her therapist's suggestion. Both she, and her son's girlfriend, Connie, take anti-depressants. In *Open City*, Julius is a

Contemporary Fiction, highlights the widespread prevalence of neurological conditions and 'syndromes' in novels, film and TV produced in the late twentieth and early twenty-first centuries. Neurology can thus be listed alongside ecology and systems theory as an example of the kind of scientific discourse which is influential in recent fiction.

Significantly, the medical conditions featured in these novels are not only experienced by individuals, they also become features of the external environment. Character, therefore, is not only reduced to the level of neurons and synapses but is also expanded outwards to incorporate large ecological processes. This is something that Patricia Waugh has associated with the "neo-phenomenological" aspect of the syndrome novel: "the phenomenological recognition that feeling is not necessarily felt; that it can be experienced as an attribute of the world" (24). Writing about Franzen's earlier novel *The Corrections*, which I discussed in detail in Chapter 6, Waugh suggests that the source of Alfred Lambert's anxiety is "the absence of an affective anchor in the world, an absence that is projected onto the world around him" (22). This projection means that "Alfred's anxiety is not felt in his body: it is a feeling that takes over everything in his world" (22). In *The Echo Maker*, Mark's head injury gives rise not only to accident-induced Capgras syndrome, but also to an associated paranoia. Echoing this individual condition, in the wake of the 'injury' inflicted by the September 11th attacks Powers represents a mood of collective national paranoia. He suggests that "America rose up striking at targets everywhere" (213), that "borderline depression was a signal indicator of appropriate response, in the summer of 2002" (137). In *Open City* there are many acts of personal forgetting on the part of the narrator: he forgets his pin number (162), and then forgets the incident of forgetting the pin number (166). He is also accused of having committed a sexual assault in the past, an accusation which is never explicitly denied, but which may refer to something which his memory has repressed (156). Moving from the individual to

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psychiatry resident whose research is based upon "affective disorders in the elderly". His habit of going on long walks through New York City begins as a form of "therapy"(7).

the collective, the country also appears to have selective amnesia when confronting traumatic incidents. For example, with reference to the names of places associated with the conflicts in Iraq and Afghanistan it is suggested that “those names will mean nothing; forgetting doesn’t take long” (171).

The ‘neo-phenomenological’ aspect of the syndrome novel sees the medical conditions of individuals experienced as attributes of the external world. In part this is, like the symbolic use of bird imagery, a way of reading the world in purely human terms. The projection of human attributes on to the environment can, of course, be troubling from an ecocritical perspective because it appears to reinforce anthropocentric perspectives by depicting the environment as an extension of the human. Yet there is an important ethical dimension to both the systems-aware novel and the syndrome novel. In fact, these texts frequently display anxiety regarding the use of either real medical conditions or real endangered species as the basis of a symbolic comment on human culture and society. In systems-aware fiction this dilemma is mitigated by the reciprocal, two-way nature of the projection. While the natural world is modelled in human terms, ‘nature’ frequently provides the novelist with a means of modelling the problems of culture. Where neo-phenomenology meets systems realism is in the systems novel’s recognition that ecosystems and cities are complex systems analogous to the human brain, and, therefore, that it is possible to define the activity within cities and ecosystems as mental processes. Fritjoff Capra writes in *The Web of Life*, that “according to the theory of living systems, mind is not a thing but a process”, and therefore “the organizing activity of living systems, at all levels of life, is mental activity” (172). For Capra, and for the systems novelist, this is more than just a detached comparison; it asserts an identification which echoes that seen in Black’s concept of existential analogy. In *The Echo Maker*, Powers creates a sustained analogy between brain damage and environmental harm, based upon the similarities of structure which exist between brain and biosphere, two agent-based systems which generate emergent behaviour. Descriptions of Mark’s brain after his

accident show neurological agents reassembling themselves into a whole, a process which mirrors the way in which cranes assemble themselves into migratory flocks. Mark relates how “his parts come back to him” (42), and compares his body to “countless microscopic creatures banded together in need” (43). Similarly, we see the cranes “shed the solitary need” and become part of a “larger motion” (98). Pain signals in Mark’s brain are described as “a flock of birds, each one burning” (10). These analogies are reciprocal, or in Powers’ terms “bi-directional”; while the environment is read in human terms, the human mind is also read in ecological terms.

Birds are agents within the ecosystem, just as neurons are agents within the brain. Agent interaction, both bird and human, is modelled in terms of migration, thus reinforcing the similarities of structure between the different systems. When Karin is waiting for her brother to regain consciousness, and later, when she is waiting for him to remember her, she talks in terms of a return journey – “she watched him return” (20), “never doubting that he would come back” (37) – in a manner which echoes the “blind, self-organizing return” of the cranes (278). The migratory route traced by the cranes is a “single, continuous, repeating loop” which mirrors the feedback loops found in human mental processes and human social systems (98). Just as the birds use the river to navigate, Karin drives “tracking the Platte” (5). She “found Good Samaritan the way the birds found the Platte”, by using memory (both conscious and genetic) (6). Karin suggests that her repeated returns to Kearney mean that she is “stuck in a stupid loop […] worse than the damn birds” (75). Daniel Riegel too is said to be “like the birds […] always turning home” (192). Mark’s friend Rupp refers to Karin and Daniel’s renewed relationship as “the annual migration” because of their past history of break-ups and reconciliations (216). The brain too, “can’t escape its past” (17). As Mark regains higher cognitive functioning, his speech traces “tight loops” (37), while physical therapy sees him walking in circles, tracing “a tiny solar system, orbits within orbits” (34). Though Powers does at times use anthropomorphism to encourage preservation – referring to the sandhill cranes’ pair

bonds and their experience of grief, for instance – the novel is most successful in those sections where, using the cycles of migration, Powers creates a functional equivalence between brain and ecosystem. Within this model birds appear as the neurons of the wetlands, and it is true that this model could work in the service of an anthropomorphic projection of the human upon the natural world, and in consequence reading the world in human terms. In fact, however, Powers is suggesting that we need to read both humans and the wetlands in systems terms. The novel uses models in what Max Black might see as an 'existential' way, asserting not only similarity but deeper structural identity or homology.

As well as describing memory as a form of migration, Powers uses his cognitive neurologist Gerald Weber to introduce a range of additional spatial metaphors describing the brain. Weber's latest book on brain function is called *The Country of Surprise.* He elsewhere refers to the brain as "a surprising place" (169), and "the final frontier" (189). Drawing attention to the brain as a collection of agents acting simultaneously in interdependent relationships, Weber suggests that we think of ourselves "as a unified, sovereign nation" though neurology suggests that we are more like "a blind head of state, barricaded in the presidential suite" (363). The self is at best a "provisional confederation" at risk of splitting into "unrecognisable new countries" (171). If brains are "like coral reefs […] complex but fragile ecosystems" then, by analogy, we can suggest that ecological harm is a form of brain damage (186). Presenting brains and ecosystems as analogous complex systems helps to suggest that humans should be wary of disturbing the ecological balance. Powers shows that the human brain is vulnerable to harm, and that brain injury can have unpredictable consequences. By representing the brain in spatial terms, we are able to see a correspondence with the environment, which is also delicately balanced and vulnerable to harm. As a nonlinear system, intervention in the environment may have unpredictable negative consequences analogous to the effects of Capgras syndrome which drives Mark to attempted suicide.

Open City also draws comparisons between human journeys and bird migration. The narrator's repeated walks "out into the city" occur during a period of his life when he is also frequently "watching bird migrations" from his apartment window, and he raises the possibility that these two phenomena are connected in some way (4). Attesting to the global nature of communications systems, Julius listens to internet radio stations from Canada, Germany or the Netherlands, to voices which, like the birds, have travelled "thousands of miles" (4). In his memory, these voices "remain connected […] with the apparition of migrating geese" (5). Setting out and returning home each evening, Julius traces a circular, repeating migratory route like the birds. However, these walking loops occur in New York, described by the narrator as an "island that turned in on itself" (54). Manhattan's shore is "a carapace, permeable only at certain selected points" and the narrator's walks resemble that of a prisoner pacing his cell (54). Against "the miracle of natural immigration", in which birds freely migrate across national borders, Cole presents the illegal immigrant, detained and awaiting deportation (4). This opposition resembles the distinction drawn between closed and open systems which we saw earlier in Chapter 6, where open systems were valued for their ability to learn, grow and adapt.

In the final part of this chapter I address how the three novels I have discussed are situated in relation to nineteenth-century realism and post-postmodernism. Being works of systems realism these texts articulate their concerns using those formal attributes of realism which we associate with the nineteenth century. They exhibit, for instance, social concern by means of detailed social observation, and stress the importance of simultaneity and analogy to an understanding of the world. As I stated in Chapter 3, Richard Powers has commented upon his connection to nineteenth-century fiction, speculating upon whether his novels "somehow resemble works of nineteenth-century encyclopedic social survey" (Pellegrin, par. 8). Many online reviews of *Freedom* and *Open City* speak in similar terms of the resemblances between these novels and nineteenth-century texts. Nicholas Lezard writes that *Freedom* "really wants to be […] *War and*

Peace", though "it would, however, settle for being *Middlemarch*". Tim Walker in *The Independent* writes that "*Freedom* is resolutely a novel in the classic form, a 19th century-style narrative set against the wars – political, social, actual – of the 21st". Lev Grossman writing in *Time Magazine* calls Franzen "a throwback, practically a Victorian". James Lever in *The London Review of Books* suggests that *Freedom* "belongs to an Upton Sinclair tradition" concerned with "the interconnections of the capitalist system". Claire Messud comments on *Open City*'s reliance upon "digression", "small […] observations" and "peculiar detail", all of which we associate with the nineteenth century social novel. She also suggests that "Cole's enterprise is not new"; that "it has a long literary history".

In the case of *Open City*, this connection to an earlier era of time is also reflected in the text, where the past is often seen to bleed into the present. The narrator frequently makes statements such as "time […] had somehow vanished" (40), and that "time became elastic" (75). Frequently we appear to have made a return to a past era, as we witness "voices cut out of the past into the present" (75). A man's raincoat becomes the folds of a Victorian dress; noises in the street become "a commotion from an earlier time […] what, it seemed to me, were draft riots"; and fabric caught in a tree becomes for an instant "the body of a lynched man" (75). Adding to the impression that feedback loops operate in time as well as in space, at one point the narrator states that "it was hard to escape a feeling that we were having a conversation before the twentieth century had begun" (126).

However, as discussed in Chapter 1, post-postmodernism cannot stage a complete return to nineteenth-century realism. Life is seen as increasingly complex and does not always fit the form of a traditional narrative with a beginning, middle and end. Real world systems do not correspond to simple narrative oppositions or tidy resolutions. Furthermore, the legacy of postmodernism lends a certain anxiety to the realist engagement within these novels. They share a postmodern scepticism about the ability of language to communicate meaning. They raise the possibility that metaphor is in itself an incomplete and unsatisfactory representational strategy because it fails to capture the

nature of complexity. When Powers and Cole want to present the self as provisional and unstable they compare it to a narrative. Powers writes that “the senses were a metaphor at best” (229), and that “me is a rushed draft, pasted up by committee, trying to trick some junior editor into publishing it” (415). In particular, Gerald Weber’s breakdown is expressed as a crisis of narrative. His worry is that he is becoming an unreliable fiction, “that he himself might be an extremely detailed case history” (232). He begins to doubt his ability accurately to represent reality: “it struck him that he’d invented Nebraska […] the whole story” (367). As the crisis worsens, “the text unravels. Even the case’s name – Gerald W. – sounds like the feeblest of pseudonyms” (414). What triggers Weber’s breakdown is the realization that in treating real people as narratives he has failed to engage with them as real people. In *Open City,* narrative is an illusion which masks the real rather than facilitating its representation. The moments when we sense that the narrator may be unreliable are presented in narrative terms. He refers to his memory as “a secure version of the past that I had been constructing since 1992” (156). Attesting to an incompatibility between real systems and narratives, he claims that “we are not the villains of our own stories […] we play, and only play, the hero” (243).

What allows these novels to balance symbolism and systems realism is their relationship with analogy and homology. Due to the fluidity of systems theory, which dictates that an individual can be both part and whole, agent and system, dependent on the context within which it is viewed, the birds in these novels can be simultaneously symbol and system. As birds considered generically they may symbolise human values or desired attributes such as freedom, transcendence or the soul. As sandhill cranes and cerulean warblers they can participate in the recent ecological or ecocritical turn which evidences real concern for other species. Or finally, as neurons in an ecosystem-wide brain, birds may provide a synthesis of the human and the nonhuman, as examples of the underlying homology between ecological and mental processes. The recent neurological and ecological turns share a concern with the relationship between part and whole, micro

and macro, local and global. These are also the concerns of systems realism, and, as such, provide points of intersection between the various current approaches to contemporary literature.

