

# The Complexity Turn

*John Urry*

A flock of birds sweeps across the sky. Like a well-choreographed dance troupe, the birds veer to the left in unison. . . . The flock is organized without an organizer, coordinated without a coordinator. Bird flocks are not the only things that work that way. Ant colonies, highway traffic, market economies, immune systems – in all of these systems, patterns are determined . . . by local interactions among decentralised components. (Resnick, 1997: 3)

**T**HE SOCIAL and cultural sciences have experienced a whole array of incursions over the past few decades. These have included Marxism in the 1970s, the linguistic turn and postmodernism in the 1980s, the body, performative and global culture turns in the 1990s. Many of these turns are reflected in and partly promoted within *TCS* journals and book series.

This new Special Issue seeks to reflect upon, to develop and in part to evaluate yet another turn, the complexity turn. This turn derives from developments over the past two decades or so within physics, biology, mathematics, ecology, chemistry and economics, from the revival of neo-vitalism in social thought (Fraser et al., 2005), and from the emergence of a more general ‘complex structure of feeling’ that challenges some everyday notions of social order (Maasen and Weingart, 2000; Thrift, 1999).

Within these scientific disciplines, an array of transformations took place, loosely known as chaos, complexity, non-linearity and dynamical systems analysis. There is a shift from reductionist analyses to those that involve the study of complex adaptive (‘vital’) matter that shows ordering but which remains on ‘the edge of chaos’. Self-assembly at the nanoscale is a current example of new kinds of matter seen as involving emergent complex adaptive systems. At the nanoscale the laws of physics operate in different ways, especially in the way that molecules stick together and through self-assembly can form complex nanoscale structures that could be the basis of whole new products, industries and forms of ‘life’ (Jones, 2004).

The properties of nano, it seems, cannot be understood through reductionism (see Wynne, this volume).

More generally, the term ‘complexity’ is ‘present’ and doing metaphorical, theoretical and empirical work within many social and intellectual discourses and practices besides ‘science’. These include alternative healing, architecture, consultancy, consumer design, economics, defence studies, fiction, garden design, geography, history, literary theory, management, New Age, organizational studies, philosophy, politics, post-structuralism, small world analyses, sociology, stock car racing, town planning (see Mackenzie, this volume; Thrift, 1999). Searches of Amazon indicate 1221 current complexity titles.

Some significant original and ‘popular’ books within the complexity field include Stewart’s *Does God Play Dice? The Mathematics of Chaos* (1989); Kauffman’s *The Origins of Order* (1993); Cohen and Stewart’s *The Collapse of Chaos* (1994); Casti’s *Complexification* (1994); Arthur’s *Increasing Returns and Path-Dependence in the Economy* (1994); Nicolis’ *Introduction to Non-Linear Science* (1995); Luhmann’s *Social Systems* (1995); Krugman’s *The Self-organizing Economy* (1996); Capra’s *The Web of Life* (1996); Prigogine’s *The End of Certainty* (1997); Jervis’s *System Effects* (1997); Rescher’s *Complexity* (1998); Holland’s *Emergence* (1998); Byrne’s *Complexity Theory and the Social Sciences* (1998); Kelly’s *New Rules for the New Economy* (1998); Cilliers’ *Complexity and Post-modernism* (1998); Hayles’ *How We Became Posthuman* (1999); Watts’ *Small Worlds* (1999); Rycroft and Kash’s *The Complexity Challenge* (1999); Rasch and Wolfe’s *Observing Complexity* (2000); Capra’s *The Hidden Connections: A Science for Sustainable Living* (2001); Gladwell’s *Tipping Points: How Little Things Can Make a Big Difference* (2002); Buchanan’s *Small World: Uncovering Nature’s Hidden Networks* (2002); Wolfram’s *A New Kind of Science* (2002); De Landa’s *Intensive Science and Virtual Philosophy* (2002); Barabási’s *Linked: The New Science of Networks* (2002); Taylor’s *The Moment of Complexity: Emerging Network Culture* (2003); Watts’ *Six Degrees: The Science of a Connected Age* (2003); Surowiecki’s *The Wisdom of Crowds* (2004); and Ball’s *Critical Mass: How One Thing Leads to Another* (2004).

