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Editorial

Discontinuities, tipping points, and singularities: the quest for a new social dynamics

Classical physics and mathematics, indeed even classical social science from the time of the Enlightenment to the early 20th century, are based on the notion that change is smooth, represented by a continuity that finds its best formulation in the calculus. Smooth change is also consistent with positive feedback, where the rate of change continuously modifies the existing state of any system, leading to exponential growth or decline. Linear change is the least likely scenario in this kaleidoscope of possibilities. Such exponential change is largely understandable in comparison with discontinuous change, which is peppered by abrupt reverses in direction reflecting switches in growth rates but clearly depending on the relative position of the system within its growth cycle. The early stages of exponential growth provide little sense of change but once growth begins to take off, the time it takes to double the system measure in question becomes ever more apparent, impressing on any observer a sense of qualitative change.

This notion, suggesting that smooth change can be as disruptive as discontinuous change, is a concept that has been generalised across many technologies that appear to be converging on what Ray Kurzweil calls 'the singularity'. In short, even if the rate of change, or positive feedback, remains constant, Kurzweil argues that multiple currents of change will converge to a point in time where the systems in question become radically different in their structure. In cases in which this rate of change is itself accelerating, as for many contemporary technologies, the ultimate convergence on the singularity is entirely unpredictable in its impact, timing, and meaning. The idea is not new although its implications have barely been sketched. Kurzweil (2005, page 10) quotes von Neumann, who in the 1950s said: "the ever accelerating progress of technology ... gives the appearance of approaching some essential singularity in the history of the race beyond which human affairs as we know them, could not continue."

Within this envelope our understanding of social and technological dynamics has been enriched by the notion that discontinuous change has multiple causes that conspire, from the bottom up, to generate tipping points, catastrophes, and bifurcations. Such change is unexpected, for it is the product of countless actions that cannot be managed and often cannot be tracked. In this sense it is emergent and always surprising. Markets represent the classic example. These are often governed by individual but uncoordinated actions which have the capacity to generate abrupt change. Seemingly random choices converge on behaviours which are copied by others and lead, through positive feedback, to rapid reversals of direction and fortune.

Often these patterns are buried in past actions not considered significant at the time but which slowly trigger switches in behaviour. However, sometimes they are simply the product of random events that fall into some pattern that becomes the dominant response to change. In the recent turmoil in financial markets, what was initially considered unimportant—convoluted patterns of bank lending—led to a reaction against such behaviours on the part of the banks themselves, generating a 'credit crunch' with severe implications for the housing market. In turn, the housing market is now the single greatest force in Western economies and debt there is likely to drive down the so-called real economy to the point where a full-blown depression ensues.

But no one knows if this will happen. In 2002, in an editorial echoing this theme (Batty, 2002), I argued then that the housing bubble was about to burst in the UK, but instead it blew bigger. By its very nature, the system is unpredictable.

In tracking financial markets the most obvious model of behaviour, for a myriad of individuals making investment decisions in the absence of perfect information and doing so in largely uncoordinated individualistic fashion, is a structured random walk. That is, the price signals behave randomly from time instant to time instant, but with changes on all scales following power laws that imply there are many more small changes than big. This model is a good starting point, but it is not quite right, for there are subtle patterns and correlations in a world that is not entirely random (see Mandelbrot and Hudson, 2006). Nevertheless, observing and extracting these patterns can be highly problematic while building models to explain how such behaviours emerge from the actions of millions of individuals is a daunting challenge. Where elegant models have been generated, they have a nasty habit of being roughly right for much of the time but demonstrably wrong at significant points. The demise of the firm Long Term Capital Management in the late 1990s almost brought the US economy to its knees, yet it was based on a theory of asset pricing that won its inventors, Merton and Scholes, the Nobel Prize (Lowenstein, 2000).

Explanations of such dynamics range from the simple examination of graphs to identify trends and patterns through to sophisticated market models based on complexity theory. Currently in our own field there is a curious theory proposed in 1999 by Andrew Lawrence of Dresdner Kleinwort that suggests that cycles in the construction of skyscrapers are correlated with the probability that the economy is vulnerable to global recession: the irrational exuberance displayed by developers in the West to build ever higher is indicative of a bubble ready to burst (Thornton, 2005). The theory, like that of Merton and Scholes, is half right. The great depression of the 1930s was preceded and paralleled by massive skyscraper building in New York, stagflation in the 1970s saw the end of a wave of tall building growth from the 1960s, while the current boom that is just ending is dominated by massive skyscraper building in all the world's great cities. Of course this is mere Chartism, but nevertheless it is intriguing. While it is not surprising that booms lead to such construction, predicting the end of the boom using an index of tall buildings seems fanciful at best, misleading at worst. More likely the causation is the other way round, which once again throws up the notion that no one actually understands it. After fifty or more years of sustained thinking about such dynamics, our understanding has barely advanced. What is urgently needed is an ontology of such dynamics, a classification that illustrates how discontinuities shade into continuities and catastrophes, how chaotic behaviour, phase transitions, bifurcations, and singularities relate to one another and to the systems that can be so characterised. A concentrated focus on social dynamics is long overdue.

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