In each text the modelling of one system using the structure and discourse of another analogous system is of central importance. In *Open City*, birds represent an openness and freedom of movement which is unavailable to the human figures in the novel. This symbolism is achieved using analogy: bird migration is “natural immigration”, and this is compared to both America’s border control, which restricts natural migratory behaviour, and also to the forced migration of slaves. In *Freedom*, human impact on the environment is modelled through a discussion of the impact which cats have upon other species. This model is easier to visualize than the human-level problem and solutions are more readily available and easier to test (keep your cats indoors and they will kill fewer birds). Of the three texts considered in this chapter, *The Echo Maker* is most successful as a work of systems realism because it moves beyond the identification of structural *similarity* and proposes instead structural *identification* or homology. The emergence of consciousness from neuronal activity in the brain does not merely ‘echo’ the assembly of a migratory flock; brain activity, specifically memory, exists as a form of migration and migration is seen as a form of memory. This is an ‘existential’ use of models, in Black’s terms, since it works “through and by means of underlying analogy” or structural homology (Black 229). It is visible at the level of the collective and at the level of the individual agents. In both *Freedom* and *The Echo Maker* existential models are reinforced by a medical reading of environmental processes.

Chapter 8: Swarm Systems in *Flight Behaviour* and *Anthill*

In the previous chapter I suggested that the agent-based structure and emergent behaviour of bird flocks provides a way of modelling both brain activity and ecological processes. Since the brain and the ecosystem cannot be accessed directly or in their entirety, and since meaning within such systems is emergent (found in relationships rather than physical parts), they can only be fully understood through the construction of models or simulations. In this chapter I develop further the theme of flocking behaviour which I identified in the previous chapter as a recurring feature of recent systems fiction. As accessible and easily visualized examples of complex systems, animal collectives such as insect swarms and schools of fish can also be used to help us visualize the unpredictable effects of environmental harm. I argue that the novels considered in this chapter, Edward O. Wilson's *Anthill* (2010) and Barbara Kingsolver's *Flight Behaviour* (2012), move beyond the use of insects as a reflection of human values and concerns (as, for example, the image of the ant as a diligent worker or mindless automaton), instead conceiving of the swarm as an analogous model of the wider ecosystem. I argue that the relationship between the individual agent and the collective, more easily visualized in a swarm or a flock than in the human population, encourages a perspectival shift on the part of the reader who then begins to conceptualise the world in terms of wider, interdependent wholes.

I begin the chapter with a discussion of the authors' scientific knowledge and background. The choice made to communicate an environmental message through fiction is a reflection, I suggest, of the post-postmodern awareness that the novel is a means of modelling the whole of a system, and that as a form it is adequate to an exploration of the complex. I then explore how these novels avoid the danger of didacticism while communicating their social and environmental message, and suggest that they privilege no single voice or authority. Instead, they show that an engagement with complex systemic problems necessitates an acknowledgement of multiple perspectives. In re-

reading the novel we effectively re-run the simulation, experiencing differing levels of sympathy for the protagonists, for example, or gathering new opinions on what the best response to climate change might be. As was the case in the previous chapter, I suggest that environmental problems are modelled here as medical issues, and that both authors write using the discourse of systems, proposing reciprocal analogies between ecological and biological systems. I conclude the chapter with a discussion of one particular model, the 'superorganism', which, displaying the unrestrained growth of a cancerous tumour, provides a new biological analogy by which to understand and engage constructively with the discourses of human overpopulation and habitat destruction.

Systems-aware novels are frequently written by authors with some form of scientific background. Of the authors featured in previous chapters, George Eliot and Edith Wharton were well read in the scientific literature of their time, Richard Powers and Jonathan Franzen share an early interest in science (Powers initially enrolled at university as a physics major and Franzen worked as a research assistant on scientific projects) and Cormac McCarthy is a long-term resident at the Santa Fe Institute. This chapter introduces another two novelists who have considerable scientific knowledge and experience. Barbara Kingsolver, author of *Flight Behaviour*, worked as a freelance science journalist before she became a novelist and has degrees in both biology and ecology. E.O. Wilson is a biologist, previously professor of entomology at Harvard University and winner of the Pulitzer Prize for his non-fiction writing on socio-biology and ant societies. After a long career writing for scientific publications, Wilson has only recently begun writing fiction; he turned eighty-one in the year that his first novel, *Anthill*, was published. In the last two decades, scientists and science enthusiasts have been ever more frequently turning to fiction as a vehicle for their ideas, and as a result, fiction is becoming more science literate and more permeated by systems thinking. This shift in the boundaries between the so-called 'two cultures' can be partly attributed to the renewed importance of interdisciplinarity and 'organic' systems thinking within western society as a

whole. It can also be attributed to the desire to communicate an urgent social message to a large number of people. In the case of Kingsolver and Wilson, their fiction is motivated by serious environmental concerns such as climate change and habitat destruction. The decision to articulate those concerns in a fictional form rather than through an article in a scientific publication is doubtless an attempt to engage with a greater number of people. In her review of *Anthill*, Margaret Atwood speculates as to why Wilson has turned to writing fiction: "'a wider readership for urgent ecological messages' might be one answer […] many people have trouble grasping complex hypotheses and long strings of numbers, whereas narrative skills seem to be part of the basic human toolbox". Wilson confirms this in an interview with *The Huffington Post,* stating that he had in mind "a message […] persuading Americans, and especially Southerners, of the critical importance of land and our vanishing natural environment and wildlife". Despite having expressed this message in non-fiction writing over many decades, he claims that: "the desire grew to develop it in fiction because I had come to realize that people respect nonfiction, but they read novels". Solving today's environmental problems will require the action of a majority of people, and fiction is able to reach beyond academic circles and address a more general readership. The novel as a form is a useful tool for engaging constructively with systems that we can neither fully perceive nor comprehend. It is able to provide a microcosm of the world and thus model complex environmental issues in a manner which is more effective – in the sense of being more accessible – than academic papers which rely heavily upon mathematical analysis. Kingsolver argues that fiction is an important tool in educating people about environmental issues, since "you can introduce science to people who didn't know they were interested in science" (quoted in Lichtman).

This desire to inform, educate and persuade the reader about the rightness of a particular social message echoes that of naturalist novels in the late nineteenth century which sought to raise awareness of the suffering wrought by the inequalities of the

capitalist system.[42] Upton Sinclair's *The Jungle* (1906), for instance, was a meticulously researched piece which employed journalistic techniques to expose the plight of workers in Chicago's meat-packing plants. Writing fiction with the purpose of educating or persuading, however, has its dangers. As well as the risk of appearing overly didactic, there is the potential for the message to overwhelm the medium. Writing about *The Jungle* in *The Cambridge Companion to Realism and Naturalism*, Jacqueline Tavernier-Courbin writes that "Sinclair tends to assault the reader with the message he wants to carry, subordinating plot, character development and verisimilitude to propaganda" (250). Tavernier-Courbin states that even after Sinclair had sacrificed the quality of his fiction and some accuracy of content to the presentation of a persuasive argument, his "description of dehumanising working conditions […] met largely with reader indifference" (254). There are no guarantees for novelists that their message will be acted upon, or even understood fully. Though *The Jungle* brought about an immediate change in food regulation, it did nothing to ameliorate the plight of the workers. Thus, by extension, we see that the risks to the systems novelist are as follows: that in attempting to communicate an urgent message about the importance of tackling climate change and habitat destruction they will overstate their case and appear didactic; that their commitment to scientific accuracy will be compromised by attempting to state a clear case for action; or, that their message will be forgotten once the reader has finished with the text.

Systems novels frequently introduce a knowledgeable scientist figure or other educated professional to handle the more technical items of information in the text and to articulate the appropriate lessons to be learned or conclusions to be drawn from the data presented.[43] This message is communicated in an accessible way to a less

[42] James Baldwin criticises naturalist 'protest fiction' for displaying overt sentimentality and for possessing characters which lack realism because they exist solely as mouthpieces for the social message of the author.

[43] The introduction of the flawed scientist figure parallels Raymond Williams' description of the 'liberal hero' in *Modern Tragedy*. Williams writes that the hero in Ibsen's plays, "defines an opposing world, full of

knowledgeable figure within the text (and thus to the reader as well). This device aids the systems novel in avoiding didacticism because the scientist figures are themselves involved, implicated in, compromised and made vulnerable by the systems which they seek to explicate. Though educated in the processes of the particular system which they study, these scientists do not possess all of the answers and may at times be considered unreliable sources of information. The novels do not privilege any single voice or perspective since no single agent has the authority to speak on behalf of the system as a whole. In *The Echo Maker*, neurologist Dr. Gerald Weber is accused of professional negligence and appears to suffer some form of nervous breakdown. Initially a source of authority on brain functions, by the conclusion of the novel he is almost entirely unmade by how little he really knows about himself or others. In *Flight Behaviour*, Prof. Ovid Byron launches into an environmental tirade against a journalist which almost results in physical violence, the urgency and emotional weight of the message compromising his professional distance. In *Anthill*, narrator Prof. Fred Norville conceals three murders from the authorities in order to protect a lawyer who campaigns for environmental issues. Systems novels are not afraid of compromising their environmental message by a frank acknowledgement of the bewildering complexity of the systems involved, even though this means that occasionally the overall clarity of the message is lost. Their commitment to systems realism outweighs the desire to create propaganda, but the novels are all the more effective for that commitment to scientific accuracy.

Displays of environmental concern in fiction have grown more prevalent since the 1980s. Until recently, however, few novels have directly addressed climate change and its consequences. Novelist Daniel Kramb discusses this deficiency in a recent article: although he lists a few recent examples such as Franzen's *Freedom* (2010) and Ian McEwan's *Solar* (2010) which can be said to have "touched on the issue", Kramb

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lies and compromises and dead positions, only to find, as he struggles against it, that as a man he belongs to this world, and has its destructive inheritance in himself" (98).

maintains that few novels in recent years have done more than “vaguely reference the situation”. Chapter 1 began with Tom Wolfe’s 1989 claim that “young people with serious literary ambitions [are] no longer interested in the metropolis or any other big, rich slices of contemporary life”, despite social representation seeming “the most tempting, the most challenging, and the most obvious idea an American writer could possibly have” (47, 45). In a different time and a different context, Kramb seems to echo Wolfe’s lament at fiction’s lack of engagement with real-world complexity, asking: “what is our fiction, if it's shying away from ‘the most pressing and complex problem of our time’?” Due to the nonlinearity (and thus unpredictability) of complex systems, the cultural narrative of ‘global warming’ has, as Kingsolver notes, become one of ‘global weirding’; in many places around the world recent decades have seen some of the coldest and wettest years on record (*Flight Behaviour* 261). Climate change is thus increasingly viewed by the scientific community as a systemic problem: an unpredictable set of alterations within complex meteorological systems, both influencing and influenced by all the globe’s ecosystems and human social systems. Just as the social realism which Wolfe demanded in 1989 now necessitates an engagement with systems realism, those novelists who are beginning to address the issue of climate change and other pressing environmental issues are finding that they have to write in systems terms. This poses significant challenges for authors, since, as I set out in some detail in Chapter 1, the highly distributed, nonlinear and emergent nature of complex systems is not easily represented within a realist narrative.

I suggested in the previous chapter that analogies between systems lead to greater understanding and innovation in systems science and systems fiction. I also argued that in *Freedom* and *The Echo Maker*, ecological harm was represented as a medical issue as a consequence of the authors’ decision to model ecological systems using the language of human biology. In *Flight Behaviour,* Kingsolver uses reciprocal analogies between ecological and human biological systems to begin a conversation about the complex issue of climate change. In part, this too involves medicalization, as

climate scepticism becomes modelled as cancer denial. Kramb suggests that there is an extent to which climate scepticism plays a part in making climate change unappealing as a topic for fiction writers, claiming that as a society we are "failing to have this conversation" because we find the issue "unpleasant", and that this might explain why the conversation is "not really taking place in fiction" either. Kingsolver explores the issue of climate scepticism in *Flight Behaviour* by creating an extended analogy between climate change and (potentially terminal) bodily illness. This medicalization of an ecological issue echoes the comparisons between biological and corporate systems made by Richard Powers in *Gain* (see Chapter 5) and the comparison between overpopulation and cancer seen in Chapter 7. The novel's central character, Dellarobia, explains climate change scepticism as follows: "people are scared to face up to a bad outcome […] like not going to the doctor when you've found a lump" (231). She later adds that "people resisted hearing the details of a problem, even when it was something personal, like their own cancer" (288). This analogy is repeated throughout the text; Kingsolver also writes that "trees had lost their leaves early in the unrelenting rain […] like a chemo patient losing her hair" and that climate change is "a sickness of nature" (49, 149). Drawing a comparison between climate change and cancer, Kingsolver makes environmental harm appear personal: like a bodily illness or the pervasive influence of corporations on our lives, we can choose to ignore it, but are ultimately unable to escape its effects. This analogy helps to explain climate change denial by modelling it as one reaction to illness: if there is no cure then we may as well try not to think about it. It also reinforces the point that we ignore the issue at our own peril, since a warming climate, like cancer, will not heal itself. In the novel, entomologist Ovid Byron tells Dellarobia: "I am a doctor of natural systems. And this looks terminal to me" (282). Kingsolver makes climate change a medical issue and casts the scientist in the role of doctor, a trusted figure with the authority to diagnose our collective malady (though, faced with the complexity of the systems involved, he has no cure to offer us).This kind of comparison is a familiar one amongst climate change

campaigners, which demonstrates that thinking in terms of analogous organic wholes is evident not just in the American novel but in the wider culture. For instance, at a 2013 conference on forest science, the Prince of Wales advocated action on climate issues by comparing the earth to a seriously ill patient:

> If you think about the impact of climate change, [the response should be how] a doctor would deal with the problem […] A scientific hypothesis is tested to absolute destruction, but medicine can't wait. If a doctor sees a child with a fever, he can't wait for [endless] tests. He has to act on what is there. […] The risk of delay is so enormous that we can't wait until we are absolutely sure the patient is dying. (quoted in Harvey)

It is by thinking in terms of systems (environmental, bodily, social, and informational) and the analogies or correspondences between them, that the political, cultural and fictional debate about complex environmental issues is now beginning to take place.