It is in the late 1990s that the social sciences begin to go complex, with an array of books, articles, conferences and workshops appearing (and indeed showing up in this list above). I note below that in 1996 the Gulbenkian Commission on the Restructuring of the Social Sciences, chaired by Wallerstein and including non-linear scientist Prigogine, reported and advocated breaking down the division between ‘natural’ and ‘social’ science through seeing both characterized by ‘complexity’ (Urry, this volume; Wallerstein, 1996). From then on we can say the complexity turn takes off within the social and cultural sciences (early collections include Eve et al., 1997; Keil and Elliott, 1996).

Moreover, ‘complexity’ practices can themselves be viewed as a self-organizing global network spreading ‘complexity’ notions around the globe. Complexity researchers deploy the techniques of PR and branding,

international meetings with ‘star’ speakers, guru worship, the use of global media and publishing, funding and branding by large corporations, and networking especially centred on nodes such as Santa Fe in Arizona (see Helmreich, 1998; Waldrop, 1994) or the various research institutes named after the late Nobel prizewinner Ilya Prigogine (see Prigogine and Stengers, 1984).

Overall, complexity approaches both signify and enhance a new ‘structure of feeling’; one that combines system *and* process thinking (Thrift, 1999). Such an emergent structure involves a sense of contingent openness and multiple futures, of the unpredictability of outcomes in time-space, of a charity towards objects and nature, of diverse and non-linear changes in relationships, households and persons across huge distances in time and space, of the systemic nature of processes, and of the growing hyper-complexity of organizations, products, technologies and socialities. On the last of these we can note the huge increase in the number of components within products. The Eli Whitney musket of around 1800 had 51 components while the space shuttle of the late 20th century contained 10 million (Rycroft and Kash, 1999). Even by 1970, the most valuable products in world trade were simple products produced by simple processes. But a quarter of a century later, nearly two-thirds of the most valuable products in world trade involve complex processes *and* complex products, involving vast numbers of components, cybernetic architectures and sociotechnical or hybrid systems. This increasing complexity of products, processes and organizations is linked with the proliferation of computerized networks that self-reproduce themselves around the globe, forming and reforming new ways by which ‘everything is connected to everything else’ (Barabási, 2002).

In part, the complexity sciences developed to research the behaviour of phenomena characterized by large numbers – and to use the computing power emergent from the 1980s onwards (see Waldrop’s account of this at Santa Fe). As Kelly expresses this: ‘Emergence requires a population of entities, a multitude, a collective. . . . More is different . . . large numbers behave differently from small numbers’ (1995: 26). And the social world has of course some very large numbers to contend with, over 6 billion people, 700 million cars, 1 billion Internet users, 44,000 multinational corporations – although these are many fewer than the 10 billion nerve cells and 1000 billion synapses that students of the brain examine (Casti, 1994: ch. 3).

Complexity though is not the same as simply complicated. Complex systems analyses investigate the very many systems that have the ability to adapt and co-evolve as they organize through time. Such complex social interactions are likened to walking through a maze whose walls rearrange themselves as one walks through; new footsteps have to be taken in order to adjust to the walls of the maze that are adapting to each movement made through the maze. Complexity investigates emergent, dynamic and self-organizing systems that interact in ways that heavily influence the probabilities of later events. Systems are irreducible to elementary laws or simple processes.

In particular, pre-20th-century science had operated with a view of time as Newtonian: that is invariant, infinitely divisible into space-like units, measurable in length, expressible as a number and reversible. It is time seen essentially as a kind of Cartesian space comprising invariant measurable lengths to be moved along, forwards *and* backwards. Objects are viewed as being contained within such boundaries of absolute time and space (Coveney, 2000; Coveney and Highfield, 1990).

