Philip Ball

Why Society is a Complex Matter

Meeting Twenty-first Century Challenges with a New Kind of Science

With a contribution by Dirk Helbing

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Introduction

Society: a Complex Problem

It is becoming ever more clear that the twenty-first century is not a continuation of the twentieth, but something new. War is qualitatively different now from what it was half a century ago, and so is peace. So are consumerism, access to information, environmental change, health care, demography, and perhaps the very concept of democracy. It seems we are living not at the "end of history" after all but at the beginning of a new historical phase – one that demands new ways of thinking.

This is why it is time to escape the constraints of disciplinary thinking. The major challenges of the twenty-first century are not ones that can be understood, let alone solved, from a particular academic perspective. For example, if today's patterns of consumption make global mean temperatures destined to rise by even 2 °C, the consequences for international relations, biodiversity, food and water security, and human migration are immense, and yet are at this stage little more than informed guesswork. Simply comprehending and forecasting such impending crises, let alone mitigating them, is not just a question of having more accurate models of global climate, but must involve the integration of a host of socioeconomic, technological and political factors.

The most important novelty in the changes that are currently being felt by our societies and our environment stems from the profound impact of globalization: the linkages and interconnections that transcend states and societies. The interdependence of economies, cultures and institutions has become deep and dense, in large part thanks to the pervasive nature of information and communication technologies (ICT). Nothing will work that fails to take this into account: not the economy, not policing, not international diplomacy, not governance. Bird flu pandemics, the Arab Spring revolutions, the financial crisis, terrorist networks and the spreading of cyber-crime are all manifestations of our ever more connected world. They all illustrate that the current pace of technological change, particularly in the area of ICT, is outstripping our capacity to manage it.

Our society is data-rich, but lacks the conceptual and technological tools to handle it. (Credit: worradirek/Shutterstock.)

The inter-connectedness of global phenomena, and in particular the roles of interactions between individuals, groups and institutions, give a new perspective to events that could look superficially like more of the same. For example, the fall of long-standing, dictatorial regimes in Tunisia, Egypt and Libya was unlike the dissolution of the Soviet Union, not least in terms of its bottom-up impetus. Alleged triggers of the 'Arab Spring', whether they be escalating food prices in North Africa or the self-immolation of a Tunisian street vendor in protest at official harassment, must be seen as catalysts that unleashed rather than created the phenomenon. While the importance of social networking media in these uprisings (which some have called Twitter revolutions) remains open to debate, the issue is not so much whether they 'caused' the revolutions but that their existence – and the concomitant potential for mobilizing a young, educated demographic – can alter the way things happen in North Africa, the Middle East and beyond.
Similarly, while economic crashes have always been with us, the financial crisis that began in 2008 was evidently a product of the interconnections – strong ones, yet poorly known – within the institutions that instigated it. The crisis was partly about risk hidden so deeply as to cause

paralytic fear; it was also about instruments too complicated for users to understand, and about legal and financial systems labyrinthine enough to permit deception, selfishness and mendacity to thrive.

The Arab Spring of 2011: the product of a complex, deeply interconnected social system. (Credit: MOHPhoto/Shutterstock.)

What is qualitatively new about these events is the crucial role of interdependence and interaction and the almost instantaneous transmission of information through social, economic and political networks. That novelty does not by itself explain why they happened, much less help us to identify solutions or ameliorate the unwelcome consequences. But it points to an unavoidable truth: the world has changed, and it is not going to change back.

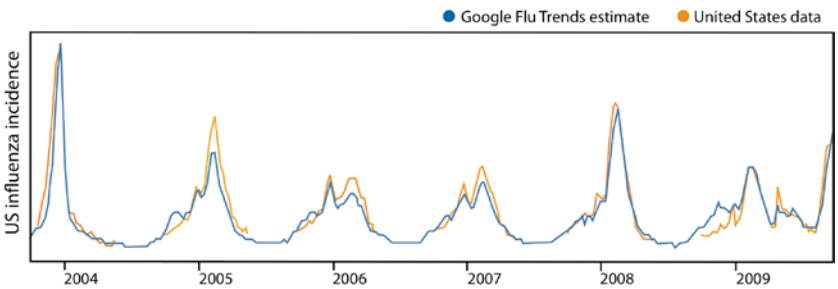
We are, for one thing, now living in a world that is data-rich, but with much of the important information highly dispersed so that it can be brought to light only by a smart process of aggregating and sifting. Intelligence may need to rely increasingly not on a few 'hard facts' but on diffuse 'sensing' of mood and opinion: on patterns normally invisible among the noise, such as the epidemiological data unearthed from Google searches by GoogleFluTrends.

Many political analysts today consider that the major challenges in the future will be examples of *discontinuous* change: not gradual shifts in the balance of power or the organization of societies and cultures, but sudden, perhaps catastrophic transformations. Such changes are extremely hard to predict, in terms not just of their magnitude, onset and occurrence but of their very nature – we don't know exactly *what* is going to break.

All this is uncharted territory for politicians, and they do not know how to navigate it. That makes for a dangerous situation, because if political leaders feel compelled to improvise solutions that fail entirely to acknowledge the nature of the problem, they stand a good chance of making things worse. As Lee C. Bollinger, president of Columbia University in New York, has said, "The forces affecting societies around the world are powerful and novel… Too many policy failures are fundamentally failures of knowledge."