Though the complexity of the systems involved is considerable, Kingsolver suggests that the main reason why so few novelists have tackled climate change is that "most novelists aren't trained in science" (Lichtman). This purported lack of scientific awareness on the part of many novelists is a restatement of the familiar two cultures debate:

> We have this divide in our culture. I think kids decide pretty early on whether they groove on the math and chemistry classes, or whether they're going to run for their lives into history and AP English. And it just goes on from there. We establish this – we kind of establish these roots for ourselves in which we're not going to really cross over. And it becomes increasingly difficult to do that. (Kingsolver, quoted in Lichtman)

In the same interview, Kingsolver speaks of wanting in her fiction to begin a conversation across the divide between scientists and non-scientists. As we have seen, analogy plays an important role in translating information between the sciences and the humanities, facilitating interdisciplinary conversations about systems whose behaviour transcends traditional disciplinary divides.

Both Kingsolver and Wilson are keen to invest their fiction with their own scientific knowledge. Wanting to communicate real scientific concerns, they feel a responsibility towards factual accuracy which influences the realist tone of the texts. Kingsolver writes that *Flight Behaviour* is designed to be: "a fictional story within a plausible biological framework" (435). Wilson draws upon his own childhood recollections of growing up in rural Florida and Alabama as well as his decades of research on ant colonies to create his novel, described by Tim Adams in his review for *The Observer* as "social realist". In keeping with the majority of recent systems-aware fiction, neither novel is overtly experimental in style or form; as texts whose primary goal is social documentation they attempt to transmit accurate and transparent information on the current state of climate change and habitat destruction. This commitment to scientific realism necessitates an engagement with complex systems, and as such, both novelists write explicitly in systems terms throughout. Each novel is therefore shaped by the particular difficulties posed by writing complexity. In order for Kingsolver to represent climate change, she must engage with the difficulties of representing nonlinear causality, vast numbers of interdependent agents, self-organization and emergence, and she must do this within a realist framework which, though acknowledging the limits of our knowledge about such systems, nevertheless encourages the reader to engage in positive environmental action. It is little wonder then that Kingsolver writes that the "biotic consequences of climate change tax the descriptive powers" (*Flight Behaviour* 435). When we address a topic like climate change, it is difficult to attribute direct cause and effect relationships and difficult,

therefore, to apportion blame or establish proof. It is also difficult to visualize the issue at all since the rise and fall of gas levels in the atmosphere is a slow moving, widely distributed and generally invisible form of action. As such, climate change is another example of the 'slow violence' which I discussed in Chapter 7. Rob Nixon suggests that environmental disasters such as climate change present writers with "formidable representational obstacles" (2). In addition to the practical difficulties of representing processes which are anonymous, invisible, and dispersed through space and time, it is also the case that climate change struggles to compete with more immediate disasters such as 9/11 because it lacks the "visceral, eye-catching and page-turning power" offered by "falling bodies, burning towers" and other highly visible and therefore more "newsworthy" disasters (3). These representational challenges go some way towards explaining why there have as yet been relatively few novels written about climate change. Writing about this deficiency, Daniel Kramb suggests that "it's probably […] true that climate change is far too complex an issue to write a definitive novel about".

Faced with the challenges of representing environmental processes which are frequently invisible and widely dispersed through space and time, and whose effects are unpredictable, Kingsolver and Wilson turn to insect collectives as a highly visual, dynamic and engaging example of both the systemic nature of the natural world and the effects of environmental harm upon a population. In *Flight Behaviour*, a migratory swarm of monarch butterflies becomes geographically displaced by the unusual climatic conditions produced by climate change. Their arrival at an unexpected location in Southern Appalachia produces a visual spectacle comparable to that of the flocking sandhill cranes featured in *The Echo Maker* (see Chapter 7). Like Powers, Kingsolver draws analogies between the animal collective and other complex systems, such as the human mind, the collective human population and the biosphere as a whole. In *Anthill*, Wilson draws on insect collectives by documenting the lives of several ant colonies, drawing explicit

parallels between their lives and our own, and questioning what it takes for a collective population (ant or human) to be in harmony with the rest of the environment.

In *Flight Behaviour*, the movement of the monarch butterfly swarm is compared to the motion of fire and water. These analogies model on a small-scale the anticipated end of the biosphere if climate change continues unabated. As such the novel renders the invisible processes of climate change visually striking and engaging. When Dellarobia is told that “every kind of weather is intensified by [global] warming”, she makes a connection between this information and references to “flood and fire” which she has gained from the Bible (280). References to fire and flood are used to join the butterflies and climate change together in the mind of the reader. Kingsolver makes reference to “the monarch system disintegrating under the pressures of fires and floods” (394), and a world unravelling into fire and flood” (432). This imagery is repeated until it becomes synonymous with the processes of climate change (394). By describing the butterflies as “sparks” or “a river in flood” (14, 56), Kingsolver makes them appear as a manifestation of climate processes, a kind of warning of the extremes of weather which are to come if global warming continues. Resembling images of fire, the butterflies appear as a “shower of orange sparks” which “spiralled upward in swirls like funnel clouds […] sparks [which] lifted high and sailed out undirected” (14).The swarm is also compared to the movement of water. For example, Dellarobia describes the movement of the swarm as a “rippling wave, like the disturbed surface of a lake” (14). This rippling motion accurately describes the collective behaviour of the swarm, whose emergent patterns of motion are also seen in the turbulent flow of air or water. Dellarobia remarks that being amongst the butterflies “gave her the sense of being underwater”, and that the butterflies appear like “bright fishes” (52). Schools of fish too display these emergent patterns of motion. The movement of the butterflies is “like water through a crevice”, a “butterfly filled current” and “a river of butterflies” (56). Though beautiful, the spectacle is also disorienting and thus makes

characters feel uneasy: Dellarobia finds that “the illusion of current knocked her off balance” (56).

Like the bird flock, the insect swarm is an emergent pattern of behaviour generated by a migratory system. The complex, emergent social behaviour of insect swarms and colonies, known as ‘swarm intelligence’ is part of a larger scientific investigation into group dynamics, frequently referred to as ‘swarm theory’. Swarm theory is the investigation of how and why disordered groups of individuals become organized and intelligent systems without any individual having taken charge of the group. Within insect swarms, schools of fish, flocks of birds and human crowds we see the same kind of dynamics:

> Every individual moving at a constant velocity matches its direction to that of its neighbors within a certain radius. As this hypothetical collective becomes bigger, it flips from a disordered throng to an organized swarm […] It’s a phase transition, like water turning to ice. The individuals have no plan. They obey no instructions. But with the right if-then rules, order emerges. (Yong)

The insights into group dynamics which are being produced by swarm theory are being utilized in diverse areas of research. For example, according to Yong, tumours can be better understood using insights gained from migratory swarms, since cancer cells “migrate into surrounding tissues”. Because the tumour “looks like a migrating swarm”, Yong speculates that if you could “figure out its algorithms” then “maybe you could divert it from vital organs or stop its progress”. A plethora of non-fiction books published in the last decade, as well as a number of recent documentaries, have addressed the value of swarm theory in solving real world systemic problems. Books such as Len Fisher’s *The Perfect Swarm: the Science of Complexity in Everyday Life* (2010), Peter Miller’s *Smart Swarm: Using Animal Behaviour to Organise Our World* (2010), and James Surowiecki's

The Wisdom of Crowds: Why the Many Are Smarter than the Few (2004) apply the insights of swarm theory to issues as diverse as traffic management and disease control. Swarm theory is one of many aspects of complexity theory which is becoming increasingly commonplace within our collective culture, and it is this culture which systems fiction emerges out of and responds to.

In systems-aware fiction, swarms, colonies and flocks are frequently used as illustrative examples of complex systems. In *The Edge of Chaos* by Pamela McCorduck, two chapters entitled “Flocking Behaviour” and “Swarm Systems” depict a Santa Fe Institute scientist offering her pupil a chance to see “complexity in action” by taking him to witness birds flocking on a vast scale (87). In scenes which explicitly mirror the flocking of sandhill cranes in Richard Powers’ *The Echo Maker*, McCorduck describes “first dozens, then hundreds, thousands, tens of thousands of snow geese, Canada geese, and sandhill cranes take to the air, a blizzard in contravention of gravity” (101). These “great flocks of birds wheeling in elegant spirals” are offered as examples of the way in which “rich and complex behaviour arises” from simple rules (96). As the birds begin to take off in ever larger numbers, the scientist figure relates that “we’re watching a system move between phase states” (100). The lessons learned both by her pupil and the reader from this visual spectacle is that “something emerges from a collective effort that’s beyond, transcends any individual’s capabilities”, and that “the whole is greater than the sum of its parts” (100, 102). Though she explicitly states that the animal collective has relevance as an illustration of complexity, McCorduck does not develop this use of flocking behaviour further. Powers’ use of sandhill cranes is therefore more effective than McCorduck’s because he fully integrates flocking behaviour and other system structures into the text, using them to drive the plot forward. Rather than telling us directly that this behaviour is an example of complex system function, Powers shows us the systemic nature of the natural world by illustrating intricately interwoven and analogous relationships between agent and

system, bird and flock, part and whole, micro and macro-levels, individual person and collective population.

What makes a bird flock or an insect swarm such a useful model both in scientific research and in fiction, is its relative accessibility in comparison to other analogous complex systems. Unlike the human brain, all of the agents in a swarm or colony are visible to the human eye, and though numerous, the agents within a single swarm are considerably fewer in number than neurons in the brain or cells within the human body. In addition, the movements and interactions of swarm members can now be mapped using computer technology. In *The Super-Organism*, E.O. Wilson writes that ant colonies "exist at a level of biological organization between the organisms that form its units [i.e. the individual ants] and the ecosystems […] of which it is [itself] a unit", and as such they provide "an accessible connection" between the two levels (xviii). Easier to visualize than entire ecosystems, colonies are nevertheless analogous to those larger systems. Thus the swarm as a model enables us to describe and make predictions about less accessible systems. As I have suggested, faced with the difficulty of representing "slow violence" and other systemic problems, and equipped with a postmodern legacy which renders authors sceptical about the possibility that narrative or language itself can communicate truth about the world, such models nevertheless allow constructive engagement. Both narrative and the novel as a form are endlessly adaptable, and as such these models can function despite – or perhaps thrive because of – the incomplete systems of knowledge involved.

Kingsolver explicitly writes about the monarch butterfly swarm in systems terms. Entomologist character Ovid Byron refers to them as "a system, a 'complicated system'" (145). Dellarobia relates that as she learns more about the butterflies, this "'complicated system' began to take hold in her mind" (146). Explaining why the butterflies have arrived in Appalachia for the first time, Ovid states that "climate change has disrupted this system" (228). Though the sight is beautiful and awe-inspiring for locals and tourists alike, it is still "evidence of a disordered system […] a biological system falling apart along its seams"

(365). The butterflies constitute a system because, each year, thousands of normally solitary butterflies (agents) gather together and organize themselves into large collectives. As well as being agent-based and self-organizing, these swarms display emergent behaviour: they migrate. Their migration is an example of emergent behaviour because it is a product of the collective which no individual could complete alone. Ovid Byron tells us that "no single butterfly ever made the round trip" from Canada to Mexico and back again, since "a lifespan of a few weeks did not add up to an annual migration of many thousand miles" (145-46). The totality of the migratory route is a pattern which exists only at the level of the collective, not that of the individual agent. Each butterfly completes only a small section of the route before it dies.

