

2011 and all that: The case for considering society as a complex system

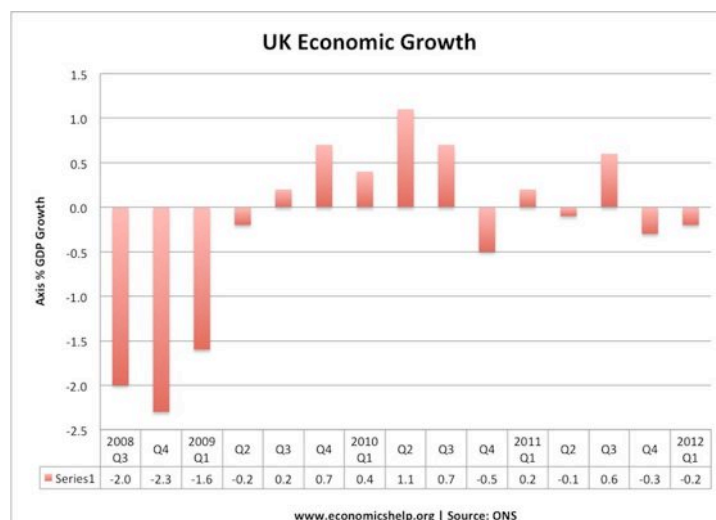
Philip Ball

This talk was delivered at the conference “Complexity Science and Social Science at the Interface to the Real World”, Chicheley Hall, Newport Pagnell, 24-25 September 2012. It is based on my article “Crisis response: the new history” in *Nature* **480**, 447-448 (2011), and the introduction to my book *Why Society is a Complex Matter* (Springer, Berlin, 2012).

Last year saw several remarkable events and developments in world politics, economics and social change, with repercussions that will be felt for some time to come, and yet which are still poorly understood. I suggest that the complex-systems view of human social systems might offer some useful perspectives. Whether or not this approach can also offer solutions remains to be seen, but nonetheless there has never seemed a better time for taking it seriously as one way to understand the behaviours that can arise in our increasingly interconnected and inter-dependent global system.

There has probably never been a generation that hasn't felt that the world is changing profoundly, but nevertheless I do feel this is a particularly strange and interesting time to be living. We know that something is badly wrong with the social structures we have created, but we have no idea how to fix it. We know, for example, that we are screwing up the planet's ecosystems and climate, but we lack any political mechanism for putting that right. The democratic notion of collective debate and consensus has been tried and found wanting. We are discovering that democracy can do some things very well and others not at all.

The global economy has been in a state of more or less permanent crisis for the past four years, as is reflected in the pitiful economic performance of the UK:



There is a growing body of opinion that the British government's present economic policy of austerity is profoundly misguided. That may well be true, but the fact remains that no one really knows how to get us out of this pitiable situation, because almost no one anticipated what got us into it. Some economic commentary and opinion has simply become bizarre and other-worldly. There are many people in the US, for example, who feel that the global crisis was the result of too *much* regulation of the markets. Others assured us, even only a little before 2008, that boom and bust was a thing of the past, notoriously the then Prime Minister:

"With Bank of England independence, tough decisions on inflation, new fiscal rules, and hard public spending controls, we today in our country have economic stability, not boom and bust."

Gordon Brown, 2002 speech to the TGWU conference.

I've heard other serious social commentators argue that the crisis was not a failure of our existing version of capitalism, because, despite almost bankrupting the world and costing in the region of ten trillion dollars, we did at least have a few decades of good living first.

It's well attested, although perhaps still not sufficiently acknowledged, that the financial crises of the past four years represent not just a crisis of economic policy but of governance in general. Here's just one instance of that suggestion:

The centre of politics has shifted.... The neoliberal thinking that has dominated the industrial world for nearly 30 years has led to a financial crisis, which in turn caused the global downturn.... Clearly, there can be no turning back to the failed and discredited politics of old. Instead, we need to use this time of emergency to aim for a different future and to get there by different means.... this is not a crisis of capitalism, but a crisis of a society and democracy that have failed to regulate the market.

Neal Lawson & John Harris, *New Statesman* 9 March 2009

In essence what remarks like this are really saying is that we have entered a period in which we are no longer so certain that we know *how to govern a society* based on capitalism. It seems trivial to say that the mere existence of a democratic system doesn't fully specify the answer to that question, but nevertheless I think it is fair to say that many people in democratic nations have been profoundly shocked by the realization of the structural weaknesses that a democratic economy can have, in which banks can vanish (and your money with it) and entire nations can go bankrupt almost overnight.