In the 20th century, the sciences dismantled such notions and prepared the way for the complexity turn (see Capra, 1996). Einstein showed that there is no fixed or absolute time independent of the system to which it refers. Time is a local, internal feature of any system of observation and measurement. It varies on where and how it is measured. It can stretch and shrink. Further, time and space are not separate from each other but are fused into a four-dimensional time–space curved under the influence of mass. Time and space are ‘internal’ to the processes by which the physical and social worlds themselves operate, helping to constitute their powers, as Whitehead (1985) analyses. Space and time are dynamic qualities: when a body moves, or a force acts, it affects the curvature of space and time, and in turn the structure of space–time affects the way in which bodies move and forces act. The subsequent development of quantum theory describes a virtual state in which electrons try out instantaneously all possible futures before settling into particular patterns. Quantum behaviour is instantaneous, simultaneous and unpredictable. The interactions between the parts are far more fundamental than the parts themselves (Zohar and Marshall, 1994).

The development of chaos theory involved rejecting the common-sense notion that only large changes in causes can produce large changes in effects (and vice versa; Gleick, 1988). Chaos theory is based upon iterating a relatively simple mathematical algorithm. Following a deterministic set of rules, unpredictable yet patterned results can be generated, with small causes on occasions producing large effects and vice versa. The classic butterfly effect, accidentally discovered by Lorenz in 1961, demonstrated that minuscule changes at one location can theoretically produce, if modelled by three coupled non-linear equations, very large weather effects very far away in time and/or space from the original site of the hypothetical flapping wings (Casti, 1994: 96; Maasen and Weingart, 2000: 93–4; Mackenzie, this volume). Relationships between variables can be non-linear with abrupt switches occurring, so the same ‘cause’ can, in specific circumstances, produce different effects.

Thermodynamics further shows the irreversible flow of time. An arrow of time results in loss of organization and an increase in randomness or disorder over time within systems. This accumulation of disorder or positive entropy results from the Second Law of Thermodynamics. However, there is not a simple growth of disorder. Prigogine shows how new order arises but is far from equilibrium (see Capra, 1996, this volume). There are dissipative structures, islands of new order within a sea of disorder, maintaining or even increasing their order at the expense of greater overall entropy.

Prigogine describes how such localized order ‘floats in disorder’. The arrow or flow of time results in futures that are unstable, relatively unpredictable and characterized by multiple possibilities.

The irreversibility of time can be seen in the research that showed how the universe expanded following the singular event of the ‘big bang’ 15 billion or so years ago. The scientific discovery of this cannot be reconciled with laws of the physical world that see time as reversible, deterministic and involving ‘classes of phenomena’. The big bang is a one-off phenomenon like nothing else ever to occur within the known universe. Laws of nature are historical, including those of time and space. The big bang apparently created in that very moment both space and time. There was no pre-existing space and time: ‘any attempt to explain the origin of the physical universe must perforce involve an explanation of how space and time came into existence too’ (Davies, 2001a: 57, 2001b). There is therefore no ‘time’ and space before the big bang; they appear spontaneously created, suddenly switched on, through an unpredictable and yet apparently irreversible quantum change (Hawking, 1988).

Central, then, to complexity is the idea of emergence. It is not that the sum is greater than the size of its parts – but that there are system effects that are different from their parts (see Jervis, 1997, on system effects). Complexity examines how components of a system through their interaction ‘spontaneously’ develop collective properties or patterns, even simple properties such as colour that do not seem implicit, or at least not implicit in the same way, within individual components (Nicolis, 1995). These are non-linear consequences that are non-reducible to the very many individual components that comprise such activities. Such emergent characteristics emerge from, but are not reducible to, the micro-dynamics of the phenomenon in question. Recently Surowiecki has described how this works in the social world as exemplifying the ‘wisdom of crowds’, that many ‘agents’ can be much smarter than the few (2004).

Moreover, if a system passes a particular threshold with minor changes in the controlling variables, switches occur such that a liquid turns into a gas, a large number of apathetic people suddenly tip into a forceful movement for change (Gladwell, 2002). Such tipping points give rise to unexpected structures and events whose properties can be different from the underlying elementary laws.