Wilson also writes explicitly in terms of systems, as for example in this description of a whole being more than the sum of its parts:

> When any organized system, whether a university, a city, or any assembly of organisms themselves, reaches a large enough size and diverse enough a population, and has had enough time to evolve, it also becomes qualitatively different […] the greater the number of parts interacting with one another, the more the new phenomena that emerge within it. (*Anthill* 277-78)

Wilson's use of the term 'system' in this example strongly resembles the way the term is used in systems science. It is applied to biological and social collectives, both of which, as kinds of living system, can be said to evolve. The system consists of a large population or large number of parts, whose interaction gives rise to the emergence of new phenomena. In addition, Wilson claims that emergence makes the system qualitatively different from a group of individuals which has not undergone spontaneous self-organization. This means that the whole is something more than the physical parts considered in isolation.

Since the publication of *Gödel, Escher, Bach* (1979), in which Douglas Hofstadter famously compared the activity of ants to that of neurons in the human brain, the ant

colony has been utilized by scientists and non-scientists alike as an illustrative example of a complex system. Prior to 1979, ant colonies were frequently referenced in literature and social theory, and their behaviour compared with or contrasted against that of humans. We can trace comparisons between ant and human societies back to Greek mythology: the name 'Myrmidons' is "cognate with the words for 'ant' and 'ant nest'", appropriate since the tribe were valued for their ant-like qualities of ferocity and loyalty (Atwood). In her recent introductory guide to the sciences of complexity, Melanie Mitchell claims that colonies of social insects (including ant colonies) are "some of the richest and most mysterious examples of complex systems in nature" (4). She refers to both ant colonies and brains as "complex systems in which relatively simple components with only limited communication amongst themselves collectively give rise to complicated and sophisticated system-wide ('global') behaviour" (6).

Roger Lewin interviewed E.O. Wilson about his work with ants, addressing the commonalities between his research and the emerging field of complex systems. Wilson states that the social behaviour of the colony is "as striking a demonstration of emergence as you could hope for" (176).These insights, familiar to us from complex systems theory, are also applied to Wilson's description of ant colonies in *Anthill*. The ants "functioned together as a well-organized whole" (182).The colony is self-organizing: though it has a queen, "she had never given orders or led them in activities of any kind" (176). Each individual agent is replaceable: just as a body replaces its cells, "one worker, or a thousand workers, could die and the colony would go on, repairing itself as needed" (183). As a whole, the population is stronger, more intelligent and more likely to survive than its individual ants when considered alone. Once the social organization is stripped away ants "lived individually only hours, or at most, a few days" (213).

Wilson draws comparisons between ants and humans, based upon their similarity as agents within complex systems. At the beginning of *Anthill*, he suggests that "there are of course vast differences between ants and men. But in fundamental ways their cycles

are similar" (15). Raff, the novel's protagonist, comes to learn through his studies in biology that "the foibles of ants […] are those of men, written in a simpler grammar" (169). When writing about ants he uses terminology we associate with human social life and when writing about human society, Wilson uses terms from biology which might equally apply to ants. These analogies are reciprocal. As Kingsolver suggests in her review of the novel, "Raff's family history is phylogeny; his settings are habitats; his parents' marital conflicts appear preordained by different biological interests. When new characters appear, their clothing and features are described as if to make them identifiable in a field guide to the humans" ("Ear to the Ground"). Aunt Jessica, in particular, resembles an ant: "sitting torpid in her chamber, she disseminates faint odors and crucial information about the family while her mysteriously unpaid lifelong servant scurries about bringing soda crackers" ("Ear to the Ground").

In the previous chapter I addressed the symbolic role of birds in recent novels. Kingsolver creates a number of symbolic parallels between human and butterfly in *Flight Behaviour.* As with my earlier point about bird symbolism, this is a form of anthropomorphic projection. However, because many of the analogies are reciprocal, there is equivalence; while ants are seem to resemble humans, for example, we see that ant societies are also key to an understanding of the human. In particular, she compares the potential loss of the species to the loss of a child. She refers to a Mexican legend that "a monarch [butterfly] is the soul of a baby that's died" (359). This story has particular resonance for the novel's protagonist, Dellarobia, because her first child was stillborn. That baby is described as "covered in fine red hair", a "red pelt of fur" which echoes the "orange blaze" of butterflies (10). Dellarobia fears that the species "would pass through this world like that baby in its pelt of red fur, while most people paid no attention" (229). Kingsolver also creates comparisons between Dellarobia and ants. The marriage flight of the ants is clearly meant to be a metaphor for her feelings of powerlessness and suffocation within her failing marriage. She reads from an encyclopaedia that, "after

mating, the female tears off her wings and crawls in a hole to start her own colony. After rearing a small nucleus of workers, she becomes an egg-laying machine" (308).When Dellarobia decides to leave her husband and begin a new life elsewhere, the ants again serve as an appropriate metaphor. Ovid relates that prospective queens, called 'perfect females', "don't need helpers or auxiliaries to function, the way worker bees do, or soldier ants. A perfect female is the lady who can go out and start a new colony by herself" (396).

These similarities are to some extent superficial in content. Unlike the modelling of climate change which I discussed previously, these similarities are symbolic rather than structural, and there is a limit to how alike ants and humans can be made to appear without overly anthropomorphising the ants or rendering human beings as over-determined automatons. In giving his ants a religious belief system, Wilson perhaps strays too far into anthropomorphism. Kingsolver, too, uses the ant as a static symbol of industriousness and the butterfly as an image of transcendence. More successful are those comparisons which posit an underlying structural homology between agent-based structures. When Wilson writes that "ants are a metaphor for us, and we for them" he is pointing to the kind of structural homology which underlies the development of all complex social systems (15). The point of *Anthill* is not that we should seek to be more or less like ants, but that we should learn to recognise the structural similarities underlying both systems, including, as I document shortly, the importance of sociality to individual development, the dependence of a social group upon the environment which supports it, and the interdependence of species within a habitat. Referring to human society as "the great human anthill", Wilson draws clear parallels between the importance of sociality to ant survival and its importance to human survival in the face of environmental threat (*Anthill* 228).

Within his novel, Wilson compares ant colonies to human societies, but also draws a further structural homology between the colony and a single biological organism. By extension human society resembles a single organism, vulnerable to harm like a body

whose parts are all interdependent, and only able to defend against harm by acting collectively. He writes that “the colony exchanged information within itself in the same way the body of one ant, one human, or any other single organism exchanges information within itself by hormones (184). Just as we saw in *The Echo Maker*, each agent (in this case, ant) is comparable to a single neuron or synapse in the human brain. The purpose of this comparison is to illustrate that no single agent (ant or neuron) has total knowledge of the whole. With reference to the colony’s collective intelligence, he writes:

> The mental life of the colony was not shared by each worker equally. What any worker knew and thought was only part of what the colony knew and thought. The colony intelligence was distributed among its members, in the same way human intelligence is distributed among the gyri, lobes and nuclei of the human brain. (141)

As a continuation of this analogy, the queen ant is seen to function as the colony’s ovaries; she issues no commands and has no control over the colony’s operations, but all of the colony members originate from her eggs, and without her the colony would be unable to reproduce. The workers act as “the Queen’s hands and feet and jaws, and increasingly they replaced her brain” (182). Adams refers to the “functional parallels” which Wilson creates between an individual human organism and an ant colony, where “individual ants function like cells, and experience a comparable mortality rate” and “the more specialised ant battalions – nurses, farmers, soldiers, and queens – have a correlation to our organs” (Adams).

Kingsolver describes the monarch collective as an entity which functions as a single living organism, with all individuals involved acting in unison for the survival of the whole. Dellarobia notes that “the population functions as a whole being […] the butterfly forest was a great, quiet, breathing beast […] sometimes the wings all moved in unison” (317). Kingsolver makes it clear that migration is a living process: “this was a living flow,

like a pulse through veins, with the cells bursting and renewing themselves as they went" (146). The monarch system can replace each agent (individual butterfly), just as an organism grows more cells to replace those that die. Alone, each butterfly is "so little and sure to die", yet as a collective they "constitute a force, like an ocean tide" (143). This collective strength gives them a greater chance of survival.

Throughout his fiction and nonfiction writing, Wilson refers to the ant colony as a "superorganism", by which he means that it is a form of social organization which "resemble[s] a large, diffuse organism" (182). The *OED* defines the term as "a group or association of organisms which behaves in some respect like a single organism; a complex system consisting of a large number of organisms which itself behaves as if it were an organic whole, as human society, an ecosystem, etc." The term 'superorganism' was first applied to the subject of social organization during the late nineteenth century when, as discussed in Chapter 3, social theorists were frequently thinking in terms of organic wholes. The *OED* lists the first recorded usage as occurring in 1878. The term was first explicitly applied to insect colonies by William Morton Wheeler in *The Social Insects* (1928). Wheeler's earlier essay "The Ant Colony as an Organism" (1911) makes comparisons between ant colonies and biological organisms which prefigure the analogies between biological and social systems made by contemporary systems science. Wheeler contends that "the animal colony is a true organism and not merely the analogue of a person" (310). He feels that these comparisons are more than metaphoric: they have real substance. His definition of an 'organism' as a kind of system anticipates the insights of complexity science:

> An organism is a complex, definitely coordinated and therefore individuated system of activities, which are primarily directed to obtaining and assimilating substances from an environment, to producing other similar systems, known as

> offspring, and to protecting the system itself and also its offspring from disturbances emanating from the environment. (308)

Wheeler notes the colony's drive to maintain its own systemic organization resembles that of any other living organism. Just like a person, the ant colony "behaves as a unitary whole, maintaining its identity in space" (310). Just as a person's immune system protects the body from invading microbes, the ant colony resists invasion from competing colonies (310). Both ant colonies and human societies are superorganisms in that they share commonalities with a single organism. These traits, including that of self-preservation, can have negative consequences for the environment. I noted in Chapter 3 that comparisons between socieities and organisms date back to the nineteenth century. Recent complexity research provides a continuation of this organicist thinking in the suggestion that cities have metabolisms, and are thus analogous to biological organisms. Wilson models this same insight with regard to ant societies, which are in various ways structually analogous to human societies.

Wilson's epigraph to *Anthill* makes clear that the title of the text refers to both "a hill thrown up by ants or termites in digging their nests" and "a [human] community congested with busy people unceasingly on the move" (1). In her review of *Anthill*, Margaret Atwood writes that "people have long been fascinated by the similarities between ants and human societies". With reference to those similarities, she suggests that "both ants and men conduct wars, divide into specialized castes of workers, build cities, maintain infant nurseries and cemeteries, take slaves, practice agriculture, and indulge in occasional cannibalism". In describing the conflict between ant colonies, Wilson uses military terminology extensively ("tactic", "territorial", "defeat" and "propaganda", for example) (204). He also makes it clear that throughout human species has always "thrived on war" (257). Yet the main similarity which Wilson draws between ants and humans is based upon the relationship between a population and its environment. Wilson tells of a genetic

mutation which occurs in one particular ant colony, which, by allowing multiple queens to reproduce, turns the colony into a “supercolony”, a “single gigantic society” which multiplies without limit (218). This supercolony “packed all the habitable ground with multiple interconnected nests” (223). As a result, all the natural resources in the area become depleted until no other species is able to survive. The existence of this new kind of ant society represents “an ominous change” to the environment. The colony is “out of balance with nature” and the density of population becomes “too heavy a burden for the habitat to carry” (225). Wilson creates a parallel between the supercolony and the human population, whose urge to develop every available piece of land for real estate represents a similar burden upon natural habitats. The protagonist Raff’s uncle argues that “grow or die” is the American way, and that settlements like theirs are “bound to keep expanding” so that in another fifty years, the nearby local cities of Mobile and Pensacola, now separated by regions of unspoiled savannah ecosystem, will eventually become “one single urban area” (278). The lessons offered to humanity by the supercolony are clear: “by trading sustainability of the home for wider dominance, its genes had made a terrible mistake” (227). By exhausting the available food supplies, the colony destroys its “support systems” and drives itself towards extinction (228). It is suggested that this is our future, too, unless we begin using natural resources more sustainably. Like a single organism, the complex systems of the biosphere are composed of interconnected and interdependent parts. Any injury to part of a system will impact upon the collective in often unpredictable ways.