I don't claim to have any answers to the immense and difficult questions that arise from all this. But I'm struck by two things. First, it seems that the current world situation is rekindling interest in old questions about governance that many had complacently considered to be settled, particularly in relation to the interplay between laws and institutions and the freedoms of individuals in an economic context.

That complacency was, I think, apparent in Francis Fukuyama's notorious prediction in the 1990s that the world was approaching the 'end of history' [F. Fukuyama, *The End of History and the Last Man* (Penguin, London, 1992)].

Fukuyama was not claiming that there would be ‘no more history’ in the sense of significant events, but rather, that liberal democracy could, after the collapse of the Soviet Union, now be seen as the logical and stable end point of civilizations. But the prospect that (as Fukuyama hoped) the world would gradually replicate the US model of liberal democracy looks more remote than it did at the end of the twentieth century. The proliferating protest movements such as Occupy in the fallout from the financial crisis are not the cries of the marginalized and disaffected, but genuine challenges to the legitimacy of the economic system on which recent liberal democracies have been based. Such is the gravity of the debt crisis in Greece that the wisdom of deploying democracy’s ultimate tool – the national referendum – to solve it has been questioned. The political situation in Russia and Turkey suggests that there is nothing inexorable or irreversible about a process of democratization, while the popular overthrow of long-standing autocratic rulers in Tunisia, Egypt and Libya – the so-called Arab Spring, which began with the Tunisian revolution at the end of 2010, demonstrates to politicians what political scientists could already have told them: that democratization can itself inflame conflict, especially when it is imposed in the absence of a strong pre-existing state. It remains far from clear into what kinds of states the Arab Spring is going to settle, and true democracy is only one of the possibilities. Meanwhile, China continues to show that aggressive capitalism depends on neither liberalism nor democracy. As a recent report of the US National Intelligence Council admits, in the coming years “the Western model of economic liberalism, democracy, and secularism, which many assumed to be inevitable, may lose its luster” [National Intelligence Council, *Global Trends 2025: A Transformed World* (US Government Printing Office, Washington DC, 2008)].



Egypt, 2011



Spain, 2011



Greece, 2011

The end of history...?

It seems that events and developments like these are compelling some commentators to point out significant gaps in our fundamental understanding of how society and its structures operate. Consider, for example, what the Nobel laureate economist Joseph Stiglitz has said about the financial crisis:

“Many of the problems our economy faces are the result of the use of misguided models. Unfortunately, too many [economic policy-makers] took the overly simplistic models of courses in the principles of economics (which typically assume perfect information) and assumed they could use them as a basis for economic policy... We need a new balance between market and government.”

Joseph Stiglitz, *New Statesman* 16 October 2008

Understanding how democratic, institutional and market structures operate might have more profound consequences even than giving us tools to plan ahead. There's now a good case for suspecting that democratic systems offer problem-solving opportunities that other political and economic systems do not. In a recent preprint, Henry Farrell and Cosma Shalizi have argued that

democracy has unique benefits as a form of collective problem solving in that it potentially allows people with highly diverse perspectives to come together in order collectively to solve problems. Democracy can do this better than either markets and hierarchies, because it brings these diverse perceptions into direct contact with each other, allowing forms of learning that are unlikely either through the price mechanism of markets or the hierarchical arrangements of bureaucracy.

[<http://cscs.umich.edu/~crshalizi/weblog/917.html>]

In other words, democracy might not only suit a widespread sense of justice and fairness but could also be a mode of social and political organization that optimizes a society's capacity for effective responses to challenges. For example, Scott Page and his coworkers have used complexity-based mathematical models to demonstrate the advantages of diversity in what we might call social computation [Scott E. Page, *Diversity and Complexity* (Princeton University Press, 2011)]. With such things in mind, it becomes ever more imperative to have a deep understanding of what democracies actually are – that is not self-evident, nor uniquely defined – and how they are affected by, for example, free-market economies, political institutions and centralization, advertising and information networks. To put it crudely, are we heading towards more or less democracy? Are we enhancing or compromising our ability to exercise effective collective decision-making?