In analysing these non-linearities, positive feedback loops are especially significant, as opposed to the negative feedback mechanism analysed by earlier systems theory in the 1940s to 1970s (see Urry, this volume). Positive feedback loops exacerbate initial stresses in the system, so rendering it unable to absorb shocks and re-establish the original equilibrium. Such positive feedback can be seen in analyses of the increasing returns that generate path dependence found in the history of various economic-technological systems (such as the VHS video system replacing the technologically superior Betamax; see Arthur, 1994; Waldrop, 1994). Such irreversible path dependence occurs when contingent events set into motion

institutional patterns or event chains over time that have deterministic properties through what Arthur terms 'lock-ins' (1994). Path dependence analyses show that causation can flow from contingent events to general processes, from small causes to large system effects, from historically or geographically remote locations to the general. 'Path dependence' shows that the ordering of events or processes through time very significantly influences the non-linear ways in which they eventually turn out, decades or even centuries later. Path dependence is thus a process model in which especially hybrid systems irreversibly develop through 'lock-ins', but with only certain small causes being necessary to prompt their initiation, as with the contingent design of the QWERTY keyboard. The importance of the lock-in means that institutions matter a great deal to how it is that systems develop over the locked-in longer time.

Complexity analyses can also show that there is no such thing as 'nature's balance', no real or primordial nature that would be in equilibrium if only humans had not intruded (Budiasky, 1995). The effects of humans are subtly and irreversibly woven into the very evolution of landscape. And any ecological system is immensely complex so that there are rarely obvious policies that simply restore nature's balance, partly because of the significance of 'critical thresholds' (see Resnick, 1997: 107–8, on forest fires). Ecological systems are on the edge of chaos without a 'natural' tendency towards equilibrium, even if all humans were to depart forever from the scene. Indeed, many ecological systems themselves depend not upon stable relationships but upon massive intrusions, of extraordinary flows of species from other parts of the globe and of fire, lightning, hurricanes, high winds, ice storms, flash floods, frosts, earthquakes and so on. The 'normal' state of nature is thus not one of balance and repose; the normal state is to be recovering from the last disaster.

Moreover, as former UK Chief Scientist Robert May showed, the population size of species shows no tendency to stability or 'equilibrium', and especially not to rise smoothly to the presumed carrying capacity of their environment and then to level off and remain stable (May, 1981). Rather, populations of most species demonstrate extreme unevenness, with populations often rising rapidly when introduced into an area and then almost as rapidly collapsing. The food consumption of animal species responds in a non-linear and time-lagged fashion to changing circumstances, and this produces massive unevenness of population size with no natural or equilibrium size. Indeed the chaotic properties of biological systems also make predictions of what favours the protection of a particular species more or less impossible.

Simultaneously, the contemporary world seems to involve highly adaptable viruses, such as Aids and ebola, new superbugs, newly lethal pathogens such as prions, and the reappearance of TB, cholera and the bubonic plague, and the development of terrorism (see Knorr Cetina, this volume; Van Loon, 2002). These phenomena appear to stem from new patterns of global travel and trade, the heightened ineffectiveness of

antibiotics that encounter increased ‘resistance’, and the development of new powerful risk cultures beyond and especially within ‘medicine’. Davis suggests that southern California seems especially characterized by the catastrophic coincidence of extreme events. This seems not a random disorder but a dynamic pattern of escalating feedback loops. Extreme events, especially extreme weather events, demonstrate the principle of non-linearity where small changes in driving variables or inputs – magnified by positive feedback – can produce disproportionate, or discontinuous, outcomes (Davis, 2000).

Something similar can be seen in the case of accidents that appear to occur ‘normally’ when the system is tightly coupled, that processes happen very fast and cannot be turned off, when the failed parts cannot be isolated and when there is no other way to keep the system going. With such tightly coupled systems, recovery from the initial disturbance that may have been relatively trivial is impossible. The consequences will spread quickly, chaotically and irreversibly throughout the system, so producing normal ‘system accidents’ (Perrow, 1999).

Overall, systems are often conceptualized as autopoietic (Luhmann, 1995; Maturana, 1981; Mingers, 1995). Autopoiesis involves the idea that living systems entail a process of self-making or self-producing. There is a network of production processes in which the function of each component is to participate in the production or transformation of other components in the network. In this way, the network comes to make itself. It is produced by the components and this in turn produces the components and its environment. In a living system the product of its operation is its own organization, with the development of boundaries specifying the domain of its operations and defining the self-making system (Hayles, 1999: ch. 6). Such autopoietic features have been especially studied in systems of urban growth. Small local preferences mildly expressed in the concerns of individuals, such as wanting to live with those who are ethnically similar, produces very strongly segregated self-organizing neighbourhoods as in large American cities. Krugman argues that residential patterns are unstable in the face of random perturbations: ‘local, short-range interactions can create large-scale [self-organizing] structure’ (1996: 17).