As I have argued, analogies which propose structural identification or homology are most effective in the construction of useful, functional models which encourage changes in perspective and enhance knowledge of system function. The relationships (both good and bad) which the ants have with each other and with their environment are analogous to our own. In *Anthill*, Wilson refers to ant colonies, human societies and the biosphere as “three parallel worlds”, whose processes, though “different in magnitude”,

are nevertheless “similar” in certain fundamental ways (15). In this comparison of human and ant social systems, Wilson encourages us to see that humans, like ants, are part of a large social structure. Kingsolver too stresses the importance of “community dynamics” to understanding both monarch butterflies and human beings (317).Thinking environmentally necessitates the realization that humanity is part of a larger whole, the biosphere, whose parts are all connected and interdependent. Changing the focus of the reader away from an individual character and towards a collective structure encourages us to think contextually and thus environmentally. Kingsolver illustrates this environmental awakening through the character of Dellarobia, who begins the novel in a profound state of self-pity, unable to see beyond her personal marital difficulties, but discovers through her experiences with the monarchs that there are species facing far greater hardships than her own. When she is asked how seeing the monarch swarm for the first time changed her outlook on life, she replies: “I was so focused on my own little life. Just one person. And here was something so much bigger” (209). In order for meaningful action on climate change to occur, individual humans must be aware of systems and must act constructively with regard to this knowledge. For example, people should act altruistically, for the good of the collective species, which is both more intelligent and more likely to survive if it acts together as a unified whole. In practical terms, however, the human species is a system so complex that no individual within it can have true awareness of the totality. Acting altruistically for the good of the collective, therefore, means believing that your own actions can make a difference, even if you can see no evidence of this: “for those of us who sometimes wonder if it's really worth recycling that extra bottle to lighten our impact on the planet, the bottom line is that our actions matter, even if we don't see how” (Miller 10). This is the lesson that swarm dynamics offer to the environmental activist:

> Think about a honeybee as she walks around inside the hive. If a cold wind hits the hive, she'll shiver to generate heat and, in the process, help to warm the nearby

> brood. She has no idea that hundreds of workers in other parts of the hive are doing the same thing at the same time to the benefit of the next generation. (Miller 10)

Throughout this thesis we have seen that writing a systems-aware novel which informs the reader about complex environmental issues poses a number of significant challenges. The novels in this chapter seek to persuade the reader to act in his or her own small way to combat climate change and other sources of environmental harm, while acknowledging that due to the complex, nonlinear and unpredictable nature of the systems involved, it is far from clear what that course of action should be. Faced with the challenge of engaging with vastly distributed, slow moving and nonlinear environments, each of these texts proposes the figure of the swarm as one solution to the representation of systems. Visually engaging and accessible in terms of size and scale, the swarm becomes an educational model from which we can gain insights about larger and more complex systems. Using knowledgeable scientist figures, the novels communicate analogies between swarms and human populations which underscore the importance of sociality and the survival of the supporting environment to continued system function. A sense of structural homology is braided into the novel at both a macro (thematic) and micro (linguistic) level and readers are encouraged to shift their perception from the individual's concerns to those of the collective. The knowledgeable scientist (or the liberal hero) in this sense thus exists as a symbol or promise of something more collective. In Chapters 7 and 8 we see the abundance of biological systems represented as a source of inherent value, unless that abundance is human in origin. Therefore, since biological excess is valued, we might assume that the form of the systems-aware novel would seek to imitate that quality and translate biological into linguistic excess. LeClair argued that this was the case in his 1987 claim that only novels of excessive size and scale are capable of effectively critiquing an excessive, runaway capitalist system. In the next

chapter, however, I will argue that a novel which deliberately features an absence of linguistic, social and biological complexity can still properly be termed a systems novel. Though complexity science tends to privilege the moment of emergence and the growth and evolution of complexity, I suggest that decline, death and decay are also a vital part of any system's narrative. It is important to note that systems-aware novelists have consistently explored this negative aspect of system function but are not as prone to alienation and despair as one might expect. Even when confronting environmental catastrophe, these texts retain their commitment to constructive and meaningful action.

Chapter 9: The End of Complexity in *The Liquidators*, *The Road* and *Caribou Island*

Faced with the increasing probability that an environmental disaster will bring about the destruction of our species, recent systems-aware fiction has engaged with bleak, apocalyptic visions of the future. *The Liquidators* (2006), *The Road* (2006), and *Caribou Island* (2011) are preoccupied with "things ceasing to be", from the social networks which situate us as agents within complex communities, to the delicately balanced food webs and weather systems which sustain our position within the biosphere as a whole (McCarthy 293). We have seen in previous chapters that both complexity science and systems-aware fiction are concerned to a large extent with emergence: how complexity arises from the combination of simple elements. I have also suggested that this focus creates an implicit positive valuation of the complex; in particular, the biologically complex. In this chapter I will explore how some systems-aware fiction reverses the process of emergence in order to consider how and why systems might lose complexity. LeClair, McCarthy and Vann assert the value and importance of both ecological and social complexity, yet they also consider the extent to which systems can be harmful to individuals and to other systems. While depicting the loss of ecological complexity as an apocalyptic catastrophe, they also consider the extent to which death, decay and de-emergence are a natural part of system function.

Stylistically, these texts are different to those discussed in previous chapters, displaying a bare, stripped-down simplicity which, though it reflects their subject matter, contrasts with the 'encyclopaedic' lexical abundance which LeClair typically associates with systems novels. While in *The Art of Excess*, LeClair asserts that "excess" is the defining feature of systemic reality and that successful systems novels must therefore be equally excessive, I argue that despite their sparseness and relative brevity, *The Liquidators*, *The Road* and *Caribou Island* are nevertheless works of systems-aware fiction. By modelling the destruction of the world's complexity and breaking systems down

into their isolated parts, I suggest that the authors communicate information about how those systems are constructed, how they interconnect and influence each other. In *The Road*, for instance, McCarthy speculates that "perhaps in the world's destruction it would be possible at last to see how it was made" (293). By reducing human social systems to a few isolated individuals McCarthy and other novelists reinforce the importance of sociality, and thus systems, to the construction of the self. Though these novelists present apocalyptic scenarios, their focus is upon the understanding and constructive action which may avert such crisis.

I begin my analysis of the three novels with a discussion of the oppositions which exist in complexity science between increasing and decreasing complexity. Though from a historical or evolutionary perspective we perceive that the amount of complexity in the world has increased over time, we also are aware that a large amount of complexity has been lost (through natural or human-instigated means) and that one day the universe itself will inevitably end. Through close reading, I will explore how the novels explore this tension and – avoiding the appearance of nihilism – distinguish between the forms of de-emergence which are an inevitable part of system function and those which are both reprehensible and avoidable. I will suggest that these novels take a pragmatic economics-based approach to the value and worth of complex systems: though human economic and social systems are seen to cause incalculable ecological loss, each of the novels acknowledges that we have 'gained' much from the culture, medicine and ethical code that civilization has provided. I will conclude the chapter with some remarks upon how the oppositions of beginning and ending, profit and loss, emergence and de-emergence accord with both LeClair's formulation of the systems novel and my proposed systems-realist genre.

Day by day, the world is becoming more complex: cities, corporations and social networks are now larger, more interconnected and globally impacted than ever before, while the pace of life continues to accelerate as our journey times become shorter and our

internet connections faster. In biological or ecological terms, too, we have travelled a long way since the evolution of the first single-celled life forms. Throughout the history of our planet more and more complex forms have continued to evolve. Murray Gell-Mann notes: "as time goes on, higher and higher social complexity keeps appearing. The same tendency occurs in biological evolution. Although some changes may involve decreases in complexity, the general trend is toward higher maximum complexity" (*Quark* 228). This experience of steadily increasing order contrasts with (though does not contradict) the second law of thermodynamics which states that the universe, as an isolated system, exhibits increasing entropy and will one day reach a state of total undifferentiation and stasis, or 'thermodynamic equilibrium'.[44] Though the opposition is striking, we know that the observed trend of increasing complexity cannot continue indefinitely. Gell-Mann argues that as a result of increasing entropy, in the future: "the emergence of complex forms will come gradually to a halt and the regression to lower complexity will become the rule. Furthermore, conditions will no longer be conducive to the existence of complex adaptive systems" (231). The forward progress of time is irreversible and, as such, all life on our planet (including all complex systems) will ultimately cease to exist:

> After an enormously long time (even by cosmological standards), the universe, as it continues to expand, will become very different. Stars will die; black holes […] will decay, and probably even protons (and heavier nuclei) will decay as well. All the structures with which we are now familiar will disappear". (230)

Theorists, including those who consider complexity's applicability to literature, have noted the opposition between evolution (increasing complexity and differentiation) and entropy (decreasing complexity and differentiation). M. Mitchell Waldrop suggests that the self-organization of complex systems illustrates that the "steady degradation" of entropy can

[44] In cosmological terms, this is known as the 'heat death' of the universe or the 'big freeze'. See "Entropy and Heat Death" in *Encyclopaedia Britannica.*

be “partially reversed” (33), while David Porush writes that “self-organizing structures […] locally contradict the second law” (57). This opposition is also important to LeClair’s formulation of the systems novel: he writes that “systems theory contributes [to literature] a reversal of the pessimism accompanying the thermodynamic formulation of closed systems and entropy” (6). What LeClair refers to as system theory’s “molecular-level optimism” provides characters with the motivation for purposive action within a realist setting that would otherwise appear coldly deterministic (why try to accomplish anything if we’re all going to die anyway?). The idea that entropy or ‘time’s arrow’ can be arrested or even reversed suggests that personal, social and environmental redemption may be achievable, without the need for any recourse to religious belief. LeClair writes that systems theory offers authors like Don DeLillo the possibility that “in an open system, such as literature or language, the arrow of change not only pointed towards exhaustion but could also be reversed or bent. Relativity could become saving mutation, and deconstruction might become reconstruction” (10). For contemporary systems novels that address threats to the environment, this potential for reversibility and reconstruction allows authors to suggest that there is still time for human ingenuity to fix the ecological problems it has caused. We know that complex systems are surprisingly resilient, often responding to negative feedback by exhibiting patterns of reduction and expansion rather than complete collapse. An example of this kind of behaviour is patterns of boom and bust in the economy: a single economy exhibits over a period of time patterns of expansion and contraction, growth and recession. We also see these sorts of patterns in biology and ecology: species can recover from the brink of extinction, land can be reclaimed from pollution, people can recover from brain damage, and those with cancer may enter remission. During the course of a single human life, each of the body’s many cells (or agents) will die and be replaced many times. Even supposing that a system cannot recover from damage inflicted upon it and eventually dies, this event may help other systems to grow and flourish, thus increasing the total amount of complexity.

We saw this broadly optimistic or redemptive attitude towards ecological disaster in the novels discussed in Chapters 7 and 8. In *The Echo Maker*, Powers asserts that "extinction is short" while "migration is long", and that following our extinction, "cranes or something like them will trace rivers again" (443). In *Flight Behaviour*, despite dire prognostications about the likelihood of their survival, a small number of monarch butterflies are able to defy the odds and emerge again in the spring. Previously I suggested that within systems-aware novels, a perceived loss of meaning at the micro-level (an individual's experience of chaos and disorder, for instance) is regained or reasserted at a higher system level. In the case of ecological catastrophe, the sense of overall meaning and purpose which is asserted frequently exists at a level above or beyond 'the human'. While occasionally pessimistic about the prospect for humanity's survival, systems-aware fiction is generally optimistic about the continuation of non-human meaning and value (unless, as in *The Road*, we manage to utterly devastate the planet's natural systems in the process of destroying ourselves).

In systems-aware fiction we see that, to some extent, death and a limited loss of complexity is a naturally occurring feature of system function. While ever more highly-organized and complex forms have appeared throughout history, there have been many examples of "regression[s] to lower complexity" which appear to prefigure the final entropic loss of order. In *Complexity*, M. Mitchell Waldrop suggests that "nature seems to be less interested in creating structures than in tearing structures apart and mixing them up" (33). Since life began over 3.5 billion years ago the earth has witnessed the emergence of innumerable complex forms, many of which have long since ceased to exist. From the extinction of the dinosaurs to the collapse of the Roman Empire, countless systems have disappeared from our planet despite having once been dominant within their environment.[45] Complexity scientists are fascinated not only by what causes

[45] The most dramatic example of this loss is the Permian-Triassic extinction event, which wiped out an estimated 90% of the planet's species. See Hoffman.

complexity to emerge, but also what causes it to disappear. Just as the emergence of complexity is a pattern which is repeated throughout the biological and social worlds, the end or death of complexity is also repeated in many forms and at many different scales. In addition to mass extinctions, the following are examples of collapses in complexity studied by scientists today: the downfall of civilizations and their attendant cultures, the abandonment of cities, failed companies and economic recessions, and the death of biological organisms.

What causes systems to cease functioning and break apart rather than continuing to grow is not fully understood, but multiple factors are usually involved. For example, extinctions and the collapse of civilizations may be attributed to natural disasters, reduction in food or water supplies and competition from other systems. In addition, the highly interconnected and interdependent nature of parts in a complex system means that problems in one area, though small, may cascade through the whole with unpredictable consequences. Our lack of complete knowledge about the way that systems function, combined with the unpredictability of intervening in them, makes the loss of complexity just as representationally challenging as any other aspect of systems reality. Rather than depicting the actual moment of systemic crisis – which could occur in any number of ways – the three novels in this chapter project us forward beyond the end of complexity and into its aftermath.