In short, there has probably never been a better time to make the case for attempting to understand society as a complex system. It's time to start to bring together the various, rather haphazard elements of this enterprise that have already been devised, such as the modeling of traffic, crowds, opinion formation, crime, the economy, conflict and cooperation, into a coherent view of how society and culture arise from collective human behaviour.

Such an effort entails asking questions like these: Which (if any) aspects of the evolution of society can be regarded as inevitable? Which are susceptible to

accurate probabilistic estimation? And which are too dependent on the vicissitudes of human behaviour to be accessible to any degree of prediction?

Making this case is more than a matter of seizing opportunistically on the fact that the world is changing and that our old descriptions of it seem increasingly unfit for purpose – although that is certainly true. For there is also, I think, good reason to think that one of the crucial respects in which it is changing is that events are becoming more susceptible to the strong interconnections that now exist between different individuals, institutions and nations, largely due to innovations in information and communications technology. This makes global society look ever more like the kind of interacting, strongly correlated, highly interdependent system that the science of complex systems has been developed to describe. And it seems to be leading to precisely the kind of behaviour that more familiar complex systems exhibit. I think that the extraordinary events of last year help to illustrate this.

You see, the real shortcoming of Francis Fukuyama's thesis is that it considers history as a process of continuous unfolding: tomorrow's history is more (or less) of the same. The talk among analysts now is of *discontinuous change*, a notion raised by Charles Handy 20 years ago [C. Handy, *The Age of Unreason* (Harvard Business School Press, Boston, 1990)], and recently invoked by Barack Obama in a 2010 speech at the West Point Military Academy last year, when he spoke of 'moments of change'. It's often felt that the primary political discontinuity of contemporary times happened on 9 September 2001 – an exaggeration, perhaps, of what was in retrospect a situation that had been developing for years, but nonetheless a reflection of what most witnesses felt that day.



Discontinuous change

In the shape of wars and economic crises, discontinuities have always been with us. But there is surely now a discontinuity in the very nature of war, a fact that the rhetoric of a 'war on terror' failed catastrophically to acknowledge. It is hard to avoid the suspicion that the 'war on terror' was one for which conventional battlegrounds needed to be found – in Afghanistan and Iraq – only to discover that the battle refused stubbornly to materialize, because that is no longer what armed conflict is about. There is not in any meaningful sense a declaration of war to kick things off, nor a peace treaty to conclude them. Formal armed forces are peripheral; so are formal leaders. We are no longer sure when we are at war, and when at peace. According to the American strategic analyst Anthony Cordesman,

“one of the lessons of modern war is that war can no longer be called war” [In H. Strachan, *Europaem Lecture*, Geneva, 9 November 2006, p. 12].

The most important novelty in both the Arab Spring and the ongoing financial and national-debt crises is precisely what makes them examples of discontinuous change. It is sometimes said – this is literally the defence of traditional economists – that by their very nature no one can be expected to foresee such radical departures from the previous quotidian. They come, like a hijacked aircraft, out of a clear blue sky. 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. Rather, they are abrupt in the same way, and for the same reasons, that phase transitions are abrupt in physics. In complex systems, including social ones, discontinuities don't reflect profound changes in the governing forces but instead derive from the interactions and feedbacks between the component parts.

That, in short, is the take-home message of the events of 2011. Superficially just another 'domino effect', the Arab Spring in fact had more differences than similarities with the collapse of the Soviet Union in 1989. It was selective, for one thing: local conditions mattered – the Saudi monarchy survived, for example. But the most hotly debated characteristic was the role of social networking media [pic]. Some have dubbed the revolts in Tunisia and Egypt 'Twitter revolutions'; others have scorned the idea. The truth is somewhere in between, yet it is abundantly clear that networking supplies the possibility for a random event to become a trigger. The Tunisian revolt was set off by the self-immolation of a street vendor, Mohammed Bouazizi, in Sidi Bouzid in protest at harsh treatment by officials. Three months earlier there was a similar case in the city of Monastir – but no one knew about it because it was not filmed and put on Facebook.

It was surely not without reasons that Twitter and Facebook were shut down by both the Tunisian and Egyptian authorities. The issue is not so much whether they 'caused' the revolutions, but that their existence – and the concomitant potential for mobilizing the young, educated populations of these countries – can alter the way things happen in North Africa, the Middle East, and beyond.