Capra argues therefore that nature turns out to be more like human nature – unpredictable, sensitive to the surrounding world, influenced by small fluctuations (Capra, this volume). This suggests enormous interdependencies, parallels, overlaps and convergences between analyses of physical *and* of social worlds. Indeed the very division between the ‘physical’ and the ‘social’ is a socio-historical product and one that is dissolving. De Landa shows that individual bodies and selves, those subjects of social science, are mere ‘transitory hardenings’ in the more basic flows of massive amounts of minerals, genes, diseases, energy, information and language (1997: 259–60). Moreover, emergent properties are never purely ‘social’ and the kinds of processes that generate them are also not simply social. Complexity would argue against the thesis that ‘phenomena’ can remain bounded,

that social causes produce social consequences. Causes are always overflowing, tipping from domain to domain and especially flowing within and across the supposedly distinct physical and social domains. For complexity, the emergent properties are irreducible, interdependent and mobile (see De Landa, 2002, on Deleuzian approaches here).

The complexity sciences thus elaborate how there is order *and* disorder within all physical and social phenomena including, according to Kauffman, within the nature of evolution though the concept of a 'fitness landscape' (1993). Complex systems are thus seen as being 'on the edge of chaos'. Physicists describe many states as being 'metastable', which means that they are next to stable (rather than simply unstable; Ball, 2004: 201). Order and chaos are in a kind of balance where the components are neither fully locked into place but yet do not fully dissolve into complete instability or anarchy. Chaos is not complete anarchic randomness but there is an 'orderly disorder' present within such systems. This argument emphasizes the nature of strong interactions occurring between the parts of systems, with often the absence of a central hierarchical structure that 'governs' and produces outcomes. These outcomes are both uncertain and yet irreversible. As we noted above, this is because more is different, 'large numbers behave differently from small numbers', as Resnick shows in the case of ants or slime-mould cells (Jenks and Smith, this volume; Kelly, 1995: 26; Resnick, 1997: 33). The use of complexity thinking should enable us to break with dualistic thinking, which holds that there either are 'systems' or there are 'system failures' (see Malpas and Wickham, 1995). Chaos and order are to be seen as interconnected as large-scale systems move in and through time-space.

A wide array of authors has found these formulations productive for developing new kinds of social science, and indeed for generating provocative overlaps between physical, biological and social science formulations. However, the borrowings from complexity are of many different forms; Kwa (2002) distinguishes between romantic and baroque borrowings. Some of these differences are reflected in this Special Issue. Leading contributors to these 'social' science debates have contributed here, ranging from those developing analyses of autopoietic processes, to critical realist formulations of the economy and politics, to ecological approaches, to Deleuzians and vitalist philosophers, to students of the global and so on.

The collection begins with two articles that set the scene and provoke a number of ways of rethinking the significance of the complex and of the potential relationships between the physical and the social. The first is by one of the leading writers on the social science of time, Helga Nowotny. She sets out many ways in which we seem to live in a complex world. Living organisms are composed of parts that function to ensure the survival and the reproduction of the whole. In the course of evolution complexity has increased, but this increase is neither universal nor inevitable. Also societies have become more complex, especially through the development of symbolic technologies. She pays particular attention to the work of

Luhmann. Nowotny argues for the importance of transdisciplinary interfaces in which analyses of complex evolving systems are not to be left to scientists alone, since they increasingly turn out simultaneously to involve human agents *and* things, science *and* society, in novel configurations. Scientific novelty thus needs a societal reading, in order to be understood and culturally appropriated.

Within the pantheon of writers contributing to the popular understanding of science and especially of complexity, Fritjof Capra is probably the world's leading figure and has indeed contributed to a societal reading of complexity (Capra, 2001). In his article he sets out some of the main contributions that non-linear dynamics has made to understanding various aspects of biological life and especially to the 'breath of life'. He develops how complexity enables living networks to be analysed as functional, open, operating far from equilibrium and, most significantly, self-generating. He also shows how solving non-linear equations results in a visual shape or 'attractor', the system's long-term pattern. Capra also brings out the significance of Prigogine's theory of dissipative structures, how living systems maintain themselves in a relatively stable state, albeit far from equilibrium.