Today, the greatest threat to complexity is environmental harm, the unpredictable consequences of which may affect all of the globe's complex systems. Due to recent ecological crises including the effects of global climate change, contemporary authors find themselves at a point in history where humanity is threatened with the prospect of a large-scale collapse in complexity from which it cannot begin again anew. This unnatural, human-instigated loss of complexity is thus distinct from the natural cycles of decline and renewal which were cited previously. Not only are we faced with the prospect of our own extinction, it also seems that we may have caused so much damage to the planet that it

will not be able to recover after our collective demise. The three novels discussed in this chapter reflect this sense of impending loss through systems-aware plots that are largely devoid of the macro-level optimism which I previously discussed as a feature of systems fiction. For these novels, a sense of overall meaning resides not only beyond the characters' perception, but also beyond the text itself. It is the reader's existence in the past, before the defining moment of system loss, which provides the main source of hope in each novel. Like Scrooge in *A Christmas Carol* (1843), who dreams of the death and irreparable loss which only 'may' come to pass, we awaken from our reading still with time to make amends. The model layout of the 'Museum of Lead' which LeClair places, without comment, at the conclusion of his novel, explicitly holds out an invitation to the visitor (and thus the reader) to learn from humanity's past mistakes in order to build better, more ecologically-aware systems in the future.

As part of their debate about the distinction between natural and unnatural system loss, LeClair, McCarthy and Vann question whether such endings are final or whether they represent the beginning of something new. In *The Liquidators,* LeClair himself presents a man, Thomas Bond, who is obsessed with his family legacy because he wants somehow to outlast himself, to continue beyond his own physical death (182). Bond, however, is troubled by the idea that maybe "nothing lasts" and believes that failure – biological, environmental and economic – is the only thing that can be relied upon to continue (117). In *Caribou Island*, David Vann depicts an individual who seeks to remove himself from the social and economic complexities of modern life in an attempt to return to an earlier, simpler time, which he hopes will simultaneously offer the chance of a new beginning: "a new land, the making of a new home" (9). Vann, however, by depicting the brutal death of both the protagonist and his wife, makes clear to the reader that this is a text about endings rather than beginnings and that there is no possibility of redemption. The fresh, virgin territory of uncharted Alaskan wilderness which Gary dreams of is already irreversibly tainted by the presence of humans; it has become "a place where

people shit", where the waste products of both industry and personal relationships cannot be effectively recycled (186). Also less than optimistic about the possibility of renewal is Cormac McCarthy in *The Road*. The wife of his unnamed protagonist refuses to be labelled a "survivor" following the collapse of civilization because the word 'survivor' implies some hope for the future. Instead she refers to her family as the "walking dead" in a horror film, the implication being that the total and irreversible collapse of ecological complexity precludes any hope of species renewal (57).

All three of these novels question whether recovery is possible after the collapse of complex environmental, social or economic systems. In recent fiction we see that destruction of the environment is, unlike patterns of boom and bust in the economy, likely to be a final and irreversible loss of the complex. In *The Road*, the man looks at his son and "very much feared that something was gone that could not be put right again" (144). At the ending of the novel the narrator points to trout, whose intricate biological patterns represent "maps of the world in its becoming", something that shows the route travelled along the path of complexity's evolution (307). Earlier, McCarthy suggests that the appeal of maps is that they allow people to situate "themselves among others, everything in its place" (194). In the post-apocalyptic world, by contrast, we see "everything uncoupled from its shoring […] unsupported" (10). These "maps and mazes" signify the interwoven complexity of systems, something which "could not be put back. Not be made right again" (307). In *Caribou Island*, Gary claims that with regard to other people, "he just couldn't feel any connection at all" (195). Vann suggests that "maybe he [Gary] was missing some basic human faculty, whatever it is that connects people to each other" (221). Having followed her husband and left behind the interconnections and interdependent relationships of complex social systems, Irene feels that "they were going too far. That something would be lost. That they wouldn't recover from this" (239). In *The Liquidators*, Bond confronts the death of his company and his own mortality, both of which appear to be irreversible endings: "Nothing saved. Everything failed […] Dead end. The dead don't

continue […] There was no other side. Transport but no transcendence" (182).

In each novel, the loss of social and economic complexity is accompanied by some form of illness, experienced by individuals in the text but also symptomatic of a wider sickness of nature or cultural malaise. Thus, these novels continue the medicalization of ecological harm which we witnessed in Chapters 7 and 8. In *Caribou Island*, Irene experiences chronic headaches throughout, and though medically inexplicable, her pain becomes strongly associated with both the decline of her marriage and the waning of the seasons. In *The Road*, the boy and his father both experience sickness and injury, and this leads to the man's eventual death. In *The Liquidators*, Bond temporarily loses consciousness while driving, and is much preoccupied with his father's death from lead poisoning (the same poisoning is seen to have a negative effect upon the environment). Some of these examples of illness, like the lead poisoning, are caused by the systems of human civilization, while others, like the arrow wound suffered by the man in *The Road*, could have been cured by those systems (through modern medicine). Though social and economic systems are capable of destruction, they also provide much which is of value.

Looking in more detail at the opposition between evolution (increasing complexity) and entropy (decreasing complexity) in *The Liquidators*, we see that the novel is set within a period of contraction in the American economic system which has caused both the collapse of many businesses and a downturn in the mood of the collective population: "auto manufacturers and airlines have gone under […] small business failure is up. Personal bankruptcies are on the rise […] Consumer confidence is sinking" (67). The narrator refers to his children growing up in "the deficit millennium" (31). The reasons why companies fail are multiple, due to "forces beyond their control – fluctuation in the prime rate, new government regulation, natural disaster – or maybe just a fixture of a boom and bust economy" (18). The novel looks at the failure of a company, Midwest Liquidators, who themselves buy and sell the stock of companies which have failed. If we suggest that

the postmodern period was concerned with the failure of reference, communication and meaning, the post-postmodern period, like Midwest Liquidators, concerns itself with how to convert this experience into constructive action, and thus to make failure functional. The narrator, Bond, believes that companies like Midwest Liquidators will always be needed because thanks to repeating cycles of boom and bust, “failure is endemic. Failure continues” (67). To convey that this loss is a natural part of the economic system, the representation of this process is supported by the use of biological analogies As an entity which ‘feeds’ on the remains of its less successful counterparts, the company is referred to in biological terms as both “predator” and “vulture” (18). Though these accusations are meant to be derogatory, the people involved see themselves as providing a necessary service in the economic food chain, the “chain of sale” (4). The narrator describes their task, “diffusing the collected waste of our nation’s commerce” as being “a purifying process as necessary as sewage treatment plants” (9). LeClair applies the words “failure” and “waste” to both economic and environmental systems in order to highlight the fact that the two systems are in fact analogous and interrelated: economic waste becomes environmental waste if not correctly disposed of, while money travels along the “chain of sale” like energy through the food chain, being recycled and reinvested. The cycle of economic failure and partial recovery which Midwest Liquidators represent is reflected in the continuous “1,500-mile jagged loop” which the liquidators travel each year (3) and the narrator’s love for the concept of “return and recovery” (164).

As a continuation of this analogy between economic and biological systems, *The Liquidators* plays upon the similarity between the words ‘liquidation’ and ‘liquid’ in order to create the impression that the economic system is composed of organic, naturally occurring processes. Through these kinds of analogy, LeClair is able to transfer the promise of organic renewal to the economic downturn. The process of liquidation is described using the familiar metaphorical connection between money and water. Liquidators “dissolve the assets” (1) of those “drowning in debt” who cannot be “bailed

out" (2). They convert physical goods to "liquid money" on "liquid-crystal displays" (1). The physical properties of water, its fluidity as a liquid and its ability to change into ice or gas appears analogous to the 'flow' of money through the economic system, as it changes from physical currency to data in a computer or becomes invested in physical goods. Though a product of the collapse of complexity, the liquidator's emporium has a maze-like complexity all of its own, containing "loops" and "folds" (30). In this temporary market-place the "aisles coil and loop like brooks" and "the customers come in shoals" (30). The borders of the sales area, usually the seating terraces of a sports arena, seem "like the shoreline of an inland sea […] drained to reveal detritus that centuries have amassed in strange heaps and meandering folds" (5). Though carefully assembled, the random assortment of items and the haphazard way in which they are displayed make the liquidator's display seem organically occurring, washed there like "the wrack of flood" (2) or "low-tide remnants" (4). Although the liquidator's temporary stores are characterised by "impermanence" (5), constantly changing like the flow of water, comparing goods to "geological strata" accumulated over centuries gives their enterprise a sense of continuity and stability, of belonging to a long history of trade (16).

Despite this broadly positive and redemptive take on the economic downturn, in some sections the novel presents a post-apocalyptic landscape which echoes that seen in *The Road*. Driving through America's polluted landscape the narrator sees "rubbish heaps, garbage dumps, and landfills […] slums […] tenements […] massive urban weight beyond transformation" (67). The phrase "beyond transformation" stands in contrast to the cycle of economic renewal set out in earlier chapters. Environmental harm is seen to disrupt, perhaps irreversibly, the natural world's regenerative cycles. These scenes are repeated across the Midwest: Bond describes the Chicago River "thick with waste, threatening to become solid (67), as well as "grey smog in Minneapolis, the smudged sky of Duluth, the ozone cloud hanging over Memphis" (68). In Chapter 5, the narrator presents a vision of a dystopian future where economic failure accelerates and "survival"

becomes the goal of each individual (68). Eventually, the narrator predicts, economic collapse will fuel cultural collapse as schools, museums and even governments begin to fail, until social bonds are called into question and “debtor families will ask us to take children off their hands” (68).

Economic, cultural and social systems are interdependent and failure cascades through the connections between them causing a large-scale collapse. In *The Liquidators*, economic and environmental complexity are seen to be interlinked, as it is the “over-produce, over-sell economy” which “depletes resources and pollutes the environment” (78). We see the connection between ecological and environmental systems, too, in *The Road*’s post-apocalyptic landscape. Here the sun is permanently obscured by cloud and all vegetation is “dead to the root”, an environmental catastrophe which has caused the collapse of all aspects of civilization, including the global economy (20). As the man and his son travel they find “coins everywhere in the ash”, abandoned because they no longer have any exchange value (22). Things which have a high monetary value in today’s world are without value in the post-apocalyptic landscape: the man and his son observe “expensive electronic equipment […] unmolested on the shelves”, of no practical use without a supporting system of electricity generation and supply (195).

The collapse of complexity in *The Liquidators* generates a landscape of waste and a complexity of waste management which rivals that created by Don DeLillo in *Underworld*, where “three thousand acres of mountained garbage” in landfill brings to mind “the construction of the Great Pyramid at Giza” (DeLillo 184). Both DeLillo and LeClair depict waste that shapes our thinking, forcing us to “build a system to deal with it” (DeLillo 288). In *The Road*, by contrast, there is no corresponding resurgence of the complex. The novel depicts a world where there are virtually no remaining social interactions between people, no trade (except slavery), no agriculture and no industry. There is little mention of art, music, literature or philosophy, pursuits which have traditionally been considered the highest emergent achievements of culture. Intellectual

ambition has been replaced by day-to-day survival. The global transportation network, evidence of which lies in descriptions of abandoned trucks, trains and boats, has become THE road, a single, linear route with no possibility of a return journey. The focus upon one individual and his child, two single agents rather than a whole system, illustrates the reduction of social complexity to its isolated component parts. This dissolution of a complex civilization is also reflected formally in the novel's short sentences, simple language, and minimal punctuation. The choice of language is weighted towards verbs which depict the physical actions of the body: within one twelve-line extract we see the words "pulled", "folded", "carried", "packed", "spread", "laid", "watching", "pulled", "buried", "looked", and "turned" (3). The text displays a simplicity that reflects the stripped-down nature of the world described and a repetitive structure which parallels the repetitive nature of life in the post-apocalyptic world. Each short paragraph is separated by a space, reflecting the absences felt within the text: the lost connections between people, the separation between objects and their functions or places and their names, the separation of the signifier from what is signified. When the boy sees his father pretend to make a phone call he asks "what are you doing?" (5). Born after the event which began the collapse of civilization, he does not possess the concept of a communication network. The telephone has become an object without a meaning or a name, while elsewhere there are names without corresponding objects; as the man and his son travel the road they find "advertisements for goods which no longer existed" (135). The man fears not only the disappearance of language but also a reduction in the amount of thoughts which it is possible to have, with each thought being necessarily articulated by means of an internal language. Once language is "shorn of its referents" it loses its "reality". He observes "the world shrinking down […] the names of things slowly following those things into oblivion" and questions "how much was gone already?" (93). Meaning in complex systems is emergent rather than inherent, created through interactions, connections and relationships. The solipsistic post-structuralist landscape depicted here represents, in

effect, a kind of postmodern apocalypse, as the scepticism about the possibility of reference and the communication of truth is taken to its logical conclusion in the loss of all meaning. Post-postmodernism, however, acknowledges the imperfect nature of perception and communication systems, but insists that we need to work constructively with what we have to build useful, albeit contingent models.