If these tools are now vital to protests like democracy movements and Occupy, they seem also to have the potential to mediate qualitatively new collective behaviours such as the English riots last summer. There still hasn't been a really satisfactory account of how and why these happened. Unlike previous riots, they weren't confined either to particular demographic subsets of the population or to areas of serious social deprivation. They had no obvious agenda, not even a release of suppressed communal fury – although there is surely a link to post-crash austerity policies. There is, however, a strong view that they can't be fully understood without taking into account the effects of social networking on these outbreaks of unrest and revolution [Paul Mason, *Why It's Kicking Off Everywhere* (Verso, 2012)].



London, 2011

Suggestions by some politicians that Twitter should be disabled in such circumstances smack of bewilderment and desperation to be seen to *do* something, however clueless. After all, police monitoring of Twitter in some UK cities provided information that helped suppress rioting. Perhaps the real shortcomings of the political response were revealed in the determined post-riot search for perpetrators, especially alleged ringleaders. I don't for a moment suggest that crimes should go unaddressed, but it seems pertinent here to point to the words of the sociologist Duncan Watts, who has said "If society is ready to embrace a trend, almost anyone can start one – and if it isn't, then almost no one can" [<http://www.fastcompany.com/641124/tipping-point-toast>]. That seems to apply to crime as much as to marketing: you might here simply replace 'trend' with 'riot'. What we really need to understand is what produces that state of social readiness, although ultimately – as I'll come to shortly – it is the actors themselves who are collectively the 'cause'.

What all these events really point towards is the profound impact of globalization in its true sense: the linkages and interconnections that transcend states and societies. Nothing will function any longer that fails to take this into account: not the economy, not policing, not international diplomacy, not democracy.

Simply, this is the world with which we must now work. It is, for example, a world that is data-rich but with much of the important information dispersed, so that it can be brought to light only by a smart process of aggregating and sifting. For example, the impending crises of the Arab Spring were detectable by massive, automated data mining of news media, in the countries that experienced them but not in those such as Saudi Arabia that did not [K. Leetaru, *First Monday* **16**, 9 (2011)]. This is just one example of how 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.

Experience with natural and technological complex systems teaches us that highly connected networks of strong interactions create a propensity for avalanches, catastrophic failures, and systemic ruptures: in short, for discontinuous change [D. Helbing & S. Balietti, *S. Eur. Phys. J. Special Topics* **195**, 3-68 (2011); A.-L. Barabási, *IEEE Control Syst. Mag.* **27**(4), 33-42 (2007); A. Vespignani, *Nature* **464**, 984-985 (2010)]. We can see that, for example, in the way the economies of the entire Eurozone hinge on what happens in Greece. The

co-dependence of national policies means that even an 'old-style catastrophe', as one might regard the earthquake-smitten Fukushima nuclear plant in Japan, has the potential for knock-on effects, in this case altering the direction of nuclear power in Germany, Switzerland and possibly Italy.

Such extreme interdependence makes it hard to find, or even to meaningfully define, the causes of major events. The US subprime mortgage problem caused the financial collapse only in the way Bouazizi's immolation caused the Arab Spring – it could equally have been something else that set events in motion. The real vulnerabilities were systemic, which means that potential solutions must lie there too. It seems likely that rising food prices played a much more fundamental role in creating the tensions in North Africa, but even they were not exactly a 'cause' in the sense that they manifested themselves within a complex web of other dependencies.

This systemic character of the financial crisis was implied in a reply from the British Academy to the Queen's question why it was not foreseen. They said this:

Everyone seemed to be doing their own job properly on its own merit. And according to standard measures of success, they were often doing it well. The failure was to see how collectively this added up to a series of interconnected imbalances... Individual risks may rightly have been viewed as small, but the risk to the system as a whole was vast.

Letter of the British Academy to The Queen, July 22, 2009

In other words, the problem was that the financial system was like a road carrying traffic above its critical threshold density: failure was unavoidable. When it comes, there's no point in blaming the driver who braked too hard: the pathology was in the system. In case you think that sounds like it exonerates our bankers, I think it implies precisely the opposite: they were so ignorant of the system they had created, with all their cocksureness and venality, that not only did they not understand it, but they didn't understand that they didn't understand it.