Author of the innovative *Transductions: Bodies and Machines at Speed* (2002), Adrian Mackenzie takes up certain issues from Capra, especially through examining the organization and structuring of the complexity sciences. He examines the 'movements' of scientific ideas through a detailed analysis of the role played by the Lorenz attractor. This notion shows up in popular images of 'deterministic chaos' and the notorious 'butterfly effect'. He examines just how complexity research moved so rapidly from the scientific laboratory to popular science, especially examining the role of print media and computer simulation. Mackenzie also develops, via De Landa, some ways in which complexity seeks to move *beyond* metaphors, a non-metaphorical movement of complexity into social and cultural analysis.

Leading sociologist of science Brian Wynne also develops an analysis of the 'movements' of complexity by examining and critiquing 'science' as the ritual authority. He thus argues against dominant social sciences approaches to complexity that suggest that awareness of complexity in late-modern society solely derives from recent scientific insights. By examining plant and human genomics sciences, he argues that public culture is already aware of particular forms of complexity, such as the many limits to predictive knowledge. He also shows that genomics science expresses both complexity and predictive determinism and reductionism, the latter stemming from commercial cultures, and by imagined publics who are important new constructed objects of institutional scientific concerns. In sustaining a strong anti-reductionist argument, Wynne shows and develops important and neglected dimensions of the interrelations of science-and-society.

One of the very earliest works in the complexity area that sought to develop its implications for empirical social science was David Byrne's *Complexity Theory and the Social Sciences* (1998). In his article here he

argues that the way to make complexity work as part of critical realist social science is through the comparative method and especially through its shaping of the tools of social science. This project he examines through a distinction between ‘simplistic complexity’ (rather like the reductionism Wynne argues against) and ‘complex complexity’. The latter involves a dialogical engagement with involved social actors seeking to transform social systems. He is less concerned with importing ideas from the sciences but rather with developing ways of thinking and challenging the social world through complexity understood as a more general epistème.

Issues of social change are also examined in Christian Suteanu’s article, partly drawing upon his work within the physics of complexity. This article addresses complexity by selecting some of its key aspects that share the feature of the power to change. He especially examines the three main ‘pillars’ that are thought to constitute science: measurability, reproducibility and prediction. He shows the disruptive consequences that complexity has for each of these pillars. Particular focus is directed to the implications of Madelbrot’s fractal theory. Suteanu goes on to examine in detail the nature of complexity’s resulting new geography, generating new landmarks, relationships among its elements, means of orientation and relationships between science and the public.

Authors of the forthcoming *Qualitative Complexity: Ecology, Cognition and the Re-emergence of Structure in Post-humanist Social Theory*, Chris Jenks and John Smith analyse the relationships between complex processes of self-organization and the environment or ecology in which these dynamic processes take place (2005). They focus upon the role of information in the formation of complex structures. Through a detailed engagement with Prigogine, the authors develop an ontology that founds both material and informational structures and argues for a radical continuity between the general thermodynamics of emergent complex orders, cognitive theory and the complex structures of human thought and culture. They emphasize the qualitatively distinct modes of dynamic organizations involved in the interplay of ‘given’ adaptation-enactment and the plasticities of human intelligence, culture and its technologies.

Elements of the global and globalization are examined in the remaining articles. Indeed, it is the awareness of the ‘global’ that has helped to generate the complexity turn within the social and cultural sciences. The huge array of books, articles, journals and popular discourse surrounding globalization has authorized a return to the notion of ‘system’ that had, for a couple of decades, slipped from view (see Walby, 2006, on the return of ‘system’). Clearly, though, many complexity notions will be highly critiqued because of this systemic orientation.

Nigel Clarke especially examines parallels and differences between the idea of the earth in interchange with a dynamic cosmos and the notion of a global complexity (and see Urry, this volume). He refers to the former as an ‘exorbitant globality’ and shows how it points towards a unaccountable excess and a radical undecideability in future deliberations. He

analyses Lovelock's Gaia thesis, and more generally the notion of the biosphere as a complex self-organizing system. Drawing upon Deleuze, De Landa and Derrida, Clarke problematizes the idea of a global system that is not closed to its immense surroundings. Indeed, we might ask what is the environment of the globe's system? Indeed, could the universe itself be thought of as a non-equilibrium, self-organized system (see Smolin, 1997)?