Earlier in the chapter I discussed the final entropic death of the universe as a loss of complexity in which "all the structures with which we are now familiar will disappear" (Gell-Mann 230). In "Fulcrums and Borderlands", Rune Graulund argues that *The Road* depicts:

> A world entirely at the mercy of the Second Law of Thermodynamics (also known as the Law of Entropy), according to which 'the world acts spontaneously to minimize potentials', meaning that all energy will in time disperse and fizzle out. […] in a world governed by regression, this [entropy] is the only real movement left […] There will be no tomorrow, no salvation from the encroaching nothingness that will in the end extinguish all that was once human. […] we find a desert that never ends nor begins, a landscape as devoid of difference as it is of life. (60-61)

Following the novel's unspecified ecological catastrophe and the attendant collapse of civilization no organized complex structures remain, and as a result the world has become "devoid of difference", with distinctions between places (climate, compass direction, urban versus rural) and people (race, wealth, social class) all rendered meaningless. After their long journey south, the man and his son experience no difference in conditions and "the futility of attempting to delineate differing categories (of any sorts) becomes painstakingly clear" (Graulund 61). The man's references to "good guys" and "bad guys" is an attempt to restore some level of difference by the imposition of simple moral categories; however, even this binary needs constantly to be reasserted and maintained, remaining continually

in doubt since even the 'good guys' have to kill if their lives depend upon it. This entropic landscape reflects Malcolm Bull's concept of the apocalyptic as "the return of the undifferentiated" (78), where undifferentiation is defined as "contradiction and indeterminacy" or "the intrusion of chaos" (83). For Bull, apocalypse breaks down the binary structures which previously maintained difference, and "may involve a return to a state prior to binary opposition" (79). In *The Road*, apocalypse is associated with the disappearance of the complex systems which maintain our place within both civilization and the biosphere. Though not binary, systems do allow the organization of agents into discrete structures by which we may differentiate between them, through a measure of each agent's connectedness to others. No longer organized into complex social systems, human beings are scattered across the landscape at random, with little to differentiate them. We never learn anyone's name, for example, apart from one old man who after claiming his name is Ely, subsequently decides that it is not his name after all, that he "could be anybody" (182).

The novel offers little or no sign that the environmental situation will improve, never referring to a thinning in the cloud cover or the returning growth of vegetation. There is, however, perhaps a glimpse of hope for a partial reversal of this entropic decay, a suggestion that the loss of complexity precedes some eventual resurgence. The man's references to he and his son as "good guys" who are "carrying the fire" seems to have Promethean implications; their refusal to eat other people demarcates a line between human and animal, and by this and their care for each other they preserve some essence of humanity which may be passed on to others in the future (87). McCarthy's references to "ancient anointing" (77) and "ancient frescoes" in caves take us back to the point when culture began to emerge among prehistoric societies and people were beginning to create a system of visual representation to signify objects existing in the world (20). We might want to interpret this as an indication that culture will one day re-emerge from the ashes of the post-apocalyptic landscape. In *After the End*, James Berger refers to apocalypses

depicted in literature as events which provide “an occasion to go ‘back to basics’ and to reveal what the writer considers to be truly of value” (8). There is a limited sense in which, for both LeClair and McCarthy, a return to the past which strips away some aspects of complex civilization is necessary for humanity to move forward into the future. In *The Road* we see a regression to the kind of nomadic, tribal existence which preceded the emergence of the complex city state. *The Liquidators* also depicts the return to a nomadic existence, that of the travelling salesman, which Bond connects to the life of “early man” (81). He suggests to his daughter that her knowledge of anthropology has taught him that “we put the customers in touch with history” (80). He claims of his business that: “we’re shepherds minding our stock, hunters and gatherers of the things people need” (81). In an age of multinational corporations the family business is a link to the past, a source of cultural value which the narrator is keen to preserve into the future. Berger claims that what is often revealed to be of value to authors following an apocalyptic return ‘back to basics’ is “some version of humanity in the midst of the inhuman” or “humanity in its essence” (10). This represents the suggestion that, in effect, there are some sources of meaning which are inherent to the individual, whose existence precedes the individual’s immersion in complex social systems. Both *The Road* and *The Liquidators* point to altruism as a positive attribute of the human which is revealed following the collapse of complexity. Bond’s daughter claims that “altruism definitely exists”, that “concern for kin, not just offspring, was genetically rewarded in primates” and that this survival mechanism was displayed in “early nomadic cultures” yet “largely lost in agricultural and industrial societies” (81). Bond sees his nomadic enterprise as embodying altruistic principles, while in *The Road*, the boy, born to a nomadic existence, displays altruism consistently, giving food to strangers even though at risk of starvation himself (173, 184). In opposition to Bull’s interpretation of apocalypse as the return of undifferentiation, this points to an alternative view of apocalypse outlined by Berger, one in which the apocalyptic ending is seen to “separate good from evil, true from false”, thus reinstating binary oppositions in

the creation of a new world “in which all identities and values are clear” (8).

Caribou Island contests the proposition that the individual possesses positive inherent qualities prior to their immersion in social systems. Vann presents the individual as an emergent product created through social interaction. He also directly attributes positive attributes such as altruism to the influence of modern civilization’s values and moral codes. Continuing the idea that a new beginning requires, paradoxically, returning to an earlier stage in history – Gary’s desire to build a cabin “from scratch” with “no foundation […] no plans, no experience, no permits” illustrates a desire to journey back to an earlier time in history when life was somehow simpler and more authentic (65). This return to ‘basics’, however, reveals nothing positive which can be said to be inherent to the human condition. Gary, a former medieval scholar, is convinced that “he could have been a Viking” (192), while his wife once spoke Icelandic; this, for her, is “a way back […] her connection to the ancient past” (146). Having moved to Alaska thirty years previously and found to his disappointment that people still insist on carpets in their cabins, the novel begins with Gary beginning a second move, to a yet more isolated location, hoping to escape the modern world entirely. This desire to leave all the complexities of modern civilization behind and begin afresh is simultaneously a desire to live in the past, “as if the two of them were the first to come upon this wilderness” (4). Gary is haunted by the idea that it is too late to begin again, that when he was younger the dream was “still fresh, still reachable” (66), that “he was supposed to have done it back then” (67). Having failed a second time to achieve his dream, Gary finds himself thinking in apocalyptic terms, “longing for what was really a kind of annihilation. A desire to see […] what you can endure, to see, finally, what you’re made of as you’re torn apart (218). Here, Gary is in accord with views of apocalypse which see the event as something which promises to cleanse away the corruption of the old order and in doing so, reveal the true essence of humanity. His thinking is, however, shown to be deeply flawed: what Gary is looking for does not exist because “the idea of Alaska […] the imagined village, the return to an idyllic

time" is illusory (89). Like those who imagined America as a new Eden, an uncharted virgin land, only to find themselves confronted with a hostile native population, the "new land" in which Gary chooses to build his "new home" is already littered with the evidence of previous habitation (9). The Viking lifestyle which he imagines, far from being idyllic, involves rape and pillage. Eventually Gary and his wife Irene conclude separately that "this search for Alaska had all been an expression of despair" (90). Another disillusioned character pronounces: "this is what Alaska is […] a place where people shit. Just a bigger toilet" (186). Gary's wife comes to the conclusion that removing themselves from social complexity was a decision which, rather than offering a new beginning, has always been about endings, both of her marriage and of their lives. Stripped of social connections, humans are revealed as inherently violent and callous, or 'animalistic' in their essence.

In the systems novel as defined by Tom LeClair, "epilogue can be prologue" (1). Central to LeClair's definition of the systems novel is the concept of the 'feedback loop', whereby the output of a system is able to re-enter the system once more as a fresh input (or feedback), thus influencing the system conditions which initially produced it. We also see feedback loops in contemporary complexity science, in which the emergent product of a system is sometimes said to be able to 'feed back' and influence in some way the behaviour of those agents which produced it. For LeClair, feedback loops operate in both space and time. In particular, he applies this concept to the form of the systems novel, arguing that systems novels should "circle back upon themselves, connect their ends with their beginnings" (17). *The Liquidators*, for instance, both begins and ends with the phrase "everything flows", suggesting (with regard to LeClair's previous assertion of the system novel's "molecular-level optimism") that a cyclic process of renewal applies to both the novel's economic and environmental themes. In *Caribou Island*, however, the last words of the novel, "the beginning, finally", imply a vicious cycle or negative feedback loop which cannot be broken (293). Rhoda's parents will not be at her side as she imagines, because they are already dead, and 'the beginning, finally' does not look forward in time to her new

life as a married woman, but instead looks back to the 'ending' of life which began the novel. Rhoda's discovery of her mother Irene's body, which we know will occur shortly after the events depicted on the final page, echoes almost exactly Irene's discovery of her own mother's body, something we learned of on the novel's first page. Before her suicide in the novel's penultimate chapter, Irene states: "this was not the beginning. She would not be made new again" (283). This "looping pattern", though not illustrating a reversal of thermodynamic pessimism, is still in alignment with LeClair's formulation of the systems novel. Despite viewing feedback cycles as predominantly positive and redemptive, he does also acknowledge within *In the Loop* that in some novels these cyclic patterns can imply "vicious circles". In LeClair's own novel, *The Liquidators*, for instance, lead poisoning is used as an example of how humanity has become stuck in a vicious loop of environmental harm, writing that "despite the recognised dangers" (151), lead has been "in continual use for six thousand years", and as such is an example of "a dumb idea repeated through the ages" (156).

The idea of the feedback loop is also central to LeClair's environmental concerns in *The Liquidators*. He sets out the damage done by our feeding lead back into the environment from which we extracted it: "leaded gasoline polluted cities, forests and the polar ice caps. Leaded pesticides poisoned yards, gardens, farms" (147). This negative feedback is seen to affect us as a species too, since in liquidating lead and dispersing it through both the ecosystem and our own bodily systems "we began liquidating ourselves" (204). The novel remains ambiguous about the potential for a resurgence of environmental complexity. LeClair points to the removal of lead from gasoline, advances in contemporary medicine to treat lead exposure, and clean-up programs which remove lead paint from impoverished communities, as examples of our ability to reverse the degeneration of our systems (202). If the environment cannot regenerate in the same way as the economy, however, it will be us as a species who need to change: the narrator argues that "we can reform […] we can adapt to limitations we can't reverse" (204).

Richard Powers, whose friendship with LeClair is well documented, concludes his novels with similar glimmers of optimism for the eventual resurgence of environmental complexity, though the scenarios he presents make clear that the continuation of the biosphere into the future may be incompatible with the survival of the human species. In *Gain*, he writes that "all things that fail to work will vanish, and life remain. Lovely lichen will manufacture soil on the roofs of the World Trade" (344). In *The Echo Maker* he writes that "when the surface of the earth is parched and spoiled, when life is pressed down to near-nothing, this word ['river'] will start its slow return. Extinction is short; migration is long. […] nothing will miss us […] cranes or something like them will trace rivers again" (443).

In "Home", LeClair states that both he and Powers are interested in small poisons which feed back to us in unpredictable ways:

> "I wanted to […] show that businesses or scientific explorations or inventions start out looking to be useful and then they punish us and they seep into our lives in ways that we have no idea. I think both Rick [Richard Powers] and I are interested in really small poisons or toxins. He's particularly interested in big pictures and forms. I am more in my criticism than my fiction, but I think we do share an interest in how very small amounts of whatever can poison humankind". (Hermanson)

LeClair's portrayal of "invisible micrograms" of lead as "too small to be seen, too light to be felt, and too unlikely to be tested" (139), is reminiscent of Rob Nixon's concept of 'slow violence', which is defined as environmental harm which "occurs gradually and out of sight […] dispersed across time and space" (Nixon 2). In Chapter 7 I discussed in more detail how Nixon argues that converting slow violence into image and narrative poses a great representational challenge, since (being what I would call 'complex'), this harm is "slow

moving and long in the making", as well as being "anonymous and star[ring] nobody" (3). McCarthy, too, is a writer with environmental concerns. In his *Guardian* review, George Monbiot somewhat hyperbolically referred to *The Road* as "the most important environmental book ever written". In making *The Road*'s environmental disaster both ambiguous in origin and something which occurs out of, or beyond, the pages of the text, McCarthy reflects accurately the "anonymous" and "out of sight" qualities of slow violence. Speculating on the cause of the environmental disaster depicted in the road, David Kushner writes that "while McCarthy suggests that the ash-covered world in the novel is the result of a meteor hit, his money is on humans destroying each other before an environmental catastrophe sets in". Joe Penhall, however, claims that McCarthy told him that the source of the disaster: "was some kind of environmental meltdown […] It's about what would happen if environmental meltdown continued to its logical conclusion: crops and animals would die, the weather would go out of control, there would be spontaneous wildfires and blizzards, you wouldn't be able to grow anything and the only thing left to eat would be tinned food and each other". Kushner's article "Cormac McCarthy's Apocalypse", suggests that McCarthy's "immersion in science has left him with an admittedly pessimistic worldview; he sees human life on the planet as temporary, and he's sensitized to the degree at which we are accelerating this fate through violence and neglect".