The potentially catastrophic effects of these interactions and cascading influences between the agents of society may have been on display in particularly dramatic form in the English riots of last year, but they are being increasingly recognized as an element of crime more generally, to take one especially concerning example of social (or antisocial) behaviour. The idea that crime breeds more crime has a long pedigree, but it has been very hard to demonstrate. It assumes that we will be more likely to behave in antisocial or irresponsible ways if we see others doing so, and this effect can be indirect and subtle. We seem to react not just to the actions we see around us but to proxies of them imprinted on the environment.

This is the so-called 'broken windows' hypothesis of sociologists James Q. Wilson and George Kelling, which supposes that people are most likely to commit criminal and antisocial acts when they see evidence that others have already done so – for example, when they are in public places that show signs of decay and neglect. This idea motivated the New York subway system's famous zero-tolerance policy on graffiti in the late 1980s (for which Kelling acted as a consultant), which is credited with improving the safety of the network.

There's now good evidence that the 'broken windows' effect is real: that criminal and antisocial behaviour is affected by what we infer about the behaviour of others from our environment. This is not merely a copying effect: it is well-known that people drop more litter in a setting that is already litter-strewn, but that doesn't imply that they will indulge other antisocial habits in the same place too. However, experiments in the Netherlands have shown that visual evidence of the violation of one norm of 'good behaviour' does encourage people to violate others. For example, cyclists were significantly more inclined to drop on the ground an advertising flyer attached to the handlebars of their parked cycles when these were located in front of a wall on which graffiti defied a prominent notice that prohibited it, than when the wall was clean.



'Broken windows': K.Keizer, S. Lindenberg & L Steg, *Science* **322**, 1681 (2008).

Pedestrians would ignore 'no entry' signs into fenced-off areas when bicycles were left locked to the fence in defiance of signs prohibiting this. And they were twice as likely to steal money from an envelope lodged in a letterbox when the box was defaced with graffiti or when the ground was littered than when it was clean.



These findings show rather dramatically, perhaps even shockingly, that many of us are not either categorically law-abiding and considerate or criminal and selfish, but may display either trait in the face of simple, subconscious cues about behavioural norms. They provide good reason to believe that criminality has a significant dependence on social interaction. Some agent-based models of crime are now starting to incorporate this element, deploying interacting agents on a geographically and demographically realistic picture of the urban environment.

Armed conflict is another problematic social situation that seems to be amenable to agent-based modeling [M. Kress, *Science* **336**, 865 (2012)]. A model called GeoSim, for example, which was developed in the late 1990s, has been used to explore the effects on interstate conflict of such factors as alliance formation and democratization, and could prove particularly useful for looking at civil wars in which provinces rebel against the central state authority [L.-E. Cederman & L. Girardin, paper prepared for the Ann. Mtg of the Am. Polit. Sci. Assoc. (2007)].

Civil wars are a key focus of current research on conflict, not least because they are so widespread. During the past several decades, civil war was being waged on average in 1 out of every 10 countries worldwide, a disproportionate number of them being poor. These conflicts challenge the traditional view of a state as being 'at war' or not, since such conflicts are often localized – in Kashmir or Chechnya, say. As a result, they lend themselves to – indeed, they demand – a picture that considers interactions between several different actors, influenced by complex, local and heterogeneous factors within a state.

The more we understand these issues, the more they fit within the picture of complex social systems. For example, the likelihood of civil violence depends on the specific modes of organization in rebel groups. Large excluded groups have more resources, but may not have much coercive power if, as with the Palestinians, they are fragmented into several competing organizations. Small, cohesive organizations have a disproportionate tendency to fight. This makes it important that models include some representation of spatial and social network structures and communities, rather than just undifferentiated hordes of aggressors.

Let me give you one recent example of this, which I use simply because it is illustrative. One of the big questions about the onset of violence within a region, state or population is whether it is rendered more or less likely by segregation. Anecdotally, either possibility can be defended. There's good evidence that social desegregation improves tolerance and reduces hostility, while segregation can harden prejudice, as seen for example in Northern Ireland or the racially segregated cities of northern England. On the other hand, the genocide in Rwanda in 1994 took place in the context of a highly mixed population of Tutsi and Hutu people, while urban violence between Muslims and Hindus in Ahmedabad in 2002 was greater in mixed rather than segregated neighbourhoods. Ethnic migration – a lessening of mixing – following deadly attacks has been found to reduce violence.