This is why politicians and decision makers need new concepts and tools if they are not to lose the capacity to govern, to manage economies, to create stable societies, to keep the world worth living in. And they will need to learn the key lesson of the management of complex, interacting systems: solutions cannot be imposed, but must be coaxed out of the dynamic system itself. There is an analogy with earthquakes, which may never be exactly predictable, but might possibly be managed by mapping out in great detail the accumulating strains that give rise to them, and perhaps inducing controlled, small-scale release of pent-up energy (for example, by injecting groundwater into fault systems). This approach, rather than top-down imposition of laws and structures, might be the way to handle 'social earthquakes' too.

It is sometimes said that by their very nature no one can be expected to foresee radical departures from the



Patterns in the number of searches for influenza-related topics worldwide turn out to closely track flu outbreaks recorded by disease-monitoring centres, with the advantage that the data are available almost instantaneously. See http://www.google.org/flutrends/.

previous status quo. Yet social and political discontinuities are rarely if ever random in that sense, even if there is a certain arbitrary character to their immediate triggers. In the complex systems familiar to natural scientists from the physical and biological sciences, discontinuities don't reflect profound changes in the governing forces but instead derive from the interactions and feedbacks between the component parts. And they are not necessarily unpredictable: sometimes there are precursory signs, and sometimes we can foresee the circumstances in which they will occur, or at least in which they will be more likely to do so.

The notion of 'complex systems' is relatively new in the social sciences. But natural scientists have studied these systems with much success for several decades now. This book argues that the time is ripe – indeed, the need is urgent – to approach the social sciences from this perspective. It calls for a collaboration between natural and social scientists between, for example, computer scientists, physicists, mathematicians, biologists, technologists, psychologists, economists, sociologists, urban planners, political scientists, philosophers, historians and artists – to build a new picture of human social behaviour and its consequences. This is an immense task, but it is already beginning. It is one we can no longer afford to neglect.

Is Society Predictable?

The idea that the social sciences can usefully employ concepts developed in the natural sciences is not new. It was evident at the very origin of modern political philosophy. In the seventeenth century, Thomas Hobbes based his theory of the state on the laws of motion recently deduced by Galileo, in particular the principle of inertia. The ascendancy of the mechanistic view of the natural world, for which the paradigm was Isaac Newton's gravitational model of the cosmos, gave rise in the eighteenth century to a belief that social behaviour also follows rigorous laws that can be expressed and understood along similar mechanistic lines. Adam Smith's notion of an 'invisible hand' that creates a stable and efficient economy from the self-interested behaviour of its many actors already embodied the image of social self-organization that required no over-arching guidance or authority. The operation of this invisible hand was deemed to be as dependable as the law of gravity, provided that the state did not interfere: a central tenet of the belief that markets must be free if they are to be efficient, which many economists and politicians still hold to some degree today.

And in the nineteenth century the cohesion of society as a collective result of the actions of its multitude of members was considered in statistical terms: what mattered was not the capriciousness of individual actions and choices, but the predictable averages. This image both influenced and was influenced by the evolving physical theories of matter envisaged as a vast collection of atoms and molecules: the ideas that gave rise to the twentieth-century science of *statistical physics*. Just as the random, unpredictable movements of individual particles in a gas produce, en masse, the wholly reliable and mathematically simple 'gas laws' that relate its pressure, temperature and volume, so might society show predictable and regular behaviour when viewed as a whole. Thus, early sociology was largely constructed according to an unspoken faith that there was a kind of 'physics of society'.

What is Complexity?

In retrospect, this idea remains valid but it often drew on the wrong analogies. Society does not run along the same predictable, 'clockwork' lines as the Newtonian universe. It is closer to the kind of complex systems that typically preoccupy statistical physicists today: avalanches and granular flows, flocks of birds and fish, networks of interaction in neurology, cell biology and technology. These systems differ from simple gases in that the component particles or agents interact strongly with one another, affecting and responding to one another's behaviour. That is true even for a non-living system like a pile of sand: tumbling grains can strike other grains, setting off cascades that can produce avalanches of all sizes, which are difficult to predict individually but which have characteristic statistical patterns.

This means that societies are more like the communities and ecosystems studied by biologists: food chains, ant and bee colonies, predators and their prey. At one level that seems hardly surprising, for what are societies but communities of a particular species of animal? But what is striking is that analogies between the group behaviour in these cases exist despite the supposedly much greater psychological and cultural sophistication of humans. Some features, such as collective movements and modes of organization, seem rather insensitive to the fine details of how individuals interact, and are determined by the very fact of those interactions, along with the *shape* of the networks they define. That's why descriptions of the resulting behaviour remain accessible to the kinds of theories of complex systems that physicists have developed. They do not necessarily need a great deal of biological or psychological realism to capture the essence of the emergent phenomena.

Thus, on the macroscopic level, social and economic systems have some features that seem to be similar to properties of certain physical or biological systems. For example, they tend to develop hierarchical organization. In social systems, individuals form groups, which establish organizations, companies, parties and so forth. These