LeClair is most well-known, not for his fiction, but for his concept of the 'systems novel'. Both *The Liquidators* and *The Road* are written in accordance with this concept in the sense that they respond to and attempt to make sense of the "growing awareness of planetary ecological threats produced by man yet now seemingly beyond his control" (10). Yet all three novels differ from LeClair's notion of the systems novel in that they are only short texts, with *The Liquidators* being the shortest at only 204 pages long. LeClair had previously suggested that systems novels seek to "reflect formally the scale of their subjects" (*Loop* 17), extending themselves to an encyclopedic scale. In contrast, these novels focus on individual families and their day-to-day survival. However, their

environmental concerns fit the idea that systems novels should consider large scales spatially and temporally. All three novels display an awareness of the "inherent circularity" of living systems (*Loop* 10), though they vary in the extent to which they believe that complex systems offer a reversal of or alternative to the "pessimism" of thermodynamics. LeClair writes that "the critic who does not understand the nature of systems may find the novels' uncertainty akin to despair", but that "the essential message of a system novel, knowledgably read, is rather different: warning against the destructive 'runaway of civilization, the novel itself – in its intricacy and equifinality – manifests possibility, futurity" (*Loop* 19). Both *The Road* and *Caribou Island*, however, in depicting the absence or loss of complex systems deliberately avoid the issue of futurity and their endings seem to deny all possibility of resurgence or renewal. Without open and adaptive complex systems, they seem to suggest, we are left with a planet which displays only the entropy and stasis of a thermodynamic closed system. If these texts cannot be termed systems novels in LeClair's formulation of the term, they are certainly systems-aware in a wider sense. They reverse *In the Loop*'s portrayal of encyclopaedic, complex abundance, to show in short, sparse and bleak terms the potential negative consequences of severe environmental harm. In relation to apocalypse, Frank Kermode argues that "we project ourselves […] past the End, so as to see the structure whole, a thing we cannot do from our spot of time in the middle" (7). This is the aim of the three novels considered here: by confronting us with apocalyptic scenarios they allow us to witness our lives' dependence upon those complex systems which we take for granted, something we cannot do in our daily lives as merely single agents within a complex totality.

Conclusion

In this thesis I have argued that a significant body of recent fiction is motivated by a desire for social engagement, representing and responding to the pressing social, economic and environmental issues of our time. However, these problems are systemic, and as such, present authors with acute representational difficulties. Twenty-first century city life, global capitalism and climate change, are, as we saw in Section 1, profoundly complex: they involve a large number of interdependent agents acting in parallel, and, in the case of climate change, those agents are frequently invisible, widely distributed and without any discernible voice or agency. In order to represent the aspects of systems which evade or exceed our perception, systems-aware novelists have turned, not to experimental literary techniques, but to a systems-aware realism which echoes nineteenth-century forms.

Both nineteenth-century and late twentieth-century texts share similar concerns with the perception and representation of systems. As I demonstrated in Section 2, they are concerned with how we conceptualise agency and causality in the case of large, interconnected wholes like corporations and cities. In the nineteenth-century novel, the contemporary systems-realist finds the tools necessary to begin this engagement: the means of narrating simultaneity, for example, and an understanding of the world based upon analogy and correspondence. As I have shown, nineteenth-century novels frequently depicted social systems as embodying organic principles of growth and adaptation. In the contemporary novel, the role of analogy is developed further: a series of reciprocal analogies are used to model the activity of one system using the structure and discourse associated with another, apparently unrelated, system. In Section 3, I developed my reading of contemporary systems-aware texts, illustrating their use of reciprocal analogies to model the pressing ecological concerns of our time. In these texts social systems are modelled as biological forms such as brains or ant colonies, while biological systems are modelled as social forms like cities or nations. These models allow

the author to simulate the action and interaction of complex systems, and, through analogy, to propose and test solutions to systemic problems.

My objective in this thesis was to update and reformulate LeClair's concept of the 'systems novel'. I have sought to illustrate that systems awareness is visible within a wider range of texts than LeClair envisaged and to show that the kind of systems involved and the methods used to model them have also changed significantly since 1987. The system novel as formulated by LeClair is motivated by social critique: it aims to represent and thus contest "power systems" (*Excess* 6), or "large scale human control systems" (2). Systems novels attack "monotheism", "imperialism and totalitarianism", and "monopolistic capitalism" (16). They critique the excesses of modern society, which LeClair terms "a cultural system of waste" (17). Contemporary systems-aware fiction retains a significant element of that social critique, particularly with regard to the excesses of global capitalism and the environmental harm which results from overpopulation and industrial production. However, broadly speaking, the attitude towards systems in recent fiction is more positive (or at least displays ambivalence rather than outright hostility). In our reading of nineteenth-century fiction, we saw that a significant proportion of the attitudes towards systems were negative: systems both biological and human-constructed were criticised for being mechanistic, impersonal, or utilitarian.[46] This strand of negativity persists into LeClair's reading of twentieth-century fiction, where 'The System' is seen as an external threat which we must contest and seek to reformulate.[47] However, in recent systems-aware fiction, novelists have sought to internalise systems thinking, and to show that we ourselves, as individuals, are systems. They also show that it is possible for systems to be

[46] It was in the 1800s that the word *system* gained negative associations and became applied to a perception of the prevailing economic or social order as "oppressive", "impersonal" and "restrictive" (Def. 1.c). See *OED*.

[47] In *The Art of Excess,* LeClair refers to Pynchon's repeated use of the phrase "The System" in *Gravity's Rainbow*, to denote Western economic and political powers (37). While LeClair's analysis identifies multiple forms of system within the text, he argues that the primary experience of all those systems is that of "fear" and "alienation" (43).

beneficial to the health and wellbeing of other systems, or at the very least, that it is or should be possible for systems to coexist without mutual destruction.

The purpose of systems realism is not only to contest systems which are oppressive, but also to engage with them constructively and, despite incomplete knowledge, to work towards some sort of positive, though necessarily contingent, action. These novels aim to discover how systems act and interact, how the part may influence the whole, and how characters (and readers) might achieve both a perception of global order and a sense of individual meaning and purpose within that larger whole. As readers of systems realism we come to the conclusion that meaning is not inherent in any one person or object, but is instead emergent, a product of relationships and interactions. Often as agents within large and complex systems we cannot perceive this emergent order. Disorder at the micro-level only resolves itself into order at the macro-level as a result of techniques such as omniscient narration which take a high level perspective of the whole.

This change in attitudes towards systems is in part a result of a change in the kind of systems theory influencing the texts. The influence of biology and the concern with ecological systems seen in complexity science brings to the systems-aware novel an awareness that systems can be naturally occurring and beneficial for us and the planet. As I mentioned previously, the individual self is now perceived as a systemic construct, whose identity is emergent not only from the interaction of neurons in the brain but also from the relationships between that individual and the rest of society. The social construction of the self makes us a part of the very systems we seek to contest, and as such, complicit in their activities. For example, as we saw in Chapter 5, *Gain* criticises the corporation but acknowledges the extent to which we are complicit in its activities and dependent upon its products for our quality of life. We might compare this to *The Jungle*, which was more straightforwardly about humanity being used and consumed by man-made systems.

For LeClair, the form of the systems novel attempts to mirror or reflect actual systems in the world; however, because the systems concerned are systems of power or control, this explicit critique becomes implicitly expressed at a formal level, and is reflected in our reading of the texts. For LeClair and the novelists he references, systems are predominantly a negative cultural development, something to be countered, mastered and undermined. Even when he refers to the biosphere as a system, in his discussion of Pynchon's use of the Gaia hypothesis, LeClair's focus is still upon mastery: how mankind has sought to "master the Earth" or how "Earth […] can be conceived as man's master" (*Excess* 45). The formal techniques used by these novelists, therefore, reflect that negative perception. We see loops become vicious circles, and information transfer become information overload. This frustrates the reader and disrupts the reading process. For LeClair, systems novelists deliberately use techniques such as discontinuities and overload in order to "stop the reading" and "cause scanning" (skimming) over the text (*Excess* 13). The experience of reading such novels is frequently frustrating: they are "disruptive" and "inaccessible" texts which set out to confuse the reader, and are thus, I argue, in some ways disempowering. Thus the experience of reading a systems novel for LeClair replicates what he sees as the experience of confronting non-literary systems in the economic, political and technological spheres (*Excess* 14).

I have argued that contemporary systems realist texts place more emphasis on plot, character and setting than LeClair's systems novels, which are more dialogue-based and concerned with noise, feedback and information loops. While LeClair associates systems perception with experimental, postmodern texts, because they reflect the experience of confusion and powerlessness which we experience when confronting certain systems, contemporary systems-aware novels turn to realism due in part to a renewed confidence in science's ability to comprehend complex wholes. As such, representation is less focused on noise, bewilderment and frustration. Realist authors conceive of systems as fundamentally ordered, even if we as agents within those systems

cannot perceive that order. Though the task of writing complexity is difficult, novelists who are systems-aware do not believe that the process of emergence is by definition unnarratable.

LeClair suggests that all novels use synecdoche, since the parts of the world which an author selects for inclusion in the text is considered an appropriate substitute for a larger whole. He suggests that "novels of excess draw attention to their [use of] synecdoche" (*Excess* 18-9). They draw attention to what is omitted from the conventional novel: "the systems novelists criticize and reformulate in various ways the conventions of synecdoche for a fiction that is truly contemporary" (*Excess* 20). Systems novelists are said to map or imitate the systems that they represent; however for LeClair this simulation necessitates the use of "as close to a one-to-one scale of information as is possible and useful" (*Excess* 48). My concept of model construction in systems-aware fiction operates at a different scale of identification and reflects a different level of synecdoche. From the ever-increasing miniaturization of technology that we have seen in recent decades we have learned that supercomputers capable of modelling vast quantities of information do not need to be large in size. And, just as smaller and smaller technological devices are capable of handling ever larger quantities of information, novels which model complexity do not need to be formally excessive. I have argued that it is not necessary for the author to attempt the one-to-one mirroring of a complex system's parts, because meaning is not found in the parts per se but in the complex and emergent relationships between them. Contemporary systems realism is accordingly concerned with relationships rather than parts, and agent interaction rather than informational density is the key feature of such texts. A novel, like a system, is 'more than the sum of its parts' and can evoke complex emergent meanings during the reading process.

While I have suggested that ecological or environmentally-conscious systems novels represent a significant strand of post-2006 systems fiction, there is still a need for research to address other possible directions for the genre. For instance, the recent global

financial crisis has given rise in recent years to an emerging strand of fiction which focuses its attention on the unpredictability of financial markets and other economic systems. In addition, the recent neurological turn has produced a set of novels which focus their attention primarily on the complexity of the human mind rather than upon social engagement and explication. While I have suggested that the novel is particularly well suited to the exploration of complexity, it is clear that poetry and drama, as well as cinema and new online mediums, have their own means of representing the complex. This too, is an area which would benefit from further research.

An examination of the extent to which authors have engaged with system concepts and systems discourse provides us with new ways of thinking about the historical development of the novel, both in thematic and in formal terms. By drawing analogies between nineteenth-century and contemporary texts we can shed new insight upon the way that authors in both periods have sought to represent the complex. Contemporary fiction's utilization of systems theory sheds new light on the nineteenth century novel's incorporation of organicist thought, something which, I argue, can be seen to have shaped the engagement with a whole range of social issues at that time. These analogies of course, being systemic, are also reciprocal. Contemporary American authors are often acutely aware of the history of the novel, and their place within it, consciously echoing the forms of earlier times. Thus, awareness of the nineteenth-century novelist's strategies for narrating complexity may cast new light upon the representational efforts of today's novelists. Recent attempts to characterise the post-postmodern novel have so far resulted in the identification of a plurality of themes and preoccupations, and I have discussed a number of them here. However, what in my view unites emergent genres such as '9/11 fiction', 'the syndrome novel', 'eco-fiction', the 'new naturalism' and 'the new sincerity' is their authors' attempts to capture the systemic complexity of the twenty-first century in a fictional narrative.

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