These apparent contradictions can only be understood by considering the spatial element of conflict: where the actors physically reside in space. One such recent model [R. Bhavnani *et al.*, submitted] is based on the classic segregation model of

Thomas Schelling developed in the 1970s [T. C. Schelling, *Micromotives and Macrobehavior* (1972)], but with an added impetus for migration: a wish to escape recent violent conflict in the neighbourhood. Interactions between the agents are represented here by a concept of 'social distance', which depended on several factors: the greater the distance, the greater the tension, and above a certain threshold this tension could erupt into violence. The model was used to simulate the situations in Jerusalem during the violent *Intifada* of 2001-4 and the somewhat more settled period of 2005-9, based on real data about the spatial demography of the Muslim and Jewish populations at these times. It was used to explore the likely consequences of different real-world proposals for distributing the populations: from complete mixing to different modes of segregation defined by the division of city districts into those under Israeli or Palestinian authority. Here the fully mixed scenario produced the most violence. But while it declined in segregated scenarios, there was less violence when segregation was partial (most markedly for the case of a return to 1967 boundaries) than when it was total.

Models like this certainly aren't advanced enough yet to offer strong policy recommendations. But they teach an important lesson: outcomes are not always intuitively obvious, since they involve a complex interplay of effects. There is diversity in the causes of conflicts, but also some regularity and perhaps even predictability. War and other violent conflicts are complex phenomena, but not random ones. It's far from utopian to imagine that they can be understood, at least in part, as a complex social phenomenon which might therefore be amenable to planning, guidance, control and mitigation.

And those are the salient concepts: it seems most unlikely that one can ever suppress conflict by force or fiat; rather, it needs to be guided towards a less incendiary state. Because that, of course, is in the nature of complex systems, which can rarely if ever be controlled by top-down measures, but must instead be managed by guiding the trajectories from the bottom up [D. Helbing (ed.), *Managing Complexity: Insights, Concepts, Applications* (Springer, Berlin, 2008)]. This doesn't imply that political interventions are doomed to fail, but just that they must take other forms from those often advanced today. Interventions must happen at a deep level, and with scope for adaptation and flexibility. Theories, let alone ideologies, are likely to be less effective than scenario modelling. Problems need to be considered at several hierarchical levels, probably with multiple, overlapping models. Much more data is needed, but only if we know how to use it. Cascading crises may be unpredictable, but the vulnerabilities that permit them are not. Thus, planning for the future might not be so much a matter of foreseeing what could go wrong as of making our systems and institutions robust enough to withstand a variety of shocks.

These are the considerations motivating a large European project called FuturICT [www.futurict.eu], which argues that the complex systems view of social sciences has now matured sufficiently for it to be possible, desirable and perhaps essential to attempt to integrate these efforts into a unified scheme for studying, understanding and ultimately planning and predicting the world we have made [P. Ball, *Why Society is a Complex Matter* (Springer, Berlin, 2012)]. Such a scheme would not constitute a single 'model of everything', but rather,

would allow society and its interactions with the physical environment to be explored through a combination of a suite of realistic models and large-scale data collection and analysis. It is a vision that should now be possible by mobilizing and coupling many different research communities, and it is one that might enable us to find new and effective solutions to major global problems that are impending or already with us, such as conflict, disease, financial instability, environmental despoliation and poverty, while avoiding unintended policy consequences. It could give us the foresight to anticipate and ameliorate crises, and at least to begin tackling some of the most intractable problems of the twenty-first century.

FuturICT is currently in a pilot phase, and is one of six such pilots competing for the €1 bn funding offered by the European Commission in its so-called Flagship Initiative, which seeks to support large-scale transformative projects invested in ICT. The decision on which of the Flagship pilots will receive full funding is due to be made at the start of 2013.

Will a project like this do any good? In all honesty, no one knows. This 'complex systems' thinking has a proven capacity to improve the management of systems such as traffic and crowds, but applying it to the economy or war is another matter. It won't be a panacea for all ills – but even small improvements in how global crises are handled could repay many times over the cost of a project like FuturICT. The hardest challenge is likely to be not so much getting the funding but persuading policy makers to abandon ideology in favour of a rational exploration of the likely consequences of their decisions. But given the magnitude of the global problems we face, from disease epidemics to ethnic conflict, international terrorism and crime, and financial meltdown, we would be crazy not to give this approach a chance.