The planet recurs also within Graeme Chesters and Ian Welsh's article on the relevance of a Deleuzian reading of complexity and of 'becoming' to interrogate the rise of networked social movements and extensive 'weak ties' operating across the globe. They examine the self-organizing anti-globalization 'movement of movements' and show how it cannot be pressed into a conventional social movements framework (see also *We Are Everywhere*, in part written by Chesters). They examine transnational gatherings, social fora, computer-mediated communications, the digital commons and unprecedented mobility, which serve to generate a fractal movement-space, a shadow realm that makes possible 'global movement'. Especially significant is their analysis of the relations of affect and intensity generated within movement 'plateaux'.

The significance of complexity analysis for global relationships is also examined in Karin Knorr Cetina's analysis of the 'new terrorism'. She takes this as a significant exemplifying case for complexity theory – with major disproportionalities between cause and effect, unpredictable outcomes, and self-organizing, emergent structures. It also illustrates the emergence of global microstructures – a topic she importantly explores elsewhere – of forms of connectivity and coordination that combine global reach with microstructural mechanisms that instantiate self-organizing principles and patterns. Such global microstructures do not exhibit institutional complexity but rather the asymmetries, unpredictabilities and playfulness of complex (and dispersed) interaction patterns. The analysis of complex global microstructures suggests a theory of microglobalization, that the texture of a global world becomes articulated through microstructural patterns that develop in the shadow of (but liberated from) national and local institutional patterns, as Chesters and Welsh show in the case of the anti-globalization 'movement'.

Such processes are also examined by John Urry as he develops some arguments from *Global Complexity* (2003). He distinguishes between 'global networks' and 'global fluids', seeing new kinds of movement and of terrorism as examples of the latter. More generally, through paradoxically drawing upon Marx's analysis of the contradictions of capitalism, he seeks to show that globalization should be conceptualized as a series of adapting and co-evolving global systems each characterized by unpredictability, irreversibility and co-evolution. This is to follow Wynne's resolutely anti-reductionist view of globalization. It is argued that such systems lack finalized 'equilibrium' or 'order'; indeed, the many pools of order à la Prigogine heighten overall disorder. The global, then, is comprised of various systems, operating at various levels or scales, each constitutes the environment for each

other. Thus criss-crossing ‘societies’ are many other mobile, material systems in complex interconnection with their environments.

Finally, Paul Cilliers, author of the major *Complexity and Post-modernism*, discusses the implications of how if something is complex then this implies that our knowledge of it will always be limited. We cannot make complete, absolute or final claims about complex systems. He draws upon and discusses three arguments: that complexity-thinking lead to relativism; that they are subject to the performative contradiction; and that their claims are vague. It is shown that these critiques are not really effective and that a responsible approach to complexity involves modest and contingent but non-relativistic claims.

Thus, for the social and cultural sciences, complexity analyses bring out how there is order *and* disorder within these various systems. In particular, we can see how the global order is a complex world, unpredictable and irreversible, disorderly but not anarchic. And elements of that disorderly world are mobile and transmuting notions of complexity science unpredictably emerging and holding a shape as they sweep into and transmute one discipline after another, as we have sought to describe and examine in *The Complexity Turn* in the social and cultural sciences.

#### *Acknowledgements*

I am very grateful to the authors of the articles appearing here who responded with enthusiasm to some significant editorial suggestions. I am also grateful to discussions on complexity within the Lancaster Complexity Network and especially to my co-organizer, Kingsley Dennis. I am also very grateful for many lengthy conversations on complexity with Sylvia Walby whose *Complex Social Systems: Theorizations and Comparisons in a Global Era* (forthcoming, 2006) develops one of the first large-scale empirical studies deploying complexity notions within the social sciences. I am also very grateful for the assistance of Susan Manthorpe and Neal Curtis in getting this issue into publication, as well as more general advice from Mike Featherstone and the editorial board of *TCS